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(54) **UNDERGROUND BARRIER FOR DETECTING HOLLOWS AND A METHOD OF USE THEREOF**

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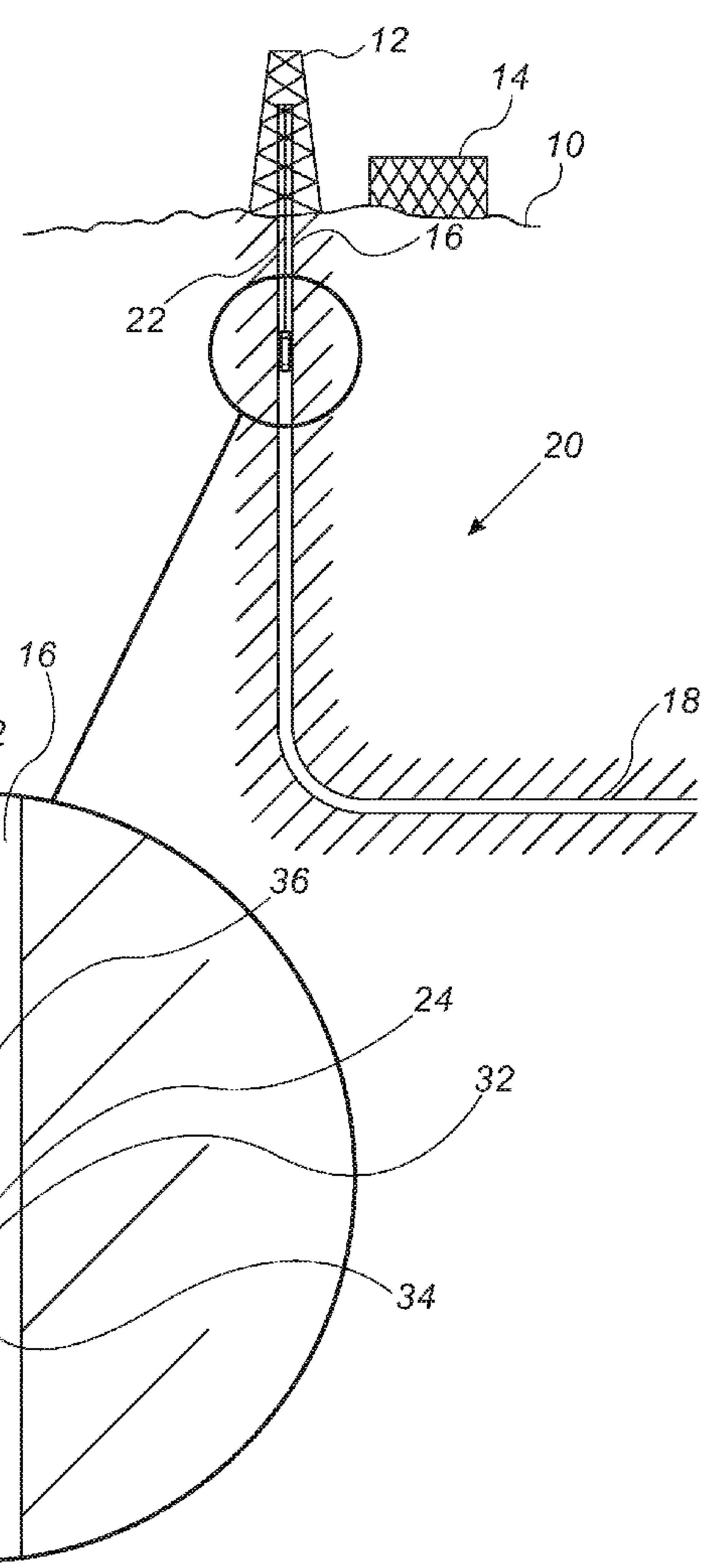
(57) **ABSTRACT**

An underground barrier for detecting underground hollows, comprising: a drilling rig; at least one drillstring, a proximal end of the drillstring, fitted on the drilling rig, the drillstring capable of drilling a borehole into the ground; a directional drilling unit, fitted on a distal end of the drillstring, capable of steering the drillstring in a desired path; a sensor unit, fitted on the distal end of the drillstring, capable of mapping the ground and hollows around the drillstring; and a control station; the control station configured to preform one or more of the following: control, the directional drilling unit to steer the drillstring in a desired path; receive, mapping data of the ground around the drillstring from the sensor unit; analyze, the mapping data received to detect underground hollows; and display, to a user of the system, using a user interface, the mapping data and the underground hollows.



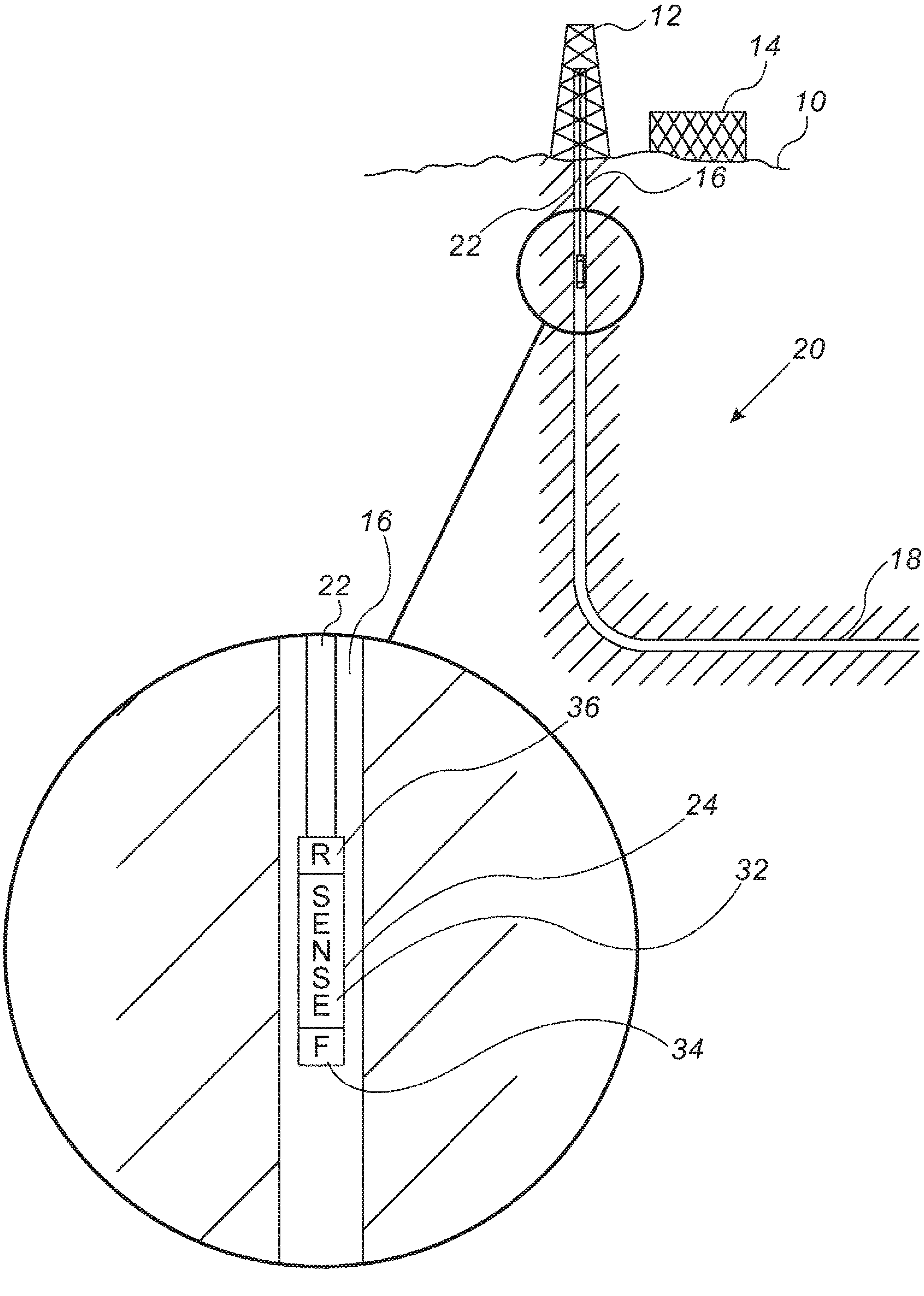



FIG. 1

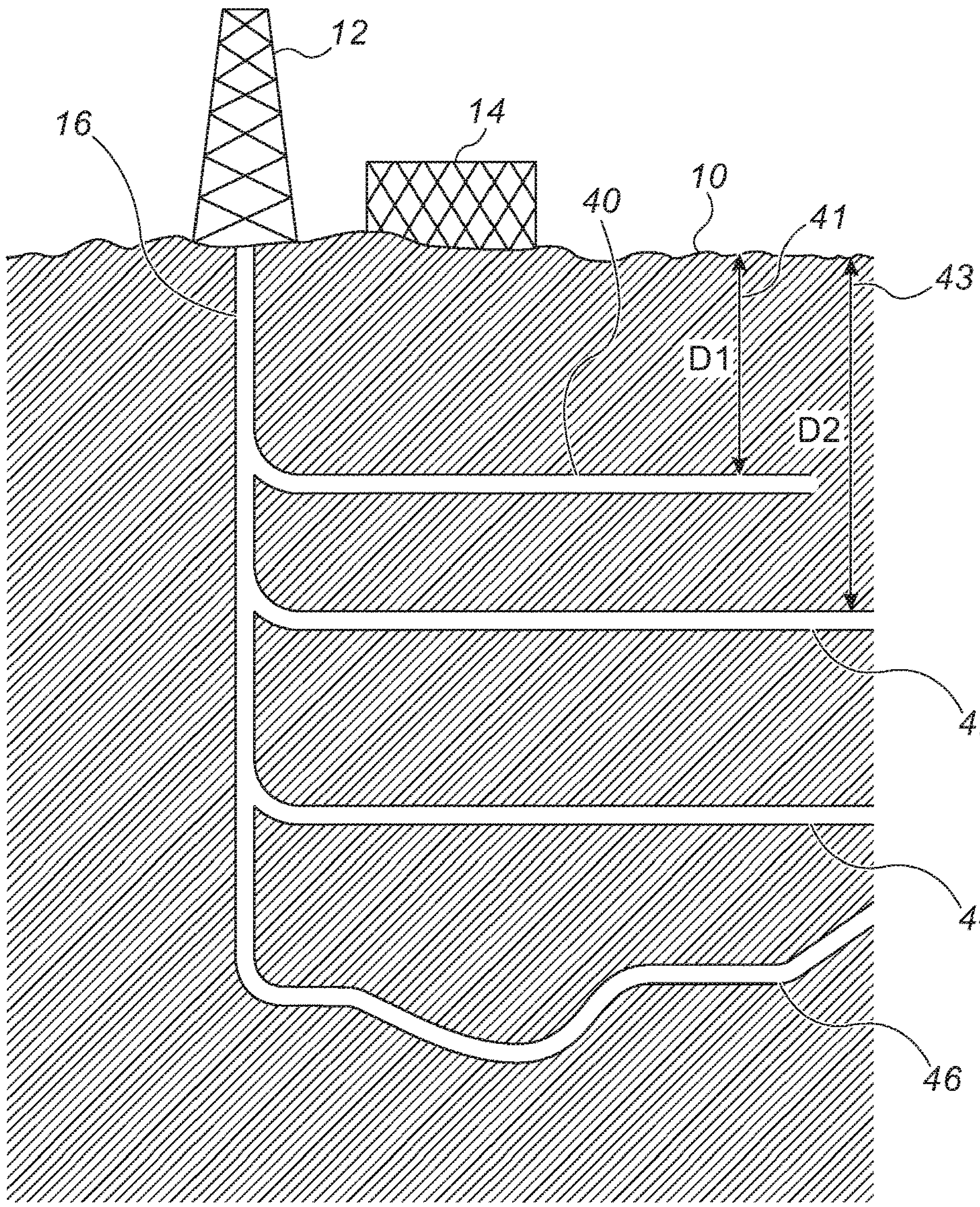



FIG. 2

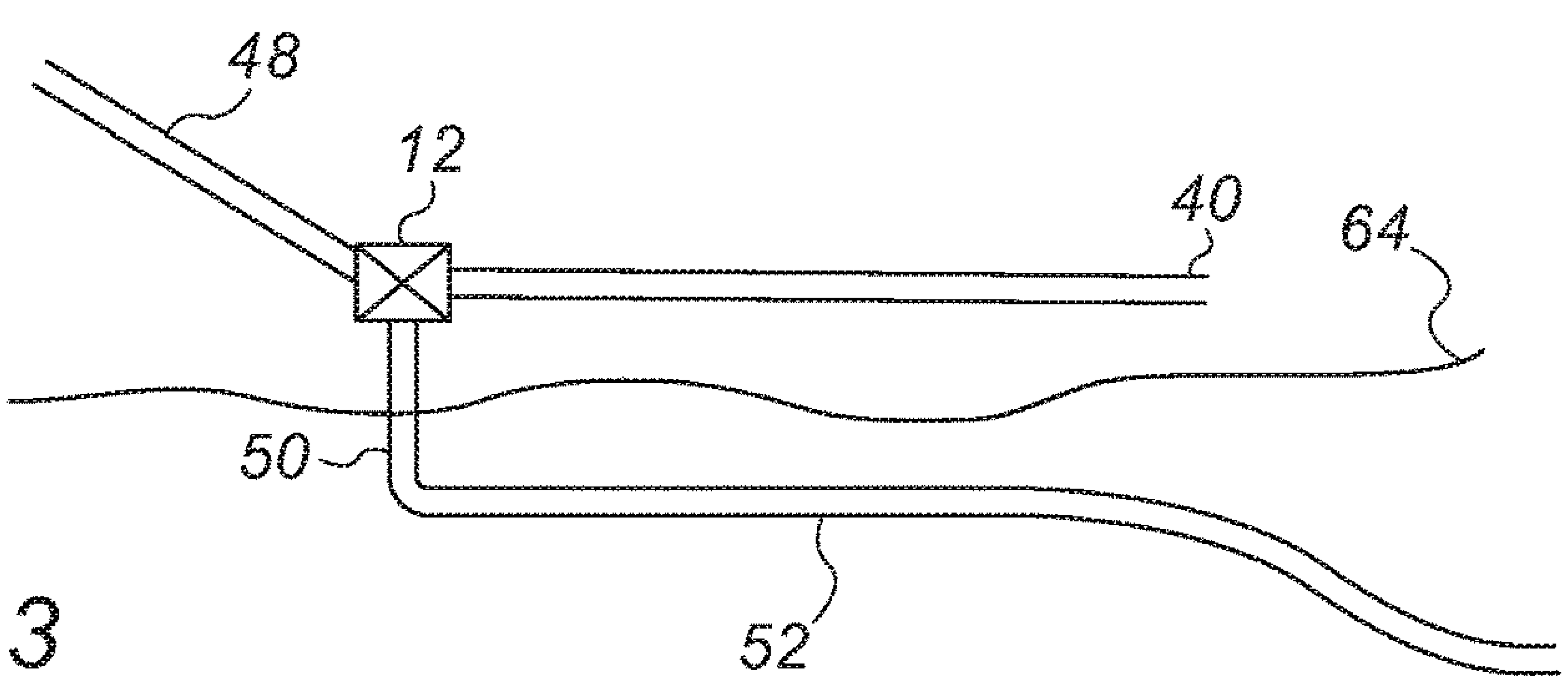
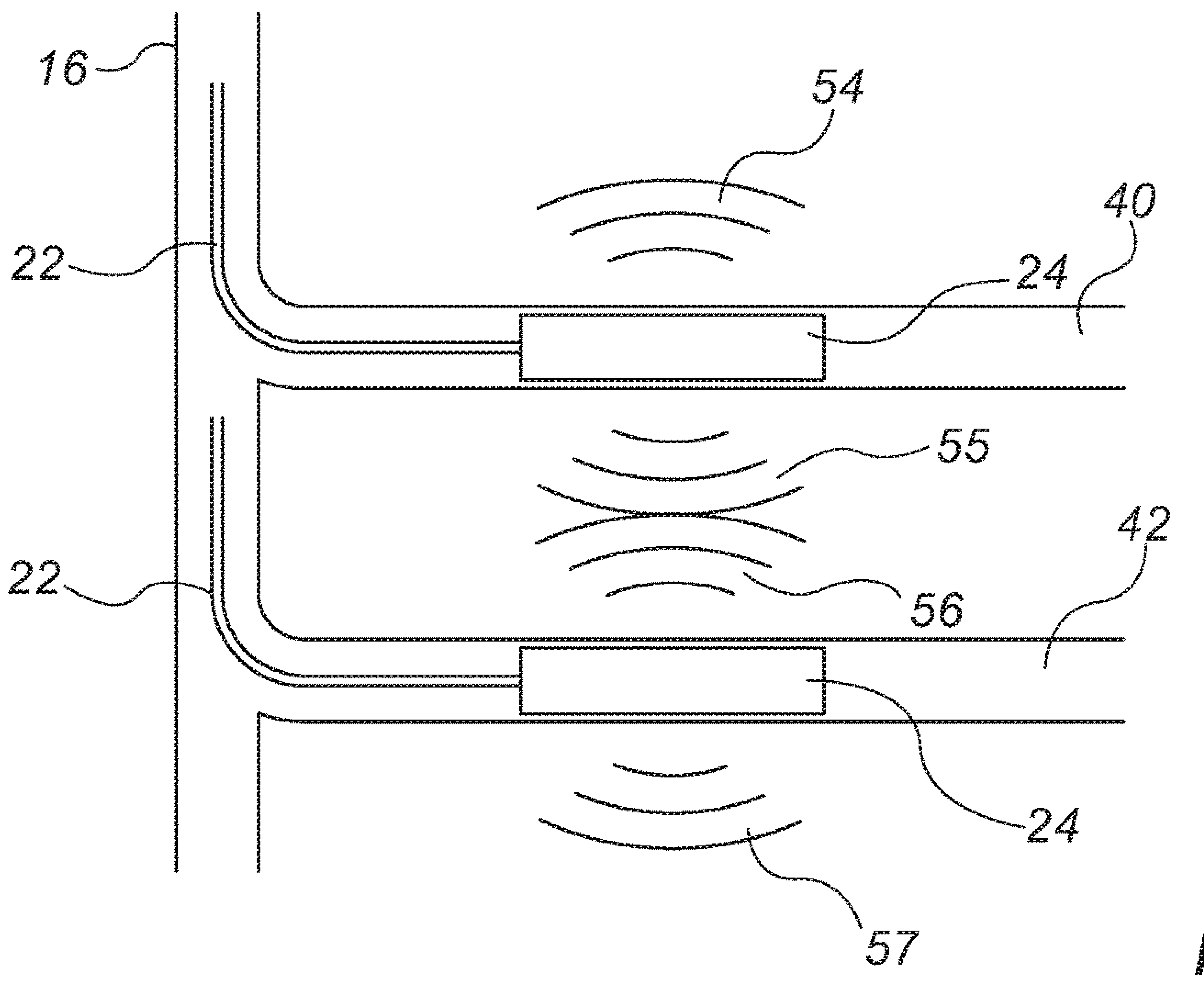



FIG. 3


16
54
40
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24
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42
22
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24
57

FIG. 4A

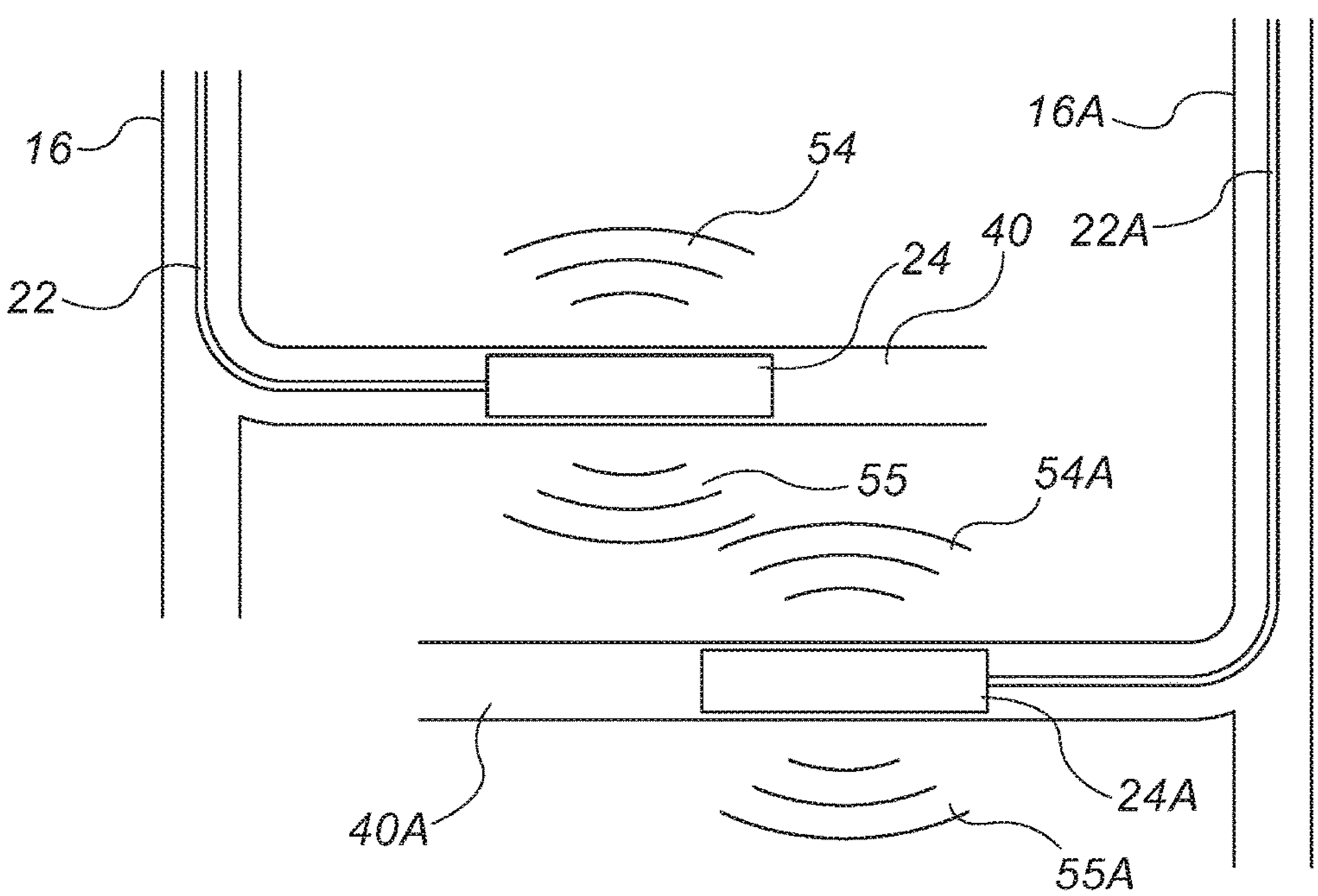

16
54
16A
22A
22
24
40
55
54A
24A
40A
55A

FIG. 4B

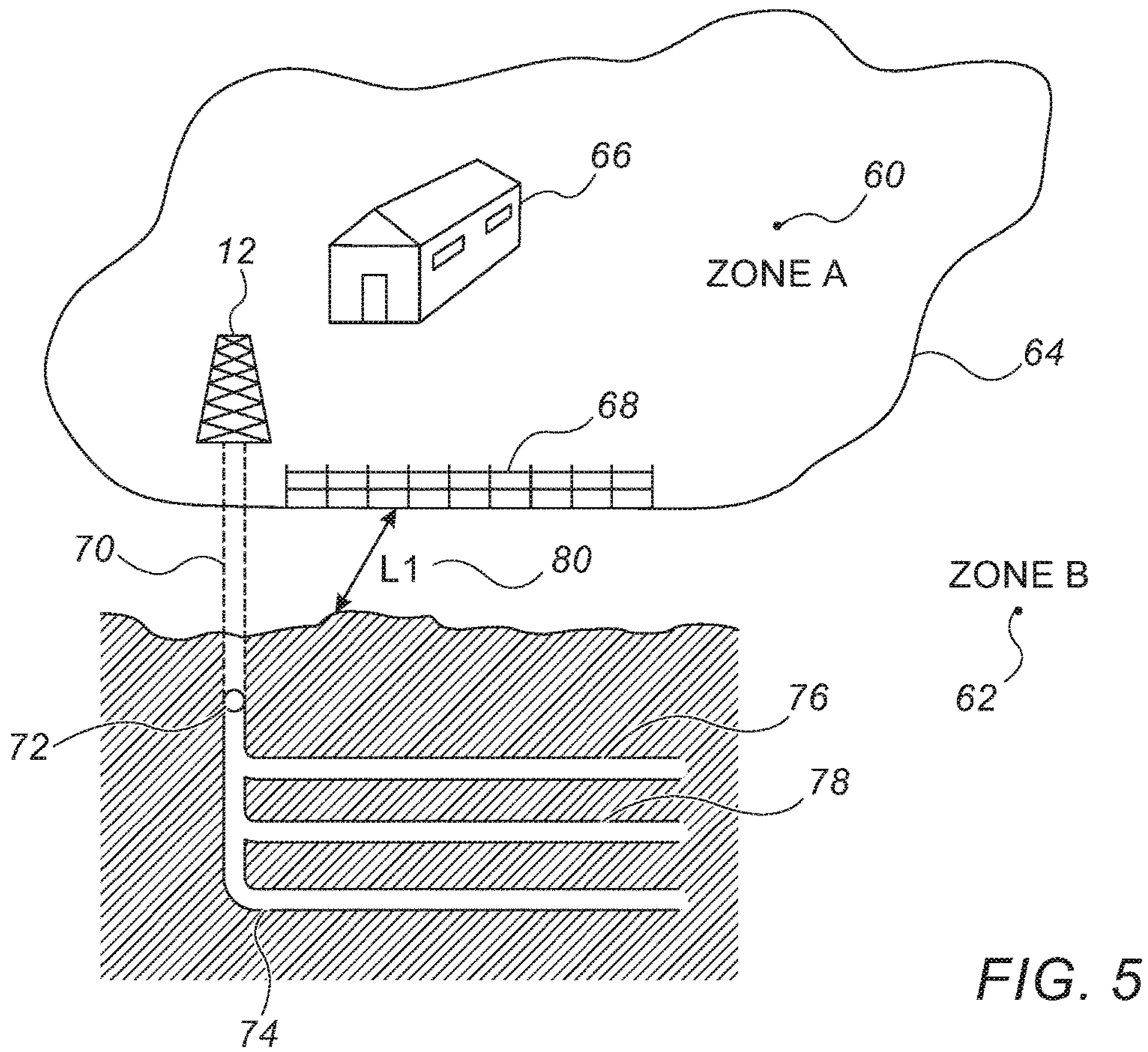

66
60
12
ZONE A
64
68
70
L1
80
ZONE B
62
72
76
78
74

FIG. 5

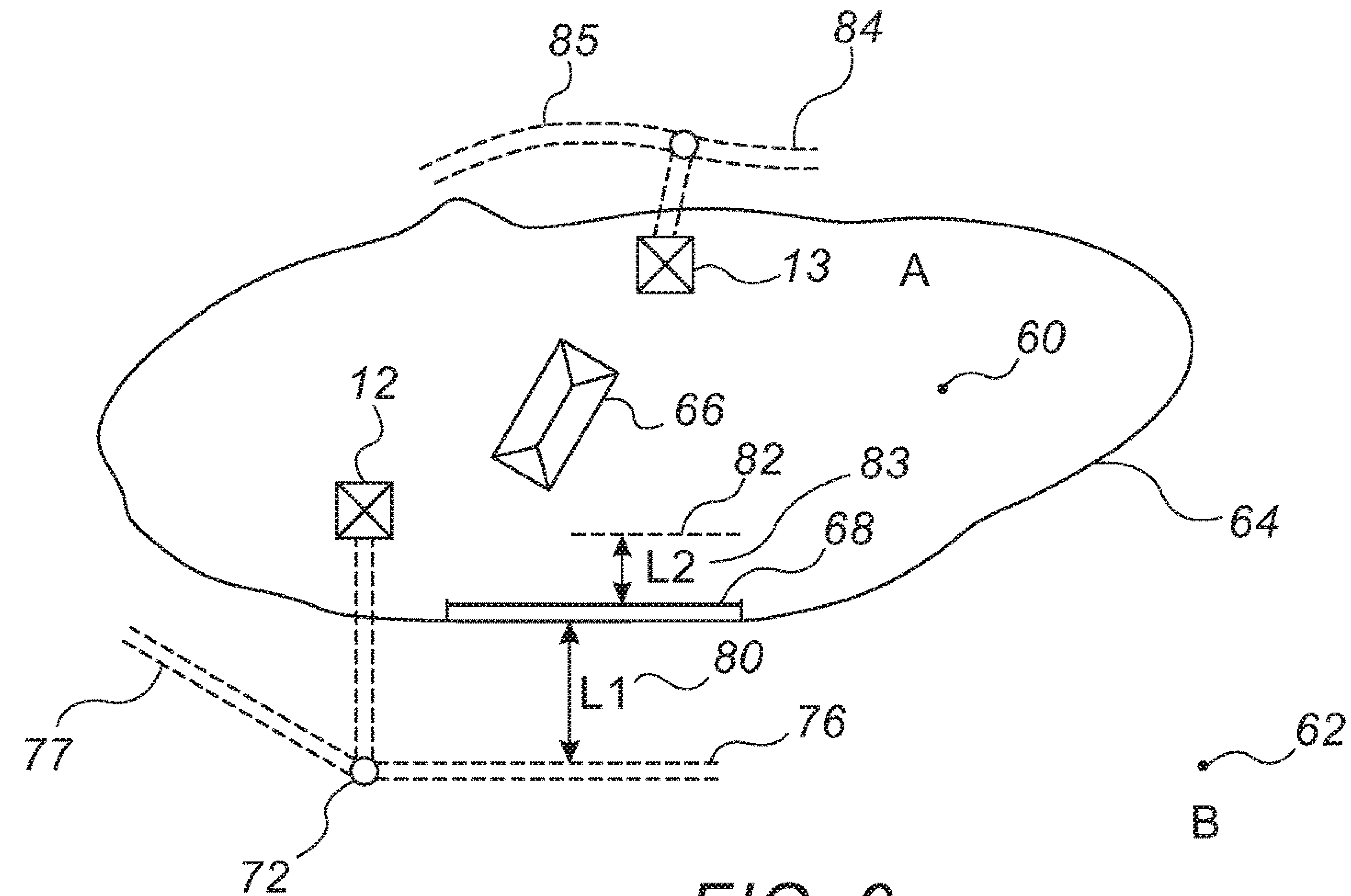
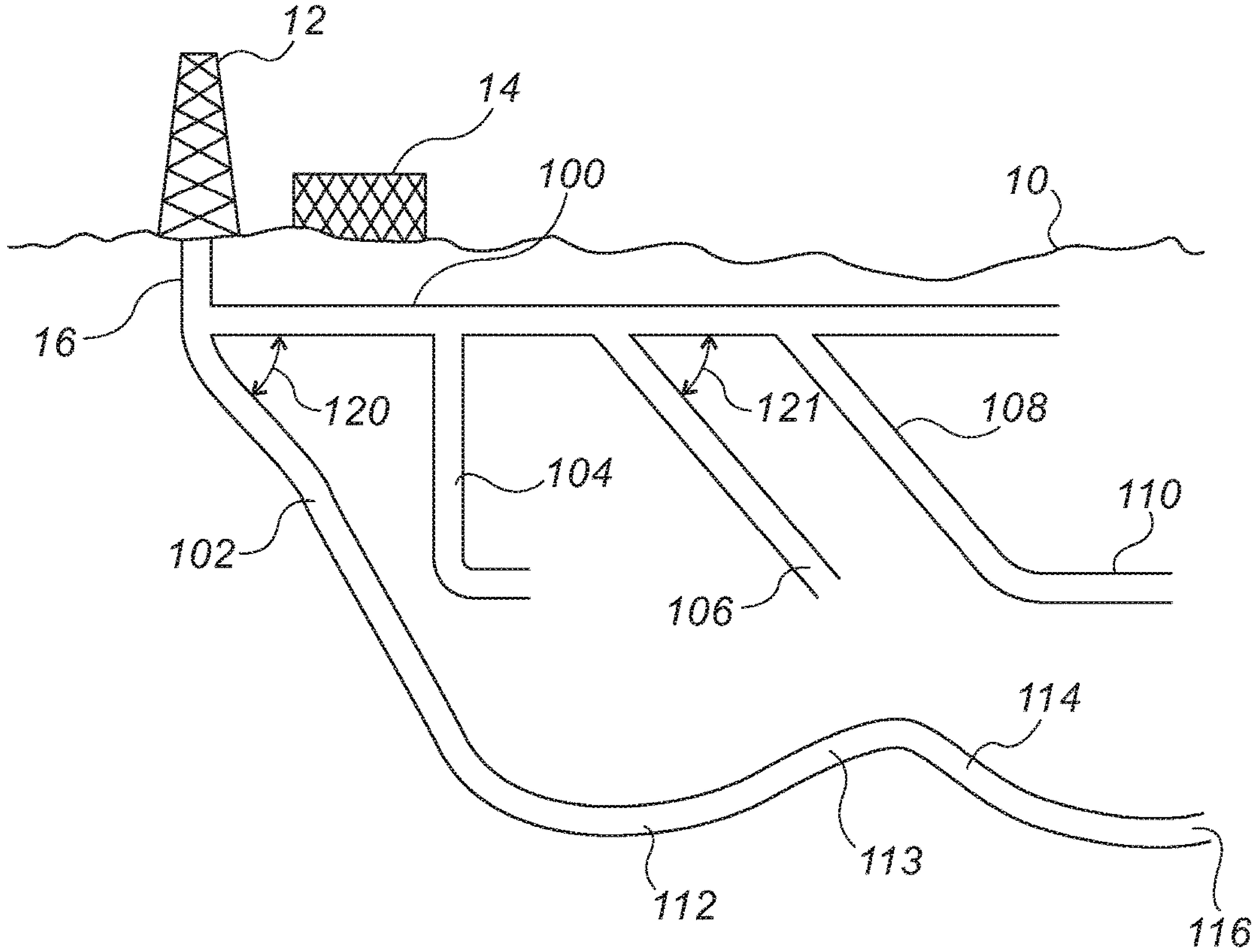

85
84
13
A
60
12
66
82
83
64
68
L2
L1
80
77
76
62
B
72

FIG. 6

FIG. 7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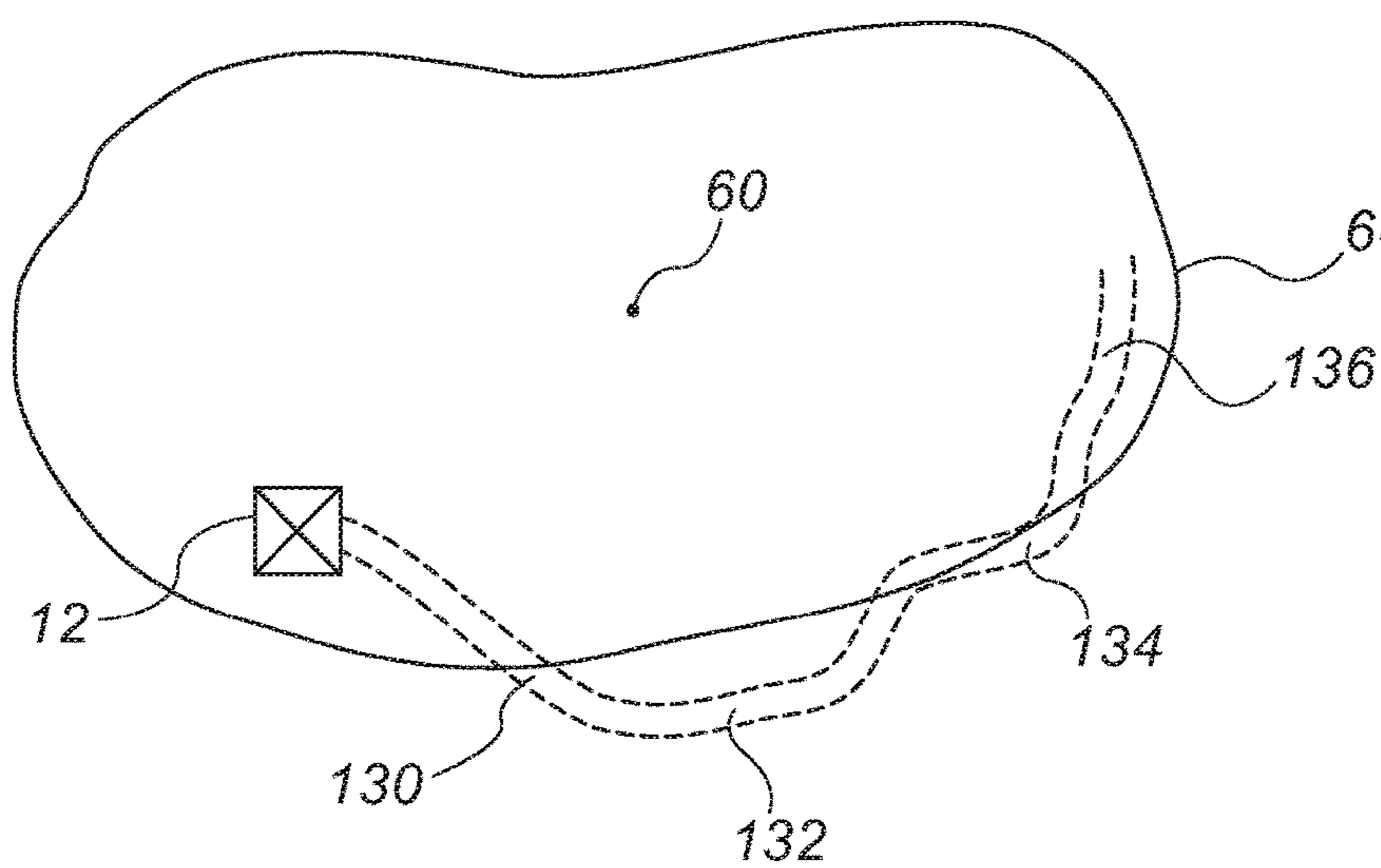
60
64
136
134
12
130
132

# UNDERGROUND BARRIER FOR DETECTING HOLLOWS AND A METHOD OF USE THEREOF

## FIELD OF THE INVENTION

**[0001]** The present invention relates to a system and method for an underground barrier that can detect irregularities and changes in underground soil and structure in order to alert of the presence of underground hollows and passages that may be used for the movement of people and goods across a boundary line.

## BACKGROUND

**[0002]** The invention belongs to the area of "underground barrier" or "underground fence". The term "underground barrier" refers to any measure that is used to detect the movement under ground level, of people or goods across a line separating area A from area B. This line may be—for example—a country border (where A is the country and B is a neighboring country), the circumference of a premises, or a battle line separating two enemy people.

**[0003]** A specific example of such a line is the border between the US and Mexico, where man-made underground passages were discovered in the past. Another specific example may be the border between North and South Korea.

**[0004]** "Underground barriers" refer to means to detect, and thus prevent, the passage of goods and humans. Goods are any of equipment, food and drugs etc.

**[0005]** Initiatives of constructing underground barriers go back many decades.

**[0006]** Current underground barriers of basic design are known to have one or more of the following components:

- **[0007]** A wall. This can be a concrete wall going down below ground level for tens of meters (vertically) and all along a border line.
- **[0008]** A trench. A deep trench used to be set as part of the wall of fortified cities (e.g. Acre, Caesarea).
- **[0009]** Sensors. These consist of ground sensors which aim to detect changes in the underground environment, changes that are related to attempt to create a hollow or a passage to cross the border line.

**[0010]** The measures currently used in underground barriers may be classified as "detect active" or "detect passive". By "detect active" we mean detecting the existence of work being done in order to build an underground hollow or passage; or detecting the actual attempt to cross the line by the underground hollow or passage, while it is occurring. "Detect passive" means detection of the existence of underground hollows or passages, a detection that may be while or after the hollows are made. "Detect passive" does not rely on present activity of the intruder.

**[0011]** The present invention provides the ability to detect passively and actively, being able to detect existing hollows and passages in the ground, and able to detect them as they are created.

**[0012]** Prior art underground barriers are costly to design and erect due to the difficulties to construct a substantial barrier underground. Even after such a barrier is constructed, there are difficulties in maintenance of the barrier and in monitoring that the barrier has not been breached.

**[0013]** Current sensors used with underground barriers, such as seismic and acoustic sensors, are limited by the structure and composition of the ground they are trying to sense through and usually can detect hollows only a few meters below ground level.

**[0014]** There is thus a need in the art for a new system and method for an underground barrier.

**[0015]** Korean Patent No. 101271689 (Sang-Wook et al.) discloses a method for locating tunnels. The method consists of having two vertical boreholes. A transmitter is inserted in one borehole, and a receiver is inserted into the other one, in a coordinated manner

**[0016]** The disclosed method of Sang-Wook et al. does not provide a manner of moving the transmitter and receiver through the boreholes, and does not provide a single transmitter-receiver solution and covers a very small area for each couple of horizontal boreholes so that many dozens of vertical boreholes will be required per every 1000 m of border length.

**[0017]** U.S. Pat. No. 8,396,610 (Mashiach) discloses a system that is based on autonomous vehicles traveling in pre-laid pipes.

**[0018]** The disclosed system of Mashiach does not disclose how the pipes, that are a prerequisite to moving vehicles in them, are laid underground. Further, it does not handle the communication difficulties of communicating with the autonomous vehicles underground and is limited in ease of deployment, and in maintenance of the deployed pipes and the complexity of the autonomous vehicles (e.g. how they are powered, and how they independently navigate).

**[0019]** U.S. Pat. No. 6,845,819 (Barret et al.) discloses a down hole tool "for logging and/or remedial operations in a wellbore in a hydrocarbon reservoir".

**[0020]** The disclosed system of Barret et al. does not disclose and does not suggest using a system and method for an underground barrier.

## SUMMARY

**[0021]** In accordance with a first aspect of the presently disclosed subject matter, there is provided an underground barrier for detecting underground hollows, comprising: a drilling rig; at least one drillstring, a proximal end of the drillstring, fitted on the drilling rig, the drillstring capable of drilling a borehole into the ground; a directional drilling unit, fitted on a distal end of the drillstring, capable of steering the drillstring in a desired path; a sensor unit, fitted on the distal end of the drillstring, capable of mapping the ground and hollows around the drillstring; and a control station; the control station configured to preform one or more of the following: control, the directional drilling unit to steer the drillstring in a desired path; receive, mapping data of the ground around the drillstring from the sensor unit; analyze, the mapping data received to detect underground hollows; and display, to a user of the system, using a user interface, the mapping data and the underground hollows.

**[0022]** In some cases, the control station is further configured to control the drillstring through a generally horizontal underground path.

**[0023]** In some cases, the control station is further configured to control at least two drill strings located in at least two adjacent generally horizontal underground paths.

**[0024]** In some cases, the control station is further configured to perform the following for controlling the drillstring through the desired path:

[0025] a) direct, the directional drilling unit to steer the drillstring to drill from a current location through a generally vertical path;

[0026] b) evaluate, the drillstring location to determine current depth of the generally vertical path;

[0027] c) guide, the directional drilling unit to steer the drillstring into a generally horizontal path, when a desired depth of the generally vertical path is attained;

[0028] d) examine, the drillstring location to determine length of the generally horizontal path;

[0029] e) return, the drillstring through the generally horizontal path back to the generally vertical path, when a desired length of the generally horizontal path is attained; and

[0030] f) repeat, steps a-e until parallel generally horizontal paths have been drilled, a desired overall depth of the generally vertical path is attained and underground area is mapped for hollows.

[0031] In some cases, the control station is further configured to preform one or more of the following: monitor, the detection of one or more hollows in an underground area designated by the user of the system through the user interface; and alert, the user of the system through the user interface when one or more hollows are detected in the underground area.

[0032] In some cases, the sensor unit includes one or more of the following:

[0033] a. a borehole ground penetrating radar;

[0034] b. a seismic sensor;

[0035] c. a magnetometer;

[0036] d. an electrical resistivity sensor;

[0037] e. an acoustic sensor; or

[0038] f. an electromagnetic sensor using high-frequency radio waves.

[0039] In some cases, the directional drilling unit is a rotary steerable unit.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0040] For a better understanding of the invention, with regard to the embodiments described, reference is made to the accompanying drawings, in which:

[0041] FIG. **1** is a schematic illustration of an environment of a system for an underground barrier, in accordance with the invention;

[0042] FIG. **2** is a schematic illustration of a side view of an embodiment of a system for an underground barrier, in accordance with the invention;

[0043] FIG. **3** is a schematic illustration of a view from above, of an embodiment of a system for an underground barrier, in accordance with the invention;

[0044] FIG. **4**A is a schematic illustration of an embodiment of a system for an underground barrier, in accordance with the invention;

[0045] FIG. **4**B is a schematic illustration of another possible embodiment of a system for an underground barrier, in accordance with the invention;

[0046] FIG. **5** is a schematic illustration of a detailed setting of a system for an underground barrier, in accordance with the invention;

[0047] FIG. **6** is a schematic illustration of a view from above, of a detailed setting of a system for an underground barrier, in accordance with the invention;

[0048] FIG. **7** is a schematic illustration of another possible embodiment of a system for an underground barrier, in accordance with the invention;

[0049] It will be appreciated that for simplicity and clarity of illustration, elements shown in the drawings have not necessarily been drawn accurately or to scale. Reference numerals may be repeated among the drawings to indicate corresponding or analogous elements. Moreover, some of the blocks depicted in the drawings may be combined into a single function.

## DETAILED DESCRIPTION OF THE INVENTION

[0050] In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. There is no intention to limit the invention to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments or of being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of description and should not be regarded as limiting.

[0051] In a general overview, some of the elements of the invention include technologies commonly used by the oil and gas industry, where they are typically used to search for underground resources, e.g. drilling for gas or oil.

[0052] Drilling is a process of making boreholes. A borehole is a narrow shaft bored in the ground, either vertically or horizontally. A borehole may be constructed for many different purposes, including the extraction of water, other liquids (such as petroleum) or gases (such as natural gas), as part of a geotechnical investigation, environmental site assessment, mineral exploration, temperature measurement, as a pilot hole for installing piers or underground utilities, for geothermal installations, or for underground storage of unwanted substances, e.g. in carbon capture and storage.

[0053] There are two technology areas described herein:

[0054] A. Rotary steerable systems (RSS), which is a tool and form of drilling technology used in directional drilling. It employs the use of specialized downhole equipment that allows a user to optimize directional drilling. RSSs allow continuous rotation of the drillstring while steering the bit.

[0055] B. Sensors, used in measurement and logging while drilling the borehole through the desired path. In particular the current invention may make use of a ground penetrating radar (GPR), of which the borehole variant is called borehole radar (BHR).

[0056] Borehole radars utilizing GPR are used to map the structures from a borehole in underground applications. Modern directional borehole radar systems are able to produce three-dimensional images from measurements in a single borehole.

[0057] The BHR is a cylindrical assembly that is connected as part of the bottom hole assembly (BHA) of the drillstring. Since the drillstring rotates, the BHR is connected to the drill string with bearings to prevent it from rotating while operating (during capture of radar images). Alternatively the BHR may rotate at a controlled speed gathering a 360 degrees image of the borehole vicinity.

[0058] Several other sensor technologies may be used, such as acoustic sensors, magnetometers and seismic sensors. Another useful type of sensors are electrical resistivity sensors, which are used with advanced processing to form 'electrical resistivity mapping', also known as 'electrical resistivity tomography'.

**[0059]** The present invention provides an improved barrier that consists of one or more horizontal underground boreholes in which sensors borne on a drillstring (such as a BHR) are deployed. The sensors provide a mapping of the ground around the borehole, as the drillstring drills through the desired path (radially, in all directions).

**[0060]** Analysis of the information, is performed in a control station, from several horizontal boreholes in which the sensors are deployed—a vertical plane of an underground barrier is constructed. The barrier enables to detect any attempt, going through hollows, to pass the vertical underground plane of the barrier and to alert such an attempt to a user.

**[0061]** The sensor data is analyzed in the control station to:

**[0062]** 1. Detect hollows in underground by analysis of the collected data from the sensors, in particular by studying discrepancies; and

**[0063]** 2. Compare to previous sensors runs—along the same underground area, in order to detect changes (i.e. new hollows).

**[0064]** Some of the many advantages of the invention include the following non-limiting examples:

**[0065]** 1. Fast deployment. The rate of borehole drilling can be dozens of meters per day, and directional drilling methods are improving daily (in particular by the oilfield services companies).

**[0066]** 2. The barrier may be implemented along a border line or along a line that is out of the actual border line (e.g. run the barrier 100 m beyond the protected area).

**[0067]** 3. Unlimited depth. The barrier can go as deep as needed even over than hundreds of meters.

**[0068]** 4. Very small—or none at all—footprint above ground. Footprint above ground can be made away from the border line.

**[0069]** 5. Can be easily upgraded—as the GPR and other sensing technology evolve (because the sensors are installed in a non-stationary fashion).

**[0070]** 6. Difficult to detect. The boreholes are relatively small, deep in the ground.

**[0071]** 7. Proven technology of the equipment used. Drilling, sensing, data collection, data transmission, and data analyzing and imaging.

**[0072]** 8. Sustainability. A "break" of a branch can be easily repaired, maintaining the barrier in full operating condition.

**[0073]** A preferred embodiment utilizes a drill string that may include a rotary steerable system and sensors part of the drillstring, such as PowerDrive ICE Ultra HT© by Schlumberger™, which includes TeleScope ICE©.

**[0074]** For BHR, a tool such as developed by T&A TISA® "3D Borehole Radar" may be added in the drillstring, or tools such as provided by Geomole™ (now CRCMining™). For Seismic imaging by borehole tools, there are tools from several companies, and an example is by Schlumberger™. Above ground monitoring and control station may include THEMA™ a drilling operation support and analysis tool, provided by Schlumberger™.

**[0075]** The drill string may contain the sensors assembly on the first drill (when the borehole is first drilled) or on following passes through the already drilled borehole. The sensors assembly, containing for example the GPR \ BHR, is run through the already drilled borehole periodically. Periodically means—for example—every several days or weeks. These runs are done to check changes in the underground, such as new hollows that were formed. For an efficient, time saving and lower cost drill, a coiled tubing drilling system may be used.

**[0076]** Coiled tubing drilling operations proceed quickly compared to using a jointed pipe drilling rig because connection time is eliminated during tripping. Coiled tubing drilling is economical in several applications, such as drilling slimmer wells, areas where a small rig footprint is essential, reentering wells and drilling underbalanced. For re-entry purposes, coiled tubing may be the preferred method.

**[0077]** Examples of coiled tubing drilling are available at:

**[0078]** http://www.slb.com/services/well_intervention/coiled_tubing/ctdirect-coiled-tubing-directional-drilling-system.aspx, And—https://www.youtube.com/watch?v=JomDgySCbM4&feature=youtube.

**[0079]** Alternatively or additionally, for re-entry to the borehole, a wireline method can be used. Wireline usually refers to a cabling technology used by operators of oil and gas wells to lower equipment or measurement devices into the well for the purposes of well intervention, reservoir evaluation, surrounding geology data collection, and pipe recovery.

**[0080]** Wireline may provide an advantage of speed and depth. In recent years, wireline methods also enable efficient re-entry of horizontal wells.

**[0081]** Bearing this in mind, attention is drawn to FIG. **1**, showing a schematic illustration of a system for an underground barrier, in accordance with the presently disclosed subject matter.

**[0082]** According to certain examples of the presently disclosed subject matter, at ground level surface **10**, a drilling rig **12** and a control station **14** are stationed. A borehole **16** is drilled vertically into ground **20**. At a desired depth the borehole turns to be horizontal **18**.

**[0083]** The borehole **16** is drilled by a drillstring **22**. The drillstring **22** is connected to the drilling rig **12**. The drilling rig **12** can be located at ground level or located at an underground facility, thereby leaving no footprint above ground. The drillstring **22** can span from hundreds to thousands of meters long, from the drilling rig **12** all the way to the end of the borehole **16** underground. The lower part of the drillstring **22** is called the bottom hole assembly (BHA) **24**.

**[0084]** In a preferred embodiment, the BHA **24** consists of a front portion "F", which includes at least the bit **34** and a rear portion "R" **36** which connects the BHA **24** to the drillstring **22**. The BHA **24** includes directional drilling equipment such as an RSS. The BHA **24** also includes measurement equipment (including various sensors) described as SENSE **32** in FIG. **1**. SENSE **32** includes the equipment for collecting, logging, and transferring data to the control station **14** while drilling. SENSE **32** may further include equipment to receive communications from the control station **14** to control the operation of the sensors.

**[0085]** Attention is now drawn to FIG. **2**, schematically illustrating a side (cut) view of an embodiment of a system for an underground barrier, in accordance with the presently disclosed subject matter.

**[0086]** According to certain examples of the presently disclosed subject matter, a drilling rig **12** and a control station **14** are stationed at ground level **10**. A vertical borehole path **16** is drilled by the drillstring **22**, from which horizontal boreholes branch **40**, **42**, **44**, **46**. At a depth of D**1** **41** a horizontal borehole **40** is drilled. At a depth of D**2** **43** another horizontal borehole **42** is drilled. Additional horizontal boreholes **44** and **46** may be drilled to make the barrier cover deeper areas into the ground, where the overall depth is determined according to the depth required for the underground barrier. As shown in branching borehole **46**, the borehole may run in a path which is not only horizontal: going upward or downward as needed, controlled by the user of the control station. The user may also steer the drillstring **22** in any navigation azimuth to create a preferred path.

**[0087]** In a preferred embodiment, the vertical gaps between the horizontal boreholes, such as D**2**-D**1** in FIG. **2**, are selected according to at least the following: (a) soil properties and structure (b) SENSE **32** technology and capabilities (c) the required resolution, i.e. the size of hollow that is needed to be detected (higher resolution will require smaller gaps).

**[0088]** Attention is now drawn to FIG. **3**, a schematic illustration of a top (aerial) view of an embodiment of a system for an underground barrier, in accordance with the presently disclosed subject matter.

**[0089]** According to certain examples of the presently disclosed subject matter, the drilling rig **12** is shown, from which the horizontal underground boreholes paths branch. Path **40**, **48** and **52** are examples. Path **50** is another example of a borehole path that goes first vertically (the same as borehole **16** in FIG. **2**) and then horizontally **50** across a borderline **64** that is to be protected, and then continues horizontally **52** along the borderline or in any other azimuth, according to the user input via the control station **14**.

**[0090]** Attention is now drawn to FIG. **4**A, a schematic illustration of an embodiment of a system for an underground barrier, in accordance with the presently disclosed subject matter.

**[0091]** According to certain examples of the presently disclosed subject matter, the BHA **24** is deployed through borehole path **40**, at time T**1**. While moving through the borehole path **40** the SENSE **32** attached to the BHA **24**, which in one preferred embodiment includes a BHR, sends electromagnetic radar waves around the borehole in all directions, and obviously above **54** and below **55** the horizontal borehole path **40**. The BHR survey results in an image representing the status of the ground around the BHA **24**. After going through horizontal borehole path **40**, the drillstring **22** is pulled back to the vertical borehole path **16** and then oriented at time T**2** into an additional horizontal borehole path **42**. Moving through horizontal borehole path **42**, the BHA **24**, utilizing the SENSE **32** attached to it, maps the ground above **56** and below **57** the additional horizontal borehole path **42**. This enables a full coverage of the ground section from ground level **10** to any required depth (by adding more horizontal boreholes). The mapping analysis process can be done via the control station **14** while the boreholes are drilled, or at any time after they were drilled.

**[0092]** Attention is now drawn to FIG. **4**B, a schematic illustration of another embodiment of a system for an underground barrier, in accordance with the presently disclosed subject matter.

**[0093]** According to certain examples of the presently disclosed subject matter, FIG. **4**B is a broader embodiment of FIG. **4**A. As shown in FIG. **4**B, moving through horizontal borehole path **40** and **40**A, the BHA **24** and **24**A, utilizing the SENSE **32** attached to it, maps the ground above **54**, **54**A and below **55**, **55**A respectively. Moving through the boreholes **40** and **40**A may be done in a coordinated manner or none coordinated manner Also, BHA **24**, **24**A may include sensors that are transmitter and receiver in the same unit or one (e.g. **24**) including a transmitter and the other (e.g. **24**A) including a receiver of the signals. Sensors included in BHAs **24** and **24**A may be of various types as mentioned above.

**[0094]** In another embodiment the underground barrier, the underground barrier is built by boreholes made from more than one vertical borehole paths **16** and **16**A. Illustrated are two examples of horizontal borehole paths **40** and **40**A branching from vertical borehole paths **16** and **16**A respectively. The BHAs **24** and **24**A correspond to the two drillstrings **22** and **22**A.

**[0095]** In this embodiment, BHAs **24** and **24**A, utilizing the SENSE **32** attached to them, map the ground around the horizontal borehole paths **40** and **40**A, while moving in a coordinated manner through horizontal borehole paths **40** and **40**A.

**[0096]** In this embodiment, BHAs **24** and **24**A may also be a receiver and transmitter, such as, for example, BHA **24** is a transmitter only, transmitting signals to be received by BHA **24**A SENSE **32** sensors in order to analyze the underground between borehole paths **40** and **40**A.

**[0097]** In a further embodiment the BHA **24** and **24**A move through borehole paths **40** and **40**A with no coordination at the same time or at different time.

**[0098]** Attention is now drawn to FIG. **5**, a schematic illustration of a detailed setting of a system for an underground barrier, in accordance with the presently disclosed subject matter.

**[0099]** According to certain examples of the presently disclosed subject matter, zone A **60** is the area to be protected by the underground barrier of the disclosed subject matter, with a protected building **66** inside, along the border of zone A **64** or beyond it, into zone B **62**. The barrier along the border of zone A **64** may optionally include an above ground barrier, e.g. a fence **68**, and an underground barrier consisting of multiple underground boreholes paths **72**, **74**, **76**, and **78**.

**[0100]** The drawing of FIG. **5**, illustrates that while the above ground barrier **68** is placed on the border line **64** between zone A **60** and zone B **62**, the underground barrier may actually be placed inside and underground zone B **62**, at a distance L**1** **80** beyond the border line **64**. This may be done by implementing a horizontal borehole path **70** that crosses the border underground, from which other horizontal borehole paths **76** and **78** will branch.

**[0101]** Attention is now drawn to FIG. **6**, a schematic illustration of a top (aerial) view of a detailed setting of a system for an underground barrier, in accordance with the presently disclosed subject matter.

**[0102]** According to certain examples of the presently disclosed subject matter, horizontal borehole paths **76** and **77** may cover segments of the border line **64**. An Additional drilling rig **13** can be placed along the border line **64** to cover additional segments of the border line **64** with more horizontal borehole paths **84** and **85**. The L**1** **80** and L**2** **83**

denote possible locations of placing an underground barrier like the horizontal borehole paths **76** and **77**. L**2** **83** depicts a position **82** of a possible barrier within the zone A **60**, with a protected building **66** inside that zone A **60**. One or more underground barriers may be set, on the border line **64** outside **76** or inside **82** zone A **60**. This acts both as redundancy and plots the direction of underground hollows or other discrepancies.

**[0103]** Attention is now drawn to FIG. **7**, a schematic illustration of another possible embodiment of a system for an underground barrier, in accordance with the presently disclosed subject matter.

**[0104]** Another embodiment is disclosed, of a system for an underground barrier comprising of a vertical borehole path **16** that branches into a horizontal borehole path **100** and from the horizontal borehole path **100**, branches in multiple directions vertical borehole paths **102**, **104**, **106** and **108** which may be at an angle with the horizon. The angle, such as **120** and **121** may vary. A vertical borehole path **108**, may turn into a horizontal borehole path **110**. Also, a path may be routed according to any needs (e.g. ground structure, underwater, soil characteristics), to go into a horizontal borehole path **112**, tending "upward" **113**, "downward" **114** and horizontally again **116**. It may also be routed across the border line **64**, parallel to the border line out of the premises **60**, under the border line **134** or inside the premises area **136** parallel to border line **64** or at any other direction. It may also be routed **130** across the border line **64**, parallel to the border line **132** out of the premises **60**, under the border line **134** or inside the premises area **136** parallel to border line **64** or at any other direction.

**[0105]** Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

**1**. An underground barrier for detecting underground hollows, comprising:
- a drilling rig;
- at least one drillstring, a proximal end of the drillstring, fitted on the drilling rig, the drillstring capable of drilling a borehole into the ground;
- a directional drilling unit, fitted on a distal end of the drillstring, capable of steering the drillstring in a desired path;
- a sensor unit, fitted on the distal end of the drillstring, capable of mapping the ground and hollows around the drillstring; and
- a control station;
  - the control station configured to preform one or more of the following:
  - control, the directional drilling unit to steer the drillstring in a desired path;
  - receive, mapping data of the ground around the drillstring from the sensor unit;
  - analyze, the mapping data received to detect underground hollows; and
  - display, to a user of the system, using a user interface, the mapping data and the underground hollows.

**2**. The underground barrier of claim **1**, wherein the control station is further configured to control the drillstring through a generally horizontal underground path.

**3**. The underground barrier of claim **1**, wherein the control station is further configured to control at least two drill strings located in at least two adjacent generally horizontal underground paths.

**4**. The underground barrier of claim **1**, wherein the control station is further configured to perform the following for controlling the drillstring through the desired path:
- a) direct, the directional drilling unit to steer the drillstring to drill from a current location through a generally vertical path;
- b) evaluate, the drillstring location to determine current depth of the generally vertical path;
- c) guide, the directional drilling unit to steer the drillstring into a generally horizontal path, when a desired depth of the generally vertical path is attained;
- d) examine, the drillstring location to determine length of the generally horizontal path;
- e) return, the drillstring through the generally horizontal path back to the generally vertical path, when a desired length of the generally horizontal path is attained; and
- f) repeat, steps a-e until parallel generally horizontal paths have been drilled, a desired overall depth of the generally vertical path is attained and underground area is mapped for hollows.

**5**. The underground barrier of claim **1**, wherein the control station is further configured to perform the following for controlling the drillstring through the desired path:
- a) direct, the directional drilling unit to steer the drillstring to drill from current location through a generally horizontal path;
- b) evaluate, the drillstring location to determine current length of the generally horizontal path;
- c) guide, the directional drilling unit to steer the drillstring into a generally vertical path, when a desired length of the generally horizontal path is attained;
- d) examine, the drillstring location to determine depth of the generally vertical path;
- e) return, the drillstring through the generally vertical path back to the generally horizontal path, when a desired depth of the generally vertical path is attained; and
- f) repeat, steps a-e until parallel generally vertical paths have been drilled, a desired overall depth of the generally horizontal path is attained and underground area is mapped for hollows.

**6**. The underground barrier of claim **1**, wherein the control station is further configured to preform one or more of the following:
- monitor, the detection of one or more hollows in an underground area designated by the user of the system through the user interface; and
- alert, the user of the system through the user interface when one or more hollows are detected in the underground area.

**7**. The underground barrier of claim **1**, wherein the sensor unit includes one or more of the following:
- a. a borehole ground penetrating radar;
- b. a seismic sensor;
- c. a magnetometer;
- d. an electrical resistivity sensor;
- e. an acoustic sensor; or
- f. an electromagnetic sensor using high-frequency radio waves.

**8**. The underground barrier of claim **1**, wherein the directional drilling unit is a rotary steerable unit.

**9**. The underground barrier of claim **1**, wherein said drilling rig is a coiled tubing drilling rig.

**10**. A method comprising:

providing control, by a control station, of a directional drilling unit, fitted on a distal end of a drillstring, capable of drilling a borehole into the ground, at least one proximal end of the drillstring fitted on a drilling rig, to steer the drillstring in a desired path;

receiving, mapping data of the ground and hollows around the drillstring from a sensor unit, fitted on the distal end of the drillstring, capable of mapping the ground and hollows around the drillstring;

analyzing, the mapping data received to detect one or more underground hollows; and

displaying, to a user of the system through a user interface the mapping data and the underground hollows.

**11**. The method of claim **10**, wherein the control station is further configured to control the drillstring through a generally horizontal underground path.

**12**. The method of claim **10**, wherein the control station is further configured to control at least two drill strings located in at least two adjacent generally horizontal underground paths.

**13**. The method of claim **10**, further comprising:

a) directing, the directional drilling unit to steer the drillstring to drill from current location through a generally vertical path;

b) evaluating, the drillstring location to determine current depth of the generally vertical path;

c) guiding, the directional drilling unit to steer the drillstring into a generally horizontal path, when a desired depth of the generally vertical path is attained;

d) examining, the drillstring location to determine length of the generally horizontal path;

e) returning, the drillstring through the generally horizontal path back to the vertical path, when a desired length of the horizontal path is attained; and

f) repeating, steps a-e until parallel generally horizontal paths have been drilled, a desired overall depth of the generally vertical path is attained and underground area is mapped for hollows.

**14**. The method of claim **10**, further comprising:

a) directing, the directional drilling unit to steer the drillstring to drill from current location through a generally horizontal path;

b) evaluating, the drillstring location to determine current length of the generally horizontal path;

c) guiding, the directional drilling unit to steer the drillstring into a generally vertical path, when a desired length of the generally vertical path is attained;

d) examining, the drillstring location to determine depth of the generally vertical path;

e) returning, the drillstring through the generally vertical path back to the generally horizontal path, when a desired depth of the generally vertical path is attained; and

f) repeating, steps a-e until parallel generally vertical paths have been drilled, a desired overall depth of the generally horizontal path is attained and underground area is mapped for hollows.

**15**. The method of claim **10**, further comprising:

monitoring, the detection of one or more hollows in an underground area designated by the user of the system through the user interface; and

alerting, the user of the system through the user interface when one or more hollows are detected in the underground area.

**16**. The method of claim **10**, wherein the sensor unit includes one or more of the following:

a. a borehole ground penetrating radar;

b. a seismic sensor;

c. a magnetometer;

d. an electrical resistivity sensor;

e. an acoustic sensor; or

f. an electromagnetic sensor using high-frequency radio waves.

**17**. The method of claim **10**, wherein the directional drilling unit is a rotary steerable unit.

**18**. The method of claim **10**, wherein said drilling is performed using the coiled tubing drilling method.

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