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(54) **CUTTING METHOD, DISASSEMBLY METHOD, REPAIR METHOD, AND OPERATION METHOD**

(57) Object

A cutting method, a disassembly method, a repair method, and an operation method that can suppress an outflow from a structure are provided.

Solving Means

The cutting method includes partitioning a cavity in a structure with a sealing material, and cutting the structure.

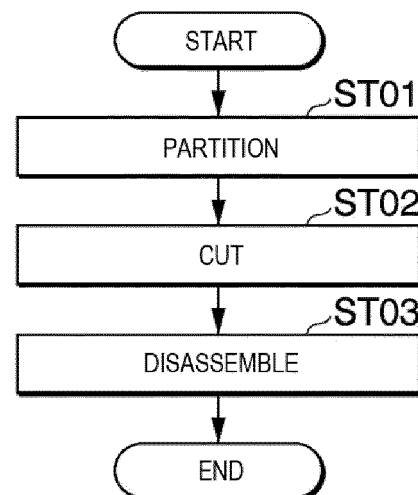


FIG. 1

Description

Brief Description of Drawings

Technical Field

[0011]

[0001] The present disclosure relates to a cutting method, a disassembly method, a repair method, and an operation method.

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FIG. 1 is a flowchart of a cutting method according to a first embodiment of the present disclosure.

FIG. 2 is a side view of a structure to be cut according to the first embodiment of the present disclosure.

FIG. 3 is a side view of the structure after performing a partitioning process according to the first embodiment of the present disclosure.

FIG. 4 is a side view of a structure after performing a partitioning process according to a second embodiment of the present disclosure.

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Background Art

[0002] When handling a structure, in addition to normal operation work, disassembly work may be required in removal of the structure, and repair work may be required in maintenance of the structure.

[0003] For example, Patent Document 1 discloses a cutting method in which a structure is toppled over sideways, and then the structure is cut and disassembled into elements.

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FIG. 5 is a partial cross-sectional view of an extension part after spraying a reinforcing resin foam according to the second embodiment of the present disclosure.

FIG. 6 is a perspective view of a drilling rig after performing a partitioning process according to a third embodiment of the present disclosure.

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Citation List

Patent Literature

[0004] Patent Document 1: JP 2019-210685 A

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FIG. 7 is a side view of a marine vessel after performing a partitioning process according to a fourth embodiment of the present disclosure.

FIG. 8 is a side view of wind power generation equipment after performing a partitioning process according to a fifth embodiment of the present disclosure.

FIG. 9 is a flowchart of an operation method according to a sixth embodiment of the present disclosure.

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Summary of Invention

Technical Problem

[0005] However, in the cutting method disclosed in Patent Document 1, an outflow sometimes flows out from a cavity in a structure at the time of cutting work of the structure.

[0006] An object of the present disclosure is to provide a cutting method, a disassembly method, a repair method, and an operation method that can suppress an outflow from a structure.

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FIG. 10 is a perspective view of a drilling rig after performing a partitioning process according to the sixth embodiment of the present disclosure.

FIG. 11 is a flowchart of a repair method according to a seventh embodiment of the present disclosure.

FIG. 12 is a side view of a marine vessel after performing an occluding process according to the seventh embodiment of the present disclosure.

FIG. 13 is a schematic cross-sectional view of a plunger pump according to an example of the present disclosure.

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Solution to Problem

[0007] In order to solve the above problems, a cutting method according to the present disclosure includes partitioning a cavity in a structure with a sealing material, and cutting the structure.

[0008] A repair method according to the present disclosure includes identifying a crack extending from a cavity in a structure to an outer surface of the structure, and occludes the crack with a sealing material.

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[0009] An operation method according to the present disclosure includes partitioning a cavity in a structure with a sealing material, and operating the structure.

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FIG. 14 is a table showing confirmation results according to examples of the present disclosure.

Description of Embodiments

[0012] Hereinafter, each embodiment of the present disclosure will be described with reference to the drawings. In all the drawings, the same or corresponding components are denoted by the same reference signs, and the common description will be omitted.

First Embodiment

Advantageous Effects of Invention

[0010] According to the method of the present disclosure, an outflow from a structure can be suppressed.

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[0013] A cutting method according to a first embodiment will be described with reference to FIGS. 1 to 3.

Overall Procedure of Cutting Method

[0014] As illustrated in FIG. 1, a worker performs a cutting method including a partitioning process (ST01), a cutting process (ST02), and a disassembling process (ST03) on a structure 1.

Configuration of Structure

[0015] As illustrated in FIG. 2, in the cutting method according to the present embodiment, the structure 1 to be cut stands in an extending manner from a water bottom to above a water surface WS.

[0016] The structure 1 includes an extension part 11 having a cavity 12 therein.

[0017] The cavity 12 contains a residue RS such as oil or grease.

[0018] The cavity 12 extends from underwater to above the water surface WS.

Partitioning Process

[0019] First, the worker performs ST01.

[0020] When performing ST01, the worker partitions the cavity 12 in the structure 1 with a sealing material 13 including resin foam 131.

[0021] As illustrated in FIG. 3, in ST01, the worker fills the cavity 12 with the resin foam 131 in a part above a cutting line CUT so as to plug the cavity 12 with the resin foam 131. At this time, the worker injects the resin foam 131 so that the resin foam 131 is bonded to the entire periphery of an inner wall 14 of the extension part 11. The worker fills an upper part and a lower part of the cavity 12 with the resin foam 131 so as to contain the residue RS with the resin foam 131 and the inner wall 14 of the extension part 11, and seals most of the cavity 12.

[0022] When it is necessary to inject the resin foam 131 in a place difficult to access the cavity 12 from the outside of the structure 1, the worker may fill the cavity 12 with the resin foam 131 by using an opening OP formed in the extension part 11. After the resin foam 131 is injected, the opening OP is sealed by a door, a cover, or the like.

[0023] The resin foam 131 is a foamed resin and contains fine bubbles inside the resin. The foamed resin has flexibility and a smaller specific gravity than that of the material of the resin alone.

[0024] As for the bubbles inside the resin foam 131, closed-cell foam is more suitable for the present use because the permeation rate of the residue RS and water into the resin foam 131 is reduced.

[0025] Examples of the resin foam 131 include foam of a thermoplastic resin and a thermosetting resin, and the thermosetting resin foam that can be constructed and cured at room temperature is more preferable.

[0026] In the case of thermosetting, the worker mixes the base agent and the hardener, and sprays an uncured resin further containing bubbles or a blowing agent to

cure the mixture. When the uncured resin is cured, it becomes spongy.

[0027] The resin foam 131 may be injected not only at two locations but also at three or more locations in order to secure leakage control of the residue RS more, or may be injected at only at one location as long as leakage control of the residue RS is possible.

[0028] The worker confirms in advance, through a test or the like, an appropriate thickness of the resin foam 131 for leakage control of the residue RS and suppressing water intrusion control.

[0029] Examples of the thermosetting resin foam include foam such as a urethane resin, a phenol resin, a urea resin, an epoxy resin, and an acrylic resin, but are not limited to them.

[0030] For example, the rigid urethane foam is obtained by mixing a polyisocyanate having two or more isocyanate groups (NCO) and a polyol having two or more hydroxyl groups (OH) together with a catalyst (amine compound or the like), a blowing agent (water, fluorocarbon, or the like), a foam stabilizer (silicone oil), and the like, spraying the mixture onto a predetermined place, and simultaneously performing a foaming reaction and a resinification reaction. The density of the rigid urethane foam is about 25 to 35 kg/m³, and the rigid urethane foam itself floats on water.

[0031] Since the usable temperature of the rigid urethane foam is about -70 to 100 °C, the rigid urethane foam can be used outdoors almost throughout the year.

[0032] In a case where it is difficult to seal the cavity 12 in a plug-like manner as in FIG. 3 due to the low viscosity and ease of flowing of the resin foam 131 before being cured, the worker may take measures to suppress the flow of the resin foam 131 before being cured, by putting up, at a lower end of the location filled with the resin foam 131, a net having an appropriate stitch size so as to suppress the flow of the resin foam 131 before being cured or a cloth or sheet having an appropriate thickness.

[0033] In a case where there is a possibility that water enters the inside of the structure 1 from a part other than the extension part 11, a connection part between the extension part 11 and a part other than the extension part 11, or the like of the structure 1, after performing ST01 and before performing ST02, the worker may take a measure such as sealing the entry path of seawater by spraying a resin material from the inside or the outside of the structure 1 to the part where water is likely to enter. In the case of spraying the resin material from the outside, the worker may directly spray the resin material to the spray target location by spraying or the like. However, in consideration of work safety and the like, for example, a spray system for discharging a resin foam may be mounted on a drone, and spraying work may be performed using the drone. The resin material to be sprayed is the same material as the resin foam 131.

Cutting Process

[0034] After performing ST01, the worker performs ST02.

[0035] When performing ST02, the worker cuts the structure 1 so as to cross the cavity 12 at the cutting line CUT that is an underwater part of the extension part 11, and causes the cut structure 1 to collapse integrally and lie on the water surface WS.

[0036] Examples of cutting means include laser cutting, an electric-powered saw, a water jet cutter, and fusing. The worker may select the cutting means in accordance with the situations such as the material of the extension part 11, the thickness between the outer surface and the inner surface of the extension part 11, the size of the extension part 11, environmental conditions, construction period, and regulations on construction implementation.

[0037] The worker may remove a part of the structure 1 other than the extension part 11 before cutting.

[0038] If the cured resin foam 131 is bonded to the inner wall 14 of the extension part 11, the resin foam 131 can control leakage of the residue RS, and can suppress water from entering the cavity 12 when the cut structure 1 is laid on the water surface WS. This makes the structure 1 easily float on the water surface WS.

[0039] The worker may install, as necessary, a float on the structure 1 lying on the water surface WS to prevent the structure 1 from sinking in water, or may omit the installation of the float when water entry into the cavity 12 is sufficiently suppressed by filling the cavity 12 with the resin foam 131 and the structure 1 does not sink in water.

[0040] Furthermore, in preparation for the occurrence of leakage of the residue RS by any chance, the worker may surround the periphery of the structure 1 that is cut and floats on the water surface WS with a fence or the like in order to suppress diffusion of the residue RS.

[0041] Furthermore, in preparation for a case where the residue RS leaks, the worker may prepare a dispersant, a gelling agent, an oil adsorbent, and the like.

[0042] At the time of cutting the structure 1, if the structure 1 falls down quickly, the structure 1 itself may be damaged and the residue RS may leak, or a float or a fence installed in advance around the location where the structure 1 falls down may be damaged due to a large impact, water spray, or the like. Therefore, the worker may gradually topple the structure 1 while supporting the structure 1 with a crane or the like.

[0043] In the case of gradually toppling the structure 1, the worker may float a raft as a float at a position where the structure 1 is to be toppled down, and slowly topple down the structure 1 on the raft. At that time, a plurality of rafts may be provided.

Disassembling Process

[0044] After performing ST02, the worker performs

ST03.

[0045] When performing ST03, the worker disassembles the cut structure 1.

[0046] At this time, in a state where the cut structure 1 floats on the water surface WS, the worker is required to tow the structure 1 to a place where the structure 1 can be disassembled, disassemble the structure 1 into small parts, and dispose of the structure 1.

Actions and Effects

[0047] According to the cutting method of the present embodiment, the residue RS remaining in the structure 1 hardly flows out of the structure 1.

[0048] Therefore, an outflow from the structure 1 to the water surface WS at the time of cutting is suppressed.

[0049] According to the cutting method of the present embodiment, the residue RS in the extension part 11 is suppressed from flowing out to the water surface WS or the residue RS is suppressed from flowing out through the extension part 11 to the water surface WS.

[0050] According to the cutting method of the present embodiment, even when the structure 1 falls onto the water surface WS, the residue RS remaining in the partitioned cavity 12 hardly flows out to the water surface WS.

[0051] Therefore, the residue RS is suppressed from flowing out to the water surface WS.

[0052] According to the cutting method of the present embodiment, construction of the resin foam 131 allows the worker to occlude even a narrow gap.

[0053] Therefore, the worker can easily partition the cavities 12 having various sizes and various shapes.

[0054] According to the cutting method of the present embodiment, since the resin material is sprayed from the outside of the structure 1 before cutting, the residue RS is suppressed from leaking to the water surface WS from a part difficult to be suppressed by the sealing material 13.

Second Embodiment

[0055] A cutting method according to a second embodiment will be described with reference to FIGS. 4 and 5.

[0056] The cutting method of the present embodiment is similar to the cutting method of the first embodiment except for the points described below.

Procedure of Cutting Method

[0057] In the present embodiment, when performing ST01, the worker partitions the cavity 12 in the structure 1 with the sealing material 13 including a balloon 132.

[0058] As illustrated in FIG. 4, in ST01, the worker inflates and installs the balloon 132 in the cavity 12 at a part above the cutting line CUT so as to plug the cavity 12 with the balloon 132. At this time, the worker installs the balloon 132 so that the balloon 132 is in contact with

the inner wall 14 over the entire periphery of the extension part 11. The worker installs the balloon 132 at the upper part and the lower part of the cavity 12 so as to contain the residue RS with the balloon 132 and the inner wall 14 of the extension part 11, and seals most of the cavity 12.

[0059] When it is necessary to install the balloon 132 in a place difficult to access the cavity 12 from outside of the structure 1, the worker may install the balloon 132 in the cavity 12 or inflate the balloon 132 by using the opening OP formed in the extension part 11. After the balloon 132 is installed or inflated, the opening OP is sealed by a door, a cover, or the like.

[0060] The balloon 132 is only required to have a shape in which the balloon 132 is in close contact with the inner wall 14 when inflated, and leakage of the residue RS can be suppressed and intrusion of water can be suppressed. For example, bulging shapes include a columnar shape, a spherical shape, and a truncated cone shape, but is not limited to them.

[0061] The size of the balloon 132 is preferably larger to some extent than an inside diameter of the extension part 11 so as to be in close contact with the inner wall 14 when inflated and to be fixed to the inner wall 14 by the inflating force of the balloon 132.

[0062] The balloon 132 is made of, but not limited to, a rubber sheet or a rubber-coated fabric. The worker may stack a plurality of rubber sheets or rubber-coated fabrics. For the purpose of suppressing the gas, the residue RS, or water from passing through the layer of the balloon 132, the worker may insert a thin film made of a material that prevents the gas, the residue RS, or water from passing through between the layers of the balloon 132.

[0063] Examples of the rubber include chloroprene rubber and urethane used in balloons, such as chloro-sulfonated polyethylene rubber applied to rescue boats and the like, but are not limited to them.

[0064] Examples of the fibers contained in the rubber-coated fabric include polyester fibers, aramid fibers, and polyethylene fibers, but are not limited to them.

[0065] When the inflated balloon 132 is brought into close contact with the inner wall 14, the balloon 132 can control leakage of the residue RS and can suppress water from entering the cavity 12 when the cut structure 1 is laid on the water surface WS. This makes the structure 1 easily float on the water surface WS.

[0066] As a reinforcing resin foam 133, the worker may spray the reinforcing resin foam 133 before being cured onto the close contact part between the balloon 132 and the inner wall 14 as illustrated in FIG. 5, and, by curing the foam, improve the sealing property of oil and seawater. The reinforcing resin foam 133 is made of the same material as that of the resin foam 131.

[0067] The balloon 132 may be provided not only at two locations but also at three or more locations in order to secure leakage control of the residue RS more, or may be provided at only at one location as long as leakage control of the residue RS is possible.

[0068] An appropriate size of the balloon 132 for leakage control of the residue RS and suppressing water intrusion control is confirmed in advance through a test or the like.

[0069] In order for the position where the balloon 132 is installed not to be displaced, the worker may suppress displacement of the balloon 132 by putting up a net at the lower end of the position where the balloon 132 is installed, in other words, at the upper end and the lower end, or may fix the balloon 132 at an appropriate position by providing a jig for lashing the balloon 132 to the inner wall 14 between the outer surface of the balloon 132 and the inner wall 14 and lashing the balloon 132.

[0070] At the time of installing the balloon 132, inside the structure 1 or the like may be installed with a system for replenishing gas (air) to the balloon 132 according to the decrease in the internal pressure in a case where the internal pressure of the balloon 132 decreases after installation of the balloon 132 and before towing ends and the structure 1 is pulled up to the land.

[0071] After being carried into the disassembly place, the worker may collapse and remove the balloon 132 before disassembly of the structure 1, and when the balloon 132 is not damaged, the worker may repeatedly use the balloon 132. This also makes it possible to reduce the amount of industrial waste discharged associated with cutting of the structure 1.

[0072] After performing ST01, the worker performs ST02 similar to that of the first embodiment.

Actions and Effects

[0073] The cutting method of the present embodiment has the same effects as those of the first embodiment.

[0074] In addition, according to the cutting method of the present embodiment, the worker can easily occlude the gap over the entire balloon 132 by inflating the balloon 132.

[0075] Therefore, the worker can easily partition the large cavity 12.

[0076] According to the cutting method of the present embodiment, the worker can collect the balloon 132 by collapsing the balloon 132 before disassembly of the structure 1.

[0077] Therefore, the worker can reuse the balloon 132.

[0078] According to the cutting method of the present embodiment, since the reinforcing resin foam 133 is sprayed and solidified between the balloon 132 and the inner wall 14 of the structure 1, leakage of the residue RS between the balloon 132 and the inner wall 14 is suppressed.

Third Embodiment

[0079] A cutting method according to a third embodiment will be described with reference to FIG. 6.

[0080] The cutting method of the present embodiment

is similar to the cutting method of the first or second embodiment except for the points described below.

Procedure of Cutting Method and Configuration of Structure

[0081] As illustrated in FIG. 6, in the cutting method according to the present embodiment, the structure 1 to be cut is a drilling rig 101 provided on water.

[0082] Similarly to the first or second embodiment, the worker performs a cutting method including the partitioning process (ST01), the cutting process (ST02), and the disassembling process (ST03) on the drilling rig 101.

[0083] The drilling rig 101 is provided on the ocean.

[0084] The drilling rig 101 includes a column part 111.

[0085] The column part 111 has the cavity 12 therein and extends from the water bottom to above the water surface WS.

[0086] The cavity 12 contains a residue RS such as oil or grease.

[0087] The cavity 12 extends from underwater to above the water surface WS.

[0088] The worker partitions the cavity 12 in the column part 111 with the sealing material 13 when performing ST01, cuts the drilling rig 101 across the cavity 12 in the underwater part of the column part 111 when performing ST02, and disassembles, when performing ST03, the cut drilling rig 101 into small parts at a location where the structure 1 can be disassembled.

[0089] As the sealing material 13 for partitioning the cavity 12, the worker can use the resin foam 131 used in the first embodiment or the balloon 132 used in the second embodiment.

Actions and Effects

[0090] The cutting method of the present embodiment has the same effects as those of the first embodiment.

Fourth Embodiment

[0091] A cutting method according to a fourth embodiment will be described with reference to FIG. 7.

[0092] The cutting method of the present embodiment is similar to the cutting method of the first or second embodiment except for the points described below.

Procedure of Cutting Method and Configuration of Structure

[0093] As illustrated in FIG. 7, in the cutting method according to the present embodiment, the structure 1 to be cut is a marine vessel 201.

[0094] Similarly to the first or second embodiment, the worker performs a cutting method including the partitioning process (ST01), the cutting process (ST02), and the disassembling process (ST03) on the marine vessel 201.

[0095] The marine vessel 201 includes a shipping

space 211 having the cavity 12 therein.

[0096] The cavity 12 contains a residue RS such as oil or grease.

[0097] The worker partitions the cavity 12 in the shipping space 211 with the sealing material 13 when performing ST01, cuts the marine vessel 201, when performing ST02, in a part including the cavity 12 into a size that makes it easy to perform of ST03, and disassembles, when performing ST03, the cut marine vessel 201 into small parts at a location where the marine vessel 201 can be disassembled.

[0098] As the sealing material 13 for partitioning the cavity 12, the worker can use the resin foam 131 used in the first embodiment or the balloon 132 used in the second embodiment.

Actions and Effects

[0099] The cutting method of the present embodiment has the same effects as those of the first embodiment.

Fifth Embodiment

[0100] A cutting method according to a fifth embodiment will be described with reference to FIG. 8.

[0101] The cutting method of the present embodiment is similar to the cutting method of the first or second embodiment except for the points described below.

Procedure of Cutting Method and Configuration of Structure

[0102] As illustrated in FIG. 8, in the cutting method according to the present embodiment, the structure 1 to be cut is wind power generation equipment 301 provided on water.

[0103] Similarly to the first or second embodiment, the worker performs a cutting method including the partitioning process (ST01), the cutting process (ST02), and the disassembling process (ST03) on the wind power generation equipment 301.

[0104] The wind power generation equipment 301 is provided on the ocean.

[0105] The wind power generation equipment 301 includes a tower 311.

[0106] In the present embodiment, the tower 311 is a tower-type structure provided on the ocean and is a large composite material structure.

[0107] The tower 311 has the cavity 12 therein and extends from the water bottom to above the water surface WS.

[0108] The cavity 12 contains a residue RS such as oil or grease.

[0109] The cavity 12 extends from underwater to above the water surface WS.

[0110] The worker partitions the cavity 12 in the tower 311 with the sealing material 13 when performing ST01, cuts the wind power generation equipment 301 across

the cavity 12 in the underwater part of the tower 311 when performing ST02, and disassembles, when performing ST03, the cut wind power generation equipment 301 into small parts in a place where the cut wind power generation equipment 301 can be disassembled.

[0111] As the sealing material 13 for partitioning the cavity 12, the worker can use the resin foam 131 used in the first embodiment or the balloon 132 used in the second embodiment.

[0112] When performing ST01, in order to suppress the residue RS remaining inside a nacelle 312 or near the nacelle 312 from flowing out, the worker may partition the cavity 12 with the sealing material 13 immediately below the nacelle 312.

[0113] If there is a possibility that water enters the inside of the structure 1 from a part of the nacelle 312, a connection part between the nacelle 312 and the tower 311, or the like of the wind power generation equipment 301, after performing ST01 and before performing ST02, the worker may take a measure such as sealing the entry path of seawater by spraying a resin material from the inside or the outside of the wind power generation equipment 301 to the part where water is likely to enter.

[0114] The worker may remove a propeller 313 of the wind power generation equipment 301 before performing ST02.

Actions and Effects

[0115] The cutting method of the present embodiment has the same effects as those of the first embodiment.

[0116] In addition, according to the cutting method of the present embodiment, the residue RS inside the nacelle 312 or near the nacelle 312 is suppressed from leaking to the water surface WS.

Sixth Embodiment

[0117] An operation method according to a sixth embodiment will be described with reference to FIGS. 9 and 10.

[0118] The partitioning process performed in the operation method of the present embodiment is the same as the partitioning process performed in the cutting method of the first or second embodiment except for the points described below.

[0119] The drilling rig 101 used in the operation method of the present embodiment is similar to the drilling rig 101 used in the cutting method of the third embodiment except for the points described below.

Procedure of Operation Method

[0120] As illustrated in FIG. 9, the worker performs an operation method including a partitioning process (ST101) and an operating process (ST102) on the structure 1.

[0121] As illustrated in FIG. 10, in the operation method

of the embodiment, the structure 1 to be operated is the drilling rig 101.

Partitioning Process

[0122] First, the worker performs ST101.

[0123] When performing ST101, in order to suppress a leakage LK in the drilling rig 101 from flowing out to the water surface WS through the column part 111, the worker partitions the cavity 12 in the column part 111 with the sealing material 13.

[0124] As the sealing material 13 for partitioning the cavity 12, the worker can use the resin foam 131 used in the first embodiment or the balloon 132 used in the second embodiment.

Operating Process

[0125] After performing ST101, the worker performs ST102.

[0126] When performing ST102, the worker operates the drilling rig 101 to win oil or gas from underground below the water surface WS.

Actions and Effects

[0127] According to the operation method of the present embodiment, it is possible to suppress the leakage LK in the structure 1 including won oil from flowing out to the water surface WS.

[0128] Therefore, an outflow from the structure 1 is suppressed.

Seventh Embodiment

[0129] A repair method according to a seventh embodiment will be described with reference to FIGS. 11 and 12.

[0130] The marine vessel 201 used in the repair method of the present embodiment is the same as the marine vessel 201 used in the cutting method of the fourth embodiment except for the points described below.

Procedure of Repair Method

[0131] As illustrated in FIG. 11, the worker performs a repair method including an identifying process (ST201) and an occluding process (ST202) on the structure 1.

[0132] As illustrated in FIG. 12, in the repair method of the present embodiment, the structure 1 to be repaired is the marine vessel 201.

Identifying Process

[0133] First, the worker performs ST201.

[0134] When performing ST201, the worker identifies a crack CK extending from the cavity 12 in the shipping space 211 of the marine vessel 201 to an outer surface 215 of the shipping space 211.

Occluding Process

[0135] After performing ST201, the worker performs ST202.

[0136] When performing ST202, the worker occludes the identified crack CK with the sealing material 13 in order to suppress the leakage LK in the cavity 12 in the shipping space 211 of the marine vessel 201 from flowing out from the crack CK to the outer surface 215 of the shipping space 211.

[0137] As the sealing material 13 for occluding the crack CK, the worker can use the resin foam 131 used in the first embodiment or the balloon 132 used in the second embodiment.

Actions and Effects

[0138] According to the repair method of the present embodiment, it is possible to suppress the leakage LK in the structure 1 from flowing out of the structure 1 from the crack CK.

[0139] Therefore, an outflow from the structure 1 is suppressed.

Modification Examples

[0140] The method of each embodiment is not limited to the structure described above, and may be applied to any structure as long as there is a possibility of an outflow.

[0141] The structure 1 applied to the method of each embodiment may be a structure provided anywhere as long as there is a possibility of an outflow.

[0142] As a modification example, the structure 1 may be a structure provided on a lake of brackish water or fresh water.

[0143] As another modification example, the structure 1 may be a structure provided on the ground.

[0144] In the partitioning process of each of the first to sixth embodiments, the worker partitions the cavity 12 with the resin foam 131 or the balloon 132, but may use any sealing material 13 as long as the cavity 12 can be partitioned.

[0145] As a modification example, the worker may partition the cavity 12 with a metal lid as the sealing material 13.

[0146] In the occluding process of the seventh embodiment, the worker occludes the crack CK with the resin foam 131 or the balloon 132, but may use any sealing material 13 as long as the crack CK can be occluded.

[0147] As a modification example, the worker may occlude the crack CK with a metal cover as the sealing material 13.

[0148] In the fifth embodiment, the worker partitions the cavity 12 in the tower 311 of the wind power generation equipment 301 with the sealing material 13, but may partition any cavity as long as it is a cavity in the wind power generation equipment 301.

[0149] As a modification example, the worker may par-

tion a cavity in a foundation (monopile or tripile), a cavity in a blade, a cavity in a nacelle, and the like in the wind power generation equipment 301.

[0150] In the cutting method of each of the first to fifth embodiments, the worker sprays the resin material from the outside of the structure 1, but any process may be performed as long as the residue RS can be suppressed from flowing out.

[0151] As a modification example, the worker may suppress outflow of the residue RS by covering the structure 1 with a sheet using a drone from the outside of the structure 1 and completely wrapping the structure 1.

[0152] As another modification example, in the fifth embodiment, the worker may suppress outflow of the residue RS by covering the nacelle 312 with a sheet using a drone from the outside of the nacelle 312 and completely wrapping the nacelle 312.

[0153] The cutting method of each of the first to fifth embodiments may be applied to any method as long as a structure is cut.

[0154] For example, the cutting method of each of the first to fifth embodiments may be performed as a disassembly method for a structure to be disassembled.

[0155] Although embodiments of the present disclosure have been described above, these embodiments have been presented as examples and are not intended to limit the scope of the disclosure. These embodiments can be implemented in various other forms, and various omissions, substitutions, and changes can be made without departing from the gist of the disclosure. These embodiments and their modification examples are included in the scope and gist of the disclosure.

Examples

[0156] Hereinafter, the present disclosure will be described more specifically with reference to examples, but the present disclosure is not limited to the following examples.

[0157] Examples of the sealing material will be described with reference to FIGS. 13 and 14.

Example for Confirming Effects of Resin Foam

1. Oil Leakage Prevention Performance Confirmation

[0158] As Examples 1 to 4, the worker confirmed oil leakage prevention performance of the resin foam 131.

[0159] Using a pipe made of the same material as that of the inner wall of the tower 311, which is the large composite material structure of the fifth embodiment, the worker discharged a two-liquid rigid urethane foam with a plunger pump 90 while mixing a liquid A (base agent) and a liquid B (hardener), injected uncured resin foam 131 into one end of the pipe, and cured to seal one end of the pipe.

[0160] The plunger pump 90 is outlined in FIG. 13, but the resin foam filling pump is not limited to this.

[0161] The resin foam 131 in the pipe axial direction came in four thicknesses of 0.3 times, 0.5 times, 0.75 times, and 1.0 time the pipe inside diameter.

[0162] The other end of the pipe was configured to be closed with a lid.

[0163] After curing the resin foam 131, the worker injected, into the pipe, the same type of oil as the oil remaining in the nacelle 312 part of the fifth embodiment.

[0164] Although no pressure was applied to the oil at the time of disassembly of the actual machine, for evaluation on the safety side in this test, the worker closed the valve in a state of applying about 0.5 atm, and held it at room temperature for 14 days in this state.

[0165] After the end of the holding period, the worker visually confirmed whether or not there was oil leakage from the part sealed with the resin foam 131, and confirmed whether or not the pressure of the oil was significantly reduced.

[0166] The confirmation result is presented in FIG. 14.

2. Seawater Intrusion Prevention Performance Confirmation

[0167] As Examples 5 to 8, similarly to "1. Oil Leakage Prevention Performance Confirmation" described above, the worker sealed one end of the pipe with the resin foam 131, covered the other end with a lid, and injected water into the pipe. In the present leakage confirmation test, the worker used tap water instead of seawater. Also thereafter, the worker performed the same work as in "1. Oil Leakage Prevention Performance Confirmation" described above.

[0168] Assuming an inside diameter of the cut part of the tower 311 of about 3 m, and assuming that about 1.5 m, which is about 1/2 of the inside diameter, sinks into seawater, a hydrostatic pressure (about 0.015 MPa) corresponding to 1.5 m at the maximum was loaded on the resin foam 131. However, for evaluation on the safety side, the worker held the water pressure at 0.05 MPa at room temperature for 14 days.

[0169] After the end of the holding period, the worker visually confirmed whether or not there was water leakage from the part sealed with the resin foam 131, and confirmed whether or not the pressure of the water was significantly reduced.

[0170] The confirmation results are presented in FIG. 14.

Example for Confirming Effects of Balloon

1. Oil Leakage Prevention Performance Confirmation

[0171] As Examples 9 to 13, using a pipe made of the same material as that of the inner wall of the tower 311, which is the large composite material structure of the fifth embodiment, the worker installed the balloon 132 having a cylindrical shape when inflated at one end of the pipe in a state of not inflating the balloon, inflated the balloon

132 by injecting air, and fixed the balloon 132 to the pipe end. The outside diameter of the balloon 132 in the inflated state was 1.2 times the inside diameter of the pipe, and the balloon 132 in the pipe axial direction came in three lengths of 0.5 times, 0.75 times, and 1.0 time the inside diameter of the pipe. The air pressure of the balloon 132 was 0.05 MPa.

[0172] After inflating the balloon 132, the worker prepared a test body with improved close contact property by spraying rigid urethane resin foam as the reinforcing resin foam 133 to the contact part between the inner surface of the pipe and the balloon 132. The side on which the reinforcing resin foam 133 is sprayed was a side that can be accessed after the balloon 132 is inflated, and the thickness of the foam sprayed onto the contact part between the inner surface of the pipe and the balloon 132 was 1/20 to 1/10 of the pipe inside diameter (the inside diameter of the tower 311 in the actual machine) at the thickest part as a guide.

[0173] The other end part of the pipe can be closed with a lid.

[0174] After the end of installation of the balloon 132, the worker injected the same type of oil as the oil remaining in the nacelle 312 part in the pipe.

[0175] Although no pressure was applied to the oil at the time of disassembly of the actual machine, for evaluation on the safety side in this test, the worker closed the valve in a state of applying a pressure of about 0.5 atm (0.05 MPa), and held it at room temperature for 14 days in this state.

[0176] After the end of the holding period, the worker visually confirmed whether or not there was oil leakage from the part sealed with the balloon 132, and confirmed whether or not the pressure of the oil was significantly reduced.

[0177] The confirmation results are presented in FIG. 14.

2. Seawater Intrusion Prevention Performance Confirmation

[0178] As Examples 14 to 18, similarly to the "1. Oil Leakage Prevention Performance Confirmation" described above, the worker sealed one end of the pipe with the balloon 132, covered the other end with a lid, and injected water into the pipe.

[0179] After inflating the balloon 132, the worker prepared a test body with improved close contact property by spraying rigid urethane resin foam as the reinforcing resin foam 133 to the contact part between the inner surface of the pipe and the balloon 132.

[0180] Assuming an inside diameter of the cut part of the tower 311 of about 3 m, and assuming that about 1.5 m, which is about 1/2 of the inside diameter, sinks into seawater, a hydrostatic pressure (about 0.015 MPa) corresponding to a water depth of 1.5 m at the maximum was loaded on the balloon 132. However, for evaluation on the safety side, the worker held the water pressure at

0.05 MPa at room temperature for 14 days.

[0181] After the end of the holding period, the worker visually confirmed whether or not there was water leakage from the part sealed with the balloon 132, and confirmed whether or not the pressure of the water was significantly reduced.

[0182] The confirmation results are presented in FIG. 14.

Notes

[0183] The methods described in the above embodiments are understood as follows, for example.

(1) The cutting method according to a first aspect includes partitioning the cavity 12 in the structure 1 with the sealing material 13, and cutting the structure 1.

[0184] According to the present aspect, the residue RS remaining in the structure 1 hardly flows out of the structure 1.

[0185] Therefore, an outflow from the structure 1 at the time of cutting is suppressed.

[0186] (2) The cutting method according to a second aspect is the cutting method of (1), in which the structure 1 includes the extension part 11 including the cavity 12.

[0187] According to the present aspect, the residue RS in the extension part 11 is suppressed from flowing out or the residue RS is suppressed from flowing out through the extension part 11.

[0188] (3) The cutting method according to a third aspect is the cutting method of (1) or (2), in which the structure 1 extends from the underwater to above the water surface WS.

[0189] According to the present aspect, even when the structure 1 falls onto the water surface WS, the residue RS remaining in the partitioned cavity 12 hardly flows out to the water surface WS.

[0190] Therefore, the residue RS is suppressed from flowing out to the water surface WS.

[0191] (4) The cutting method according to a fourth aspect is the cutting method of any of (1) to (3), in which the sealing material 13 includes the resin foam 131.

[0192] According to the present aspect, construction of the resin foam 131 allows the worker to occlude even a narrow gap.

[0193] Therefore, the worker can easily partition the cavities 12 having various sizes and various shapes.

[0194] (5) The cutting method according to a fifth aspect is the cutting method of any of (1) to (4), in which the sealing material 13 includes the balloon 132.

[0195] According to the present aspect, the worker can easily occlude the gap over the entire balloon 132 by inflating the balloon 132.

[0196] Therefore, the worker can easily partition the large cavity 12.

[0197] According to the present aspect, the worker can

collect the balloon 132 by collapsing the balloon 132 before disassembly of the structure 1.

[0198] Therefore, the worker can reuse balloon 132.

[0199] (6) The cutting method according to a sixth aspect is the cutting method of (5), in which before the cutting, the reinforcing resin foam 133 is sprayed and solidified between the balloon 132 and the inner wall 14 of the structure 1.

[0200] According to the present aspect, leakage of the residue RS between the balloon 132 and the inner wall 14 is suppressed.

[0201] (7) The cutting method according to a seventh aspect is the cutting method of any of (1) to (6), in which before the cutting, a resin material is sprayed from the outside of the structure 1.

[0202] According to the present aspect, the residue RS is suppressed from leaking from a part difficult to be suppressed by the sealing material 13.

[0203] (8) The disassembly method according to an eighth aspect is a disassembly method of a structure including the cutting method of any of (1) to (7).

[0204] According to the present aspect, the residue RS remaining in the structure 1 hardly flows out of the structure 1.

[0205] Therefore, an outflow from the structure 1 at the time of cutting is suppressed.

[0206] (9) The repair method according to a ninth aspect includes identifying the crack CK extending from the cavity 12 in the structure 1 to the outer surface 215 of the structure 1, and occludes the crack CK with the sealing material 13.

[0207] According to the present aspect, it is possible to suppress the leakage LK in the structure 1 from flowing out of the structure 1 from the crack CK.

[0208] Therefore, an outflow from the structure 1 is suppressed.

[0209] (10) The operation method according to a tenth aspect includes partitioning the cavity 12 in the structure 1 with the sealing material 13, and operating the structure 1.

[0210] According to the present aspect, a leakage in the structure 1 can be suppressed from flowing out.

[0211] Therefore, an outflow from the structure 1 is suppressed.

Reference Signs List

[0212]

- 1 Structure
- 11 Extension part
- 12 Cavity
- 13 Sealing material
- 14 Inner wall
- 90 Plunger pump
- 101 Drilling rig
- 111 Column part
- 131 Resin foam

132 Balloon
 133 Reinforcing resin foam
 201 Marine vessel
 211 Shipping space
 215 Outer surface
 311 Tower
 312 Nacelle
 313 Propeller
 CK Crack
 CUT Cutting line
 LK Leakage
 OP Opening
 RS Residue
 WS Water surface

10. An operation method, comprising:
 partitioning a cavity in a structure with a sealing material; and
 operating the structure.
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Claims

1. A cutting method, comprising:
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 partitioning a cavity in a structure with a sealing material; and
 cutting the structure.
2. The cutting method according to claim 1, wherein the structure includes an extension part including the cavity. 25
3. The cutting method according to claim 1 or 2, wherein the structure extends from underwater to above a water surface. 30
4. The cutting method according to any one of claims 1 to 3, wherein the sealing material includes a resin foam. 35
5. The cutting method according to any one of claims 1 to 4, wherein the sealing material includes a balloon. 40
6. The cutting method according to claim 5, wherein, before the cutting, a reinforcing resin foam is sprayed and solidified between the balloon and an inner wall of the structure. 45
7. The cutting method according to any one of claims 1 to 6, wherein, before the cutting, a resin material is sprayed from an outside of the structure.
8. A disassembly method of a structure, comprising the cutting method according to any one of claims 1 to 7. 50
9. A repair method, comprising:
 identifying a crack extending from a cavity in a structure to an outer surface of the structure; and
 occluding the crack with a sealing material. 55

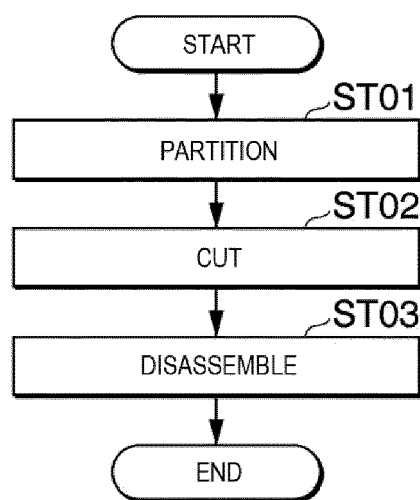


FIG. 1

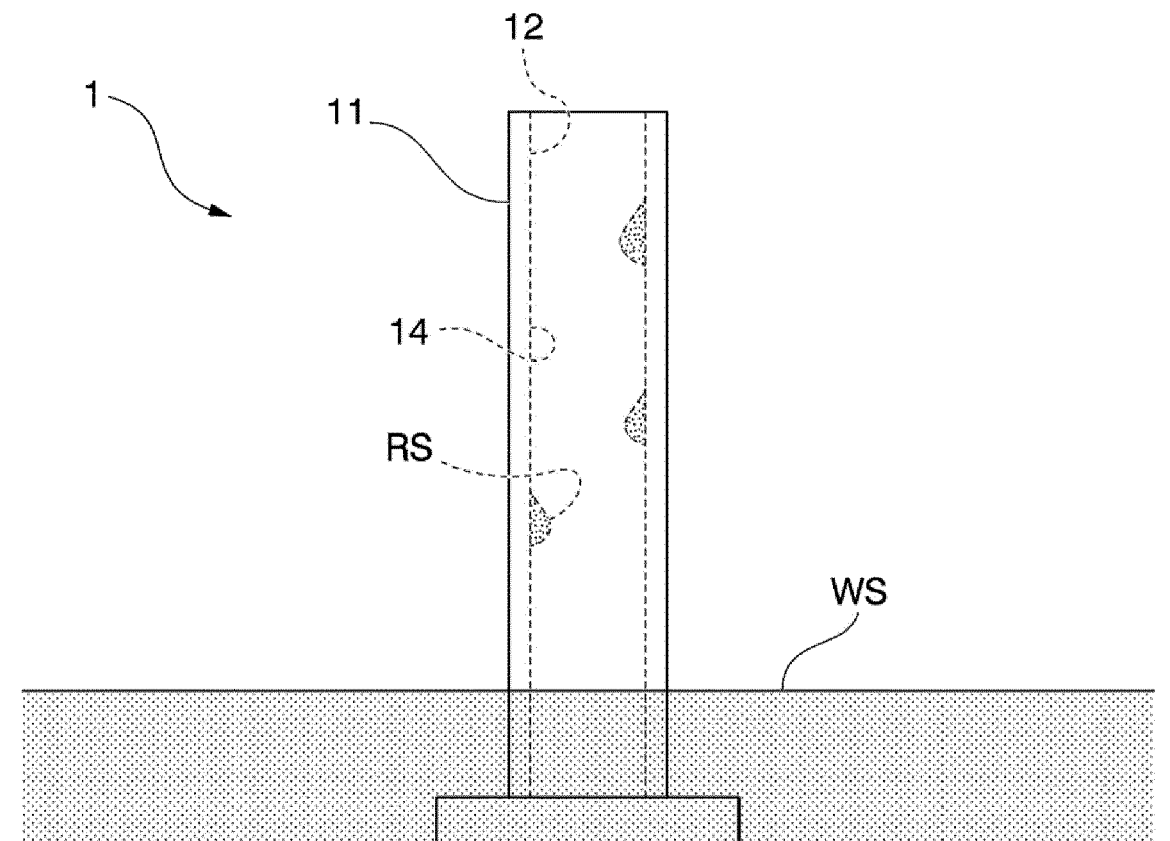


FIG. 2

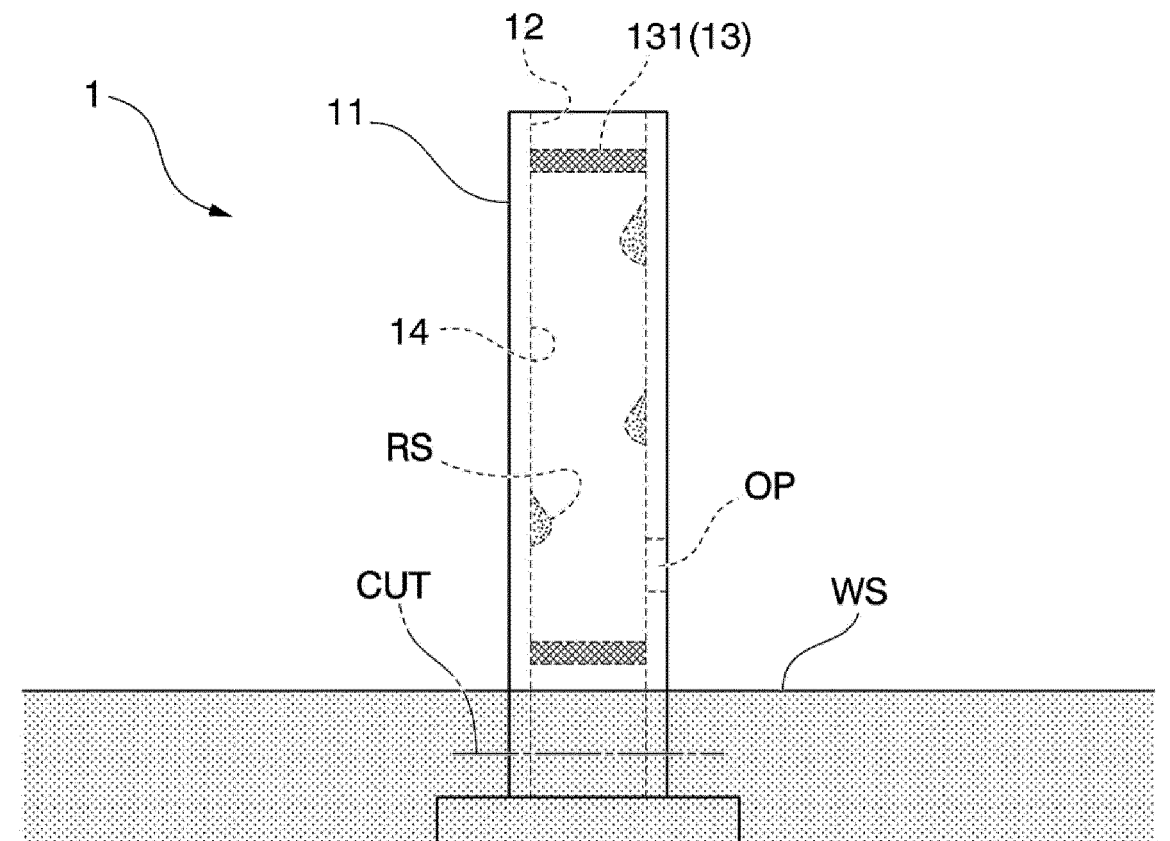


FIG. 3

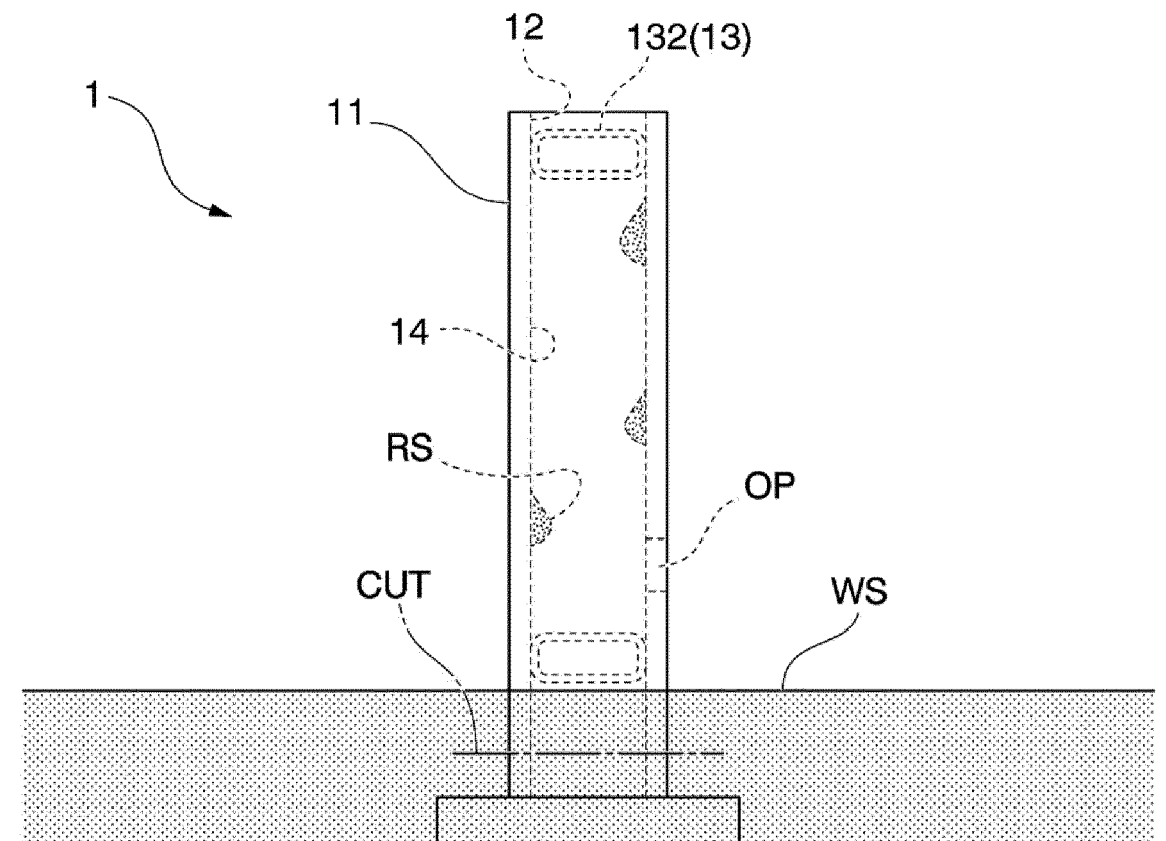


FIG. 4

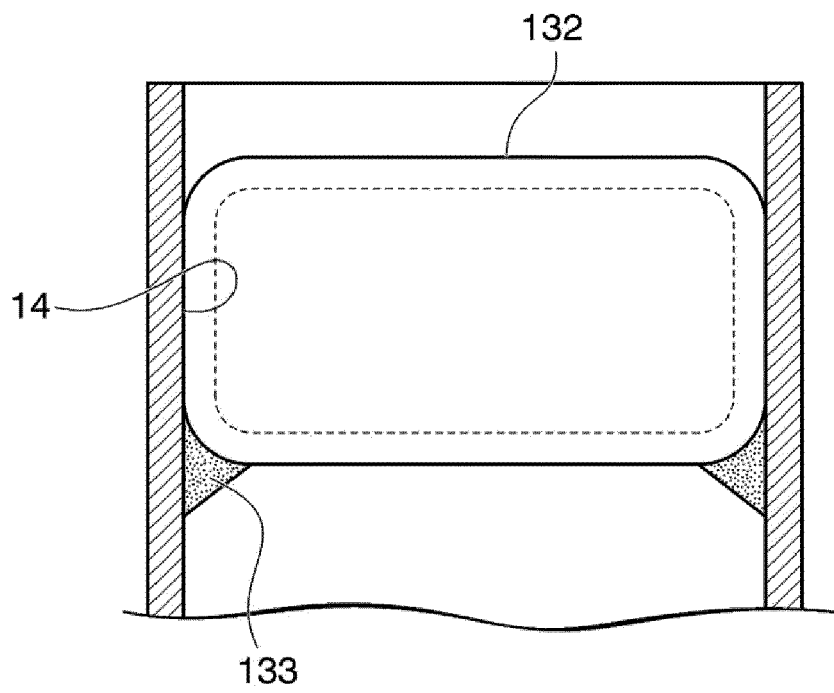


FIG. 5

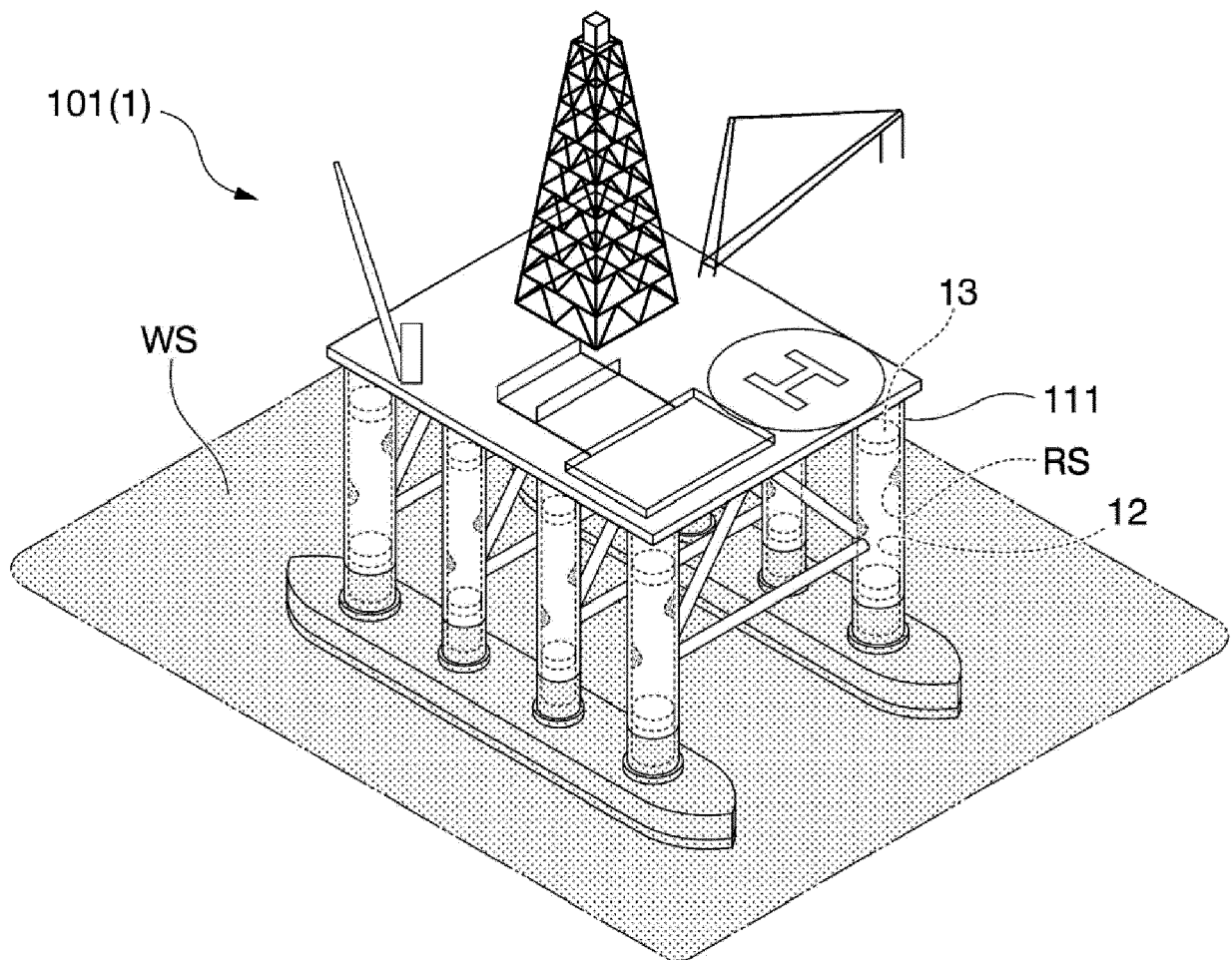


FIG. 6

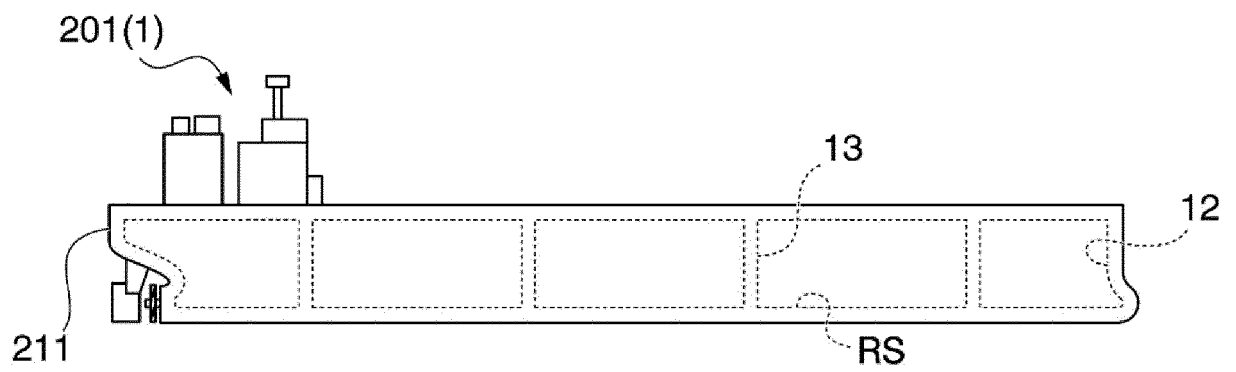


FIG. 7

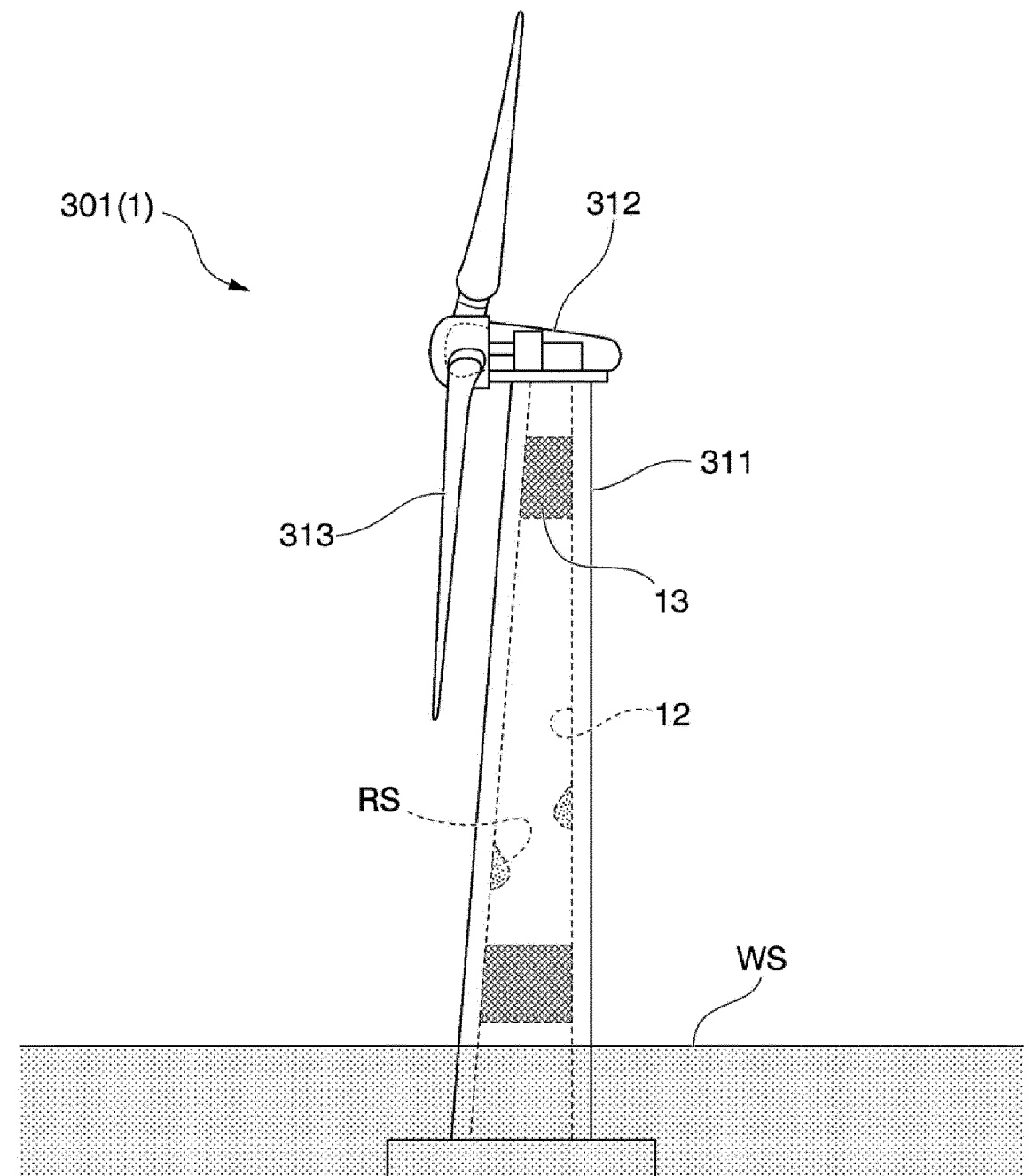


FIG. 8

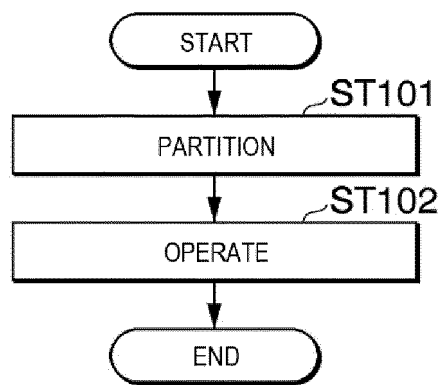


FIG. 9

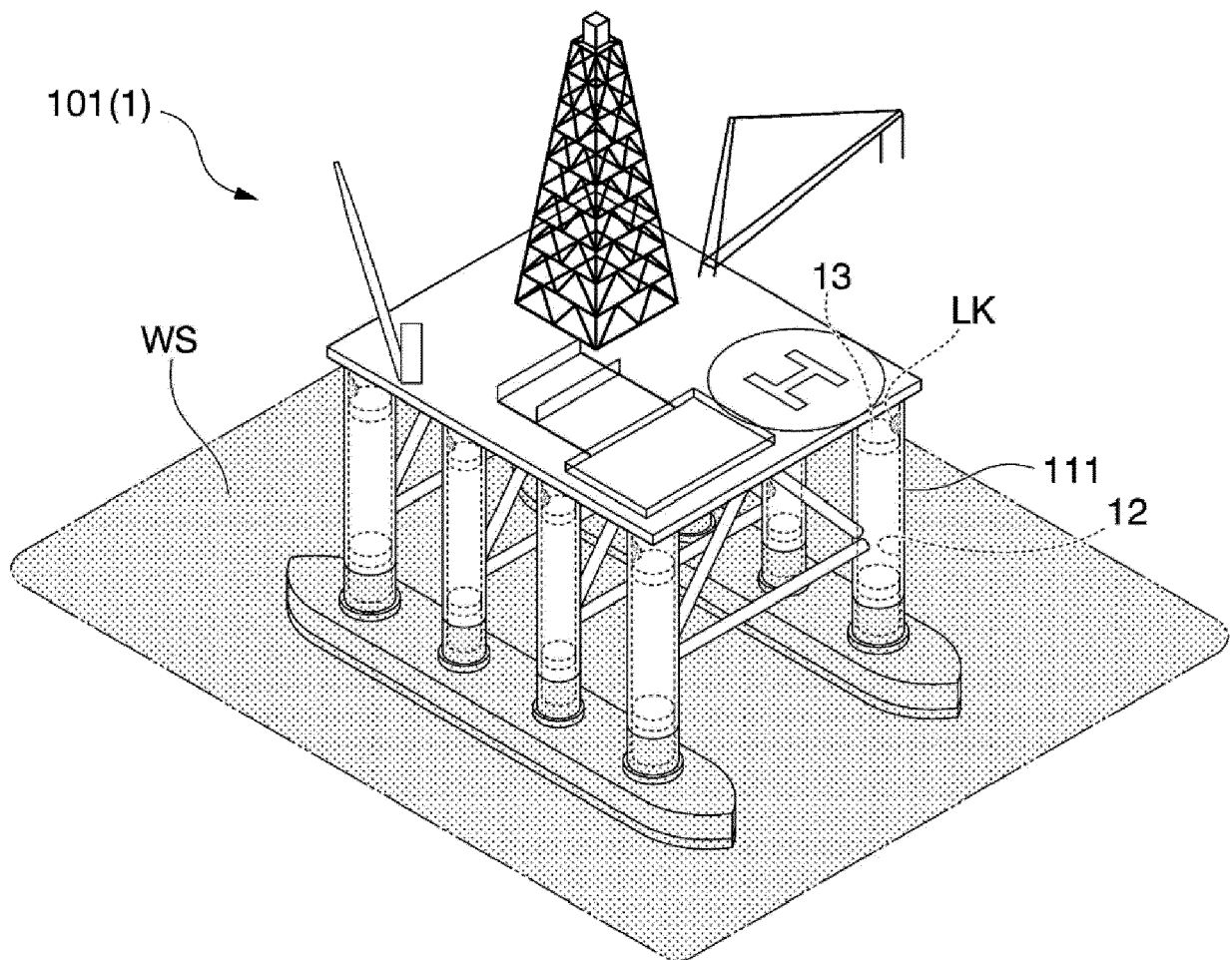


FIG. 10

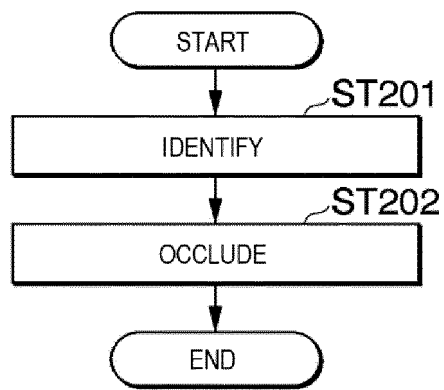


FIG. 11

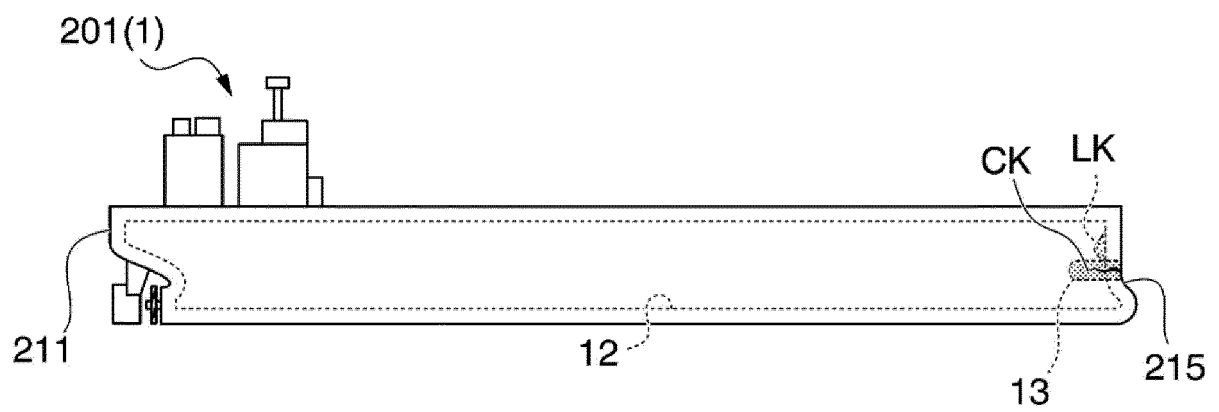


FIG. 12

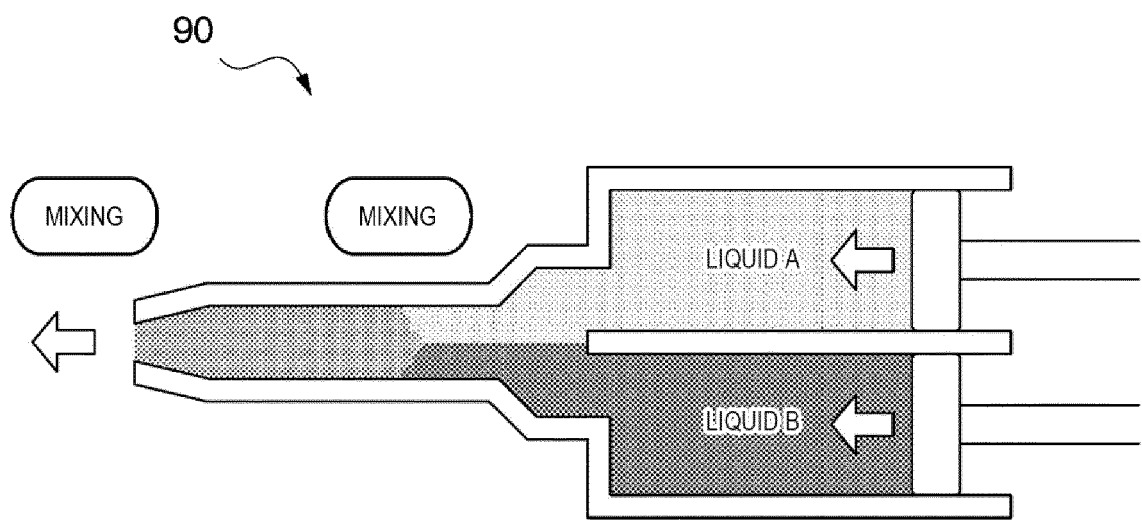


FIG. 13

	TYPE OF SEALING MATERIAL	THICKNESS OF SEALING MATERIAL IN PIPE AXIAL DIRECTION	INTERNAL FLUID	PRESENCE OF LEAKAGE AFTER 14 DAYS
EXAMPLE 1	RIGID URETHANE RESIN FOAM	0.3 TIMES INSIDE DIAMETER	OIL	SLIGHT OIL LEAKAGE
EXAMPLE 2	RIGID URETHANE RESIN FOAM	0.5 TIMES INSIDE DIAMETER	OIL	NO OIL LEAKAGE
EXAMPLE 3	RIGID URETHANE RESIN FOAM	0.75 TIMES INSIDE DIAMETER	OIL	NO OIL LEAKAGE
EXAMPLE 4	RIGID URETHANE RESIN FOAM	1.0 TIMES INSIDE DIAMETER	OIL	NO OIL LEAKAGE
EXAMPLE 5	RIGID URETHANE RESIN FOAM	0.3 TIMES INSIDE DIAMETER	WATER	SLIGHT WATER LEAKAGE
EXAMPLE 6	RIGID URETHANE RESIN FOAM	0.5 TIMES INSIDE DIAMETER	WATER	NO WATER LEAKAGE
EXAMPLE 7	RIGID URETHANE RESIN FOAM	0.75 TIMES INSIDE DIAMETER	WATER	NO WATER LEAKAGE
EXAMPLE 8	RIGID URETHANE RESIN FOAM	1.0 TIMES INSIDE DIAMETER	WATER	NO WATER LEAKAGE
EXAMPLE 9	BALLOON + RIGID URETHANE RESIN FOAM	0.3 TIMES INSIDE DIAMETER	OIL	OIL LEAKAGE
EXAMPLE 10	BALLOON	0.5 TIMES INSIDE DIAMETER	OIL	OIL LEAKAGE
EXAMPLE 11	BALLOON + RIGID URETHANE RESIN FOAM	0.5 TIMES INSIDE DIAMETER	OIL	NO OIL LEAKAGE
EXAMPLE 12	BALLOON	0.75 TIMES INSIDE DIAMETER	OIL	NO OIL LEAKAGE
EXAMPLE 13	BALLOON	1.0 TIMES INSIDE DIAMETER	OIL	NO OIL LEAKAGE
EXAMPLE 14	BALLOON + RIGID URETHANE RESIN FOAM	0.3 TIMES INSIDE DIAMETER	WATER	WATER LEAKAGE
EXAMPLE 15	BALLOON	0.5 TIMES INSIDE DIAMETER	WATER	WATER LEAKAGE
EXAMPLE 16	BALLOON + RIGID URETHANE RESIN FOAM	0.5 TIMES INSIDE DIAMETER	WATER	NO WATER LEAKAGE
EXAMPLE 17	BALLOON	0.75 TIMES INSIDE DIAMETER	WATER	NO WATER LEAKAGE
EXAMPLE 18	BALLOON	1.0 TIMES INSIDE DIAMETER	WATER	NO WATER LEAKAGE

FIG. 14



EUROPEAN SEARCH REPORT

Application Number

EP 23 15 1096

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EPO FORM 1503 03.82 (P04C01)

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
E	EP 4 166 722 A1 (MITSUBISHI HEAVY IND LTD [JP]) 19 April 2023 (2023-04-19) * abstract; figures 1-8, 25 * * paragraphs [0098] - [0100] * -----	1-3, 5, 8, 10	INV. E02B17/00 G01S11/00 G01S13/00 B63B85/00
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X	US 5 878 784 A (SALES BRIAN THOMAS [GB] ET AL) 9 March 1999 (1999-03-09) * abstract; figures * * column 4, paragraph 2 * -----	1, 2, 4, 5, 8, 10	
X	WO 2020/256240 A1 (UNIV ULSAN FOUND IND COOP [KR]) 24 December 2020 (2020-12-24) * abstract; figures * * paragraphs [0040], [0051] * -----	9	
A, D	JP 2019 210685 A (SHIMIZU CONSTRUCTION CO LTD) 12 December 2019 (2019-12-12) * abstract; claims 1, 2; figures * -----	1, 8, 10	TECHNICAL FIELDS SEARCHED (IPC) E02B E02C G01S B63B F16L B23D B23K B26F
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 11 July 2023	Examiner Buron, Emmanuel
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	



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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☒ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

**LACK OF UNITY OF INVENTION
SHEET B**

Application Number

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The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-10**Structure with a cavity****1.1. claims: 1-8, 10****Cutting method****1.2. claim: 9****Repair method**

Please note that all inventions mentioned under item 1, although not necessarily linked by a common inventive concept, could be searched without effort justifying an additional fee.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 23 15 1096

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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