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(54) Title: METHOD AND SYSTEM FOR REMOVING FLUID FROM A SUBTERRANEAN ZONE USING AN ENLARGED CAVITY

FIG. 1

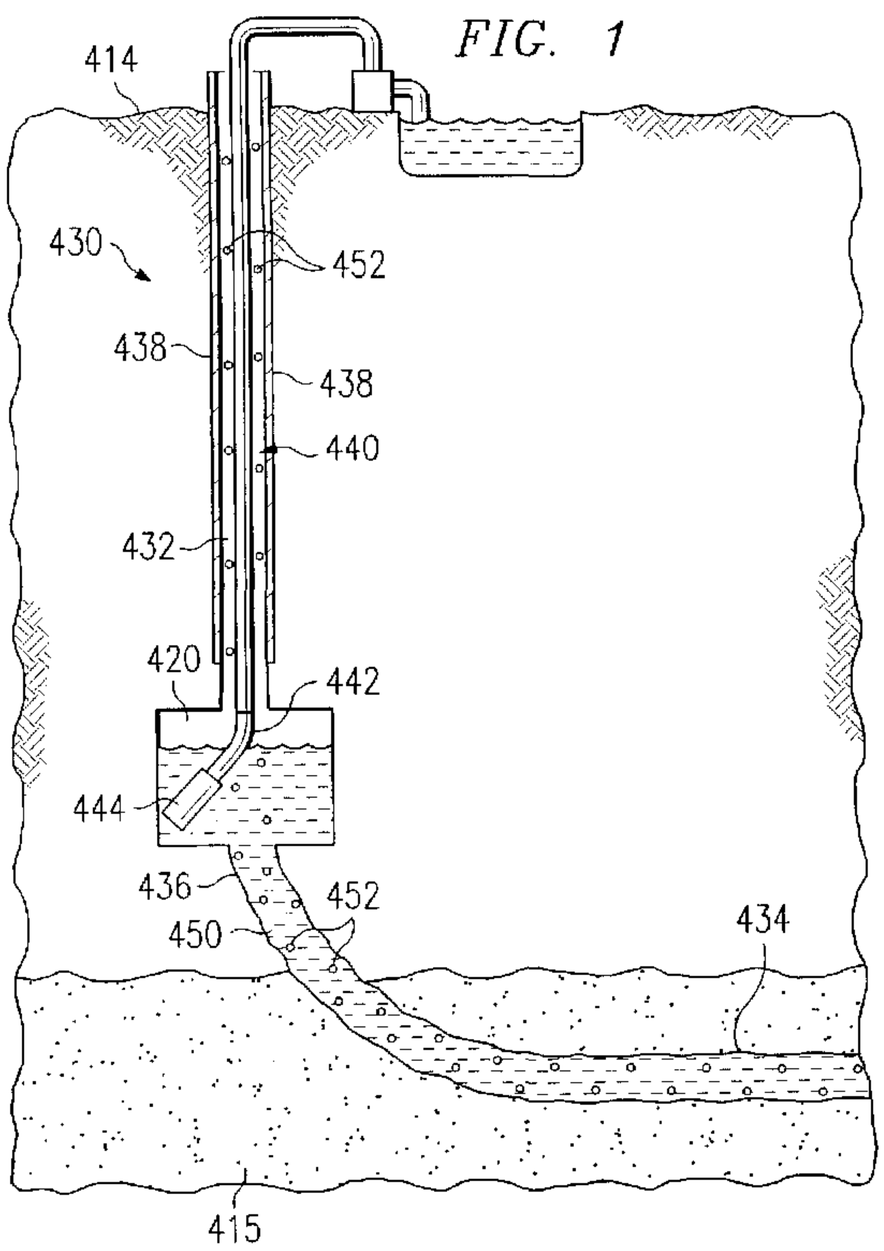
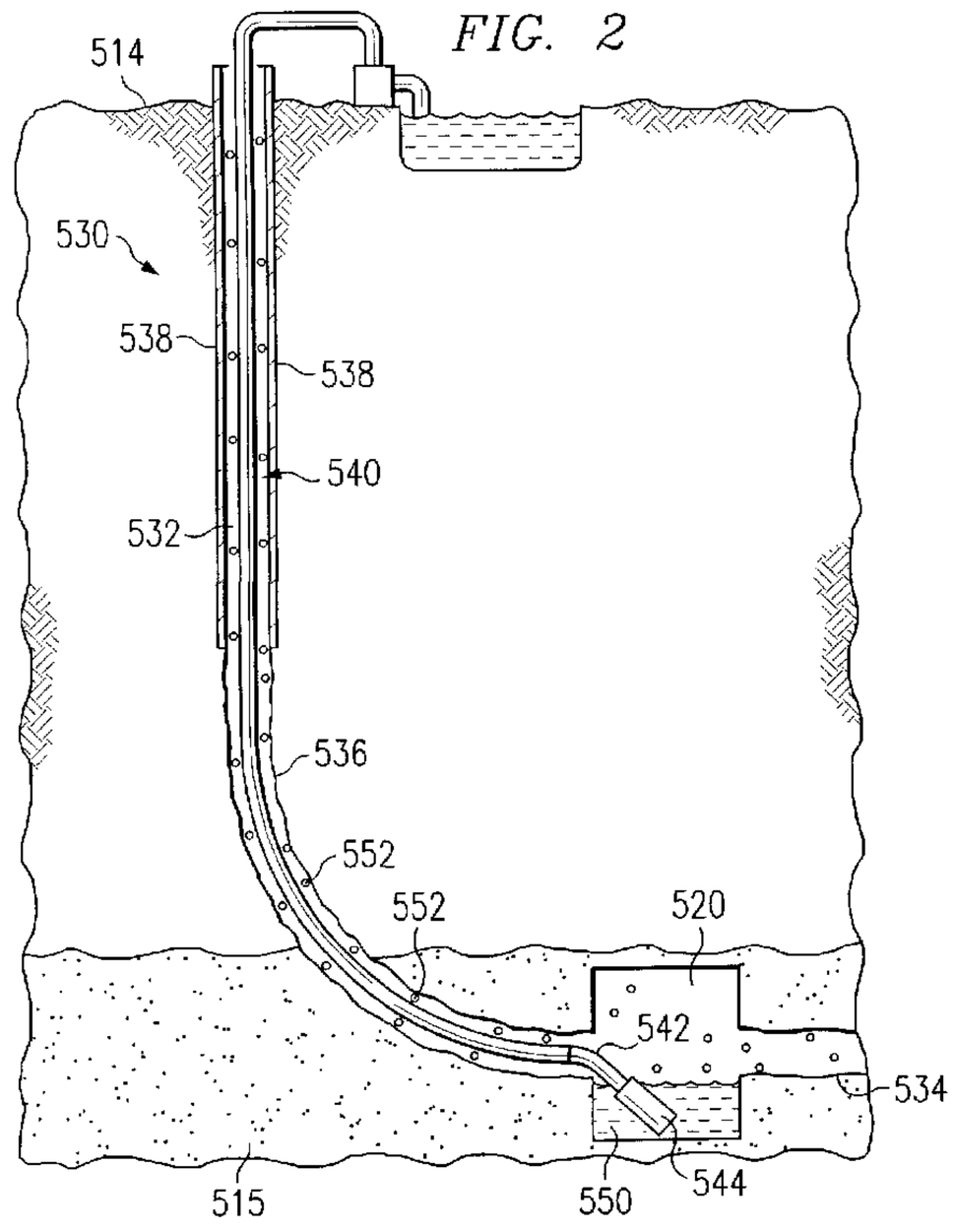


FIG. 2



(57) Abrégé/Abstract:
A method for removing fluid from a subterranean zone includes drilling a well bore from a surface to the subterranean zone and forming an enlarged cavity (420, 520, 620, 220, 120) in the well bore (430, 530, 630, 230, 130) such that the enlarged cavity acts as a chamber to separate liquid from gas flowing from the subterranean zone (415, 515, 615, 215, 115) through the well bore. The method includes positioning a pump (444, 544, 644, 244, 144) inlet within the enlarged cavity and operating a pumping unit to produce the liquid through the pump inlet. The well bore may comprise an articulated well bore.

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Declarations under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for all designations*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations*

[Continued on next page]

(54) Title: METHOD AND SYSTEM FOR REMOVING FLUID FROM A SUBTERRANEAN ZONE USING AN ENLARGED CAVITY

FIG. 1

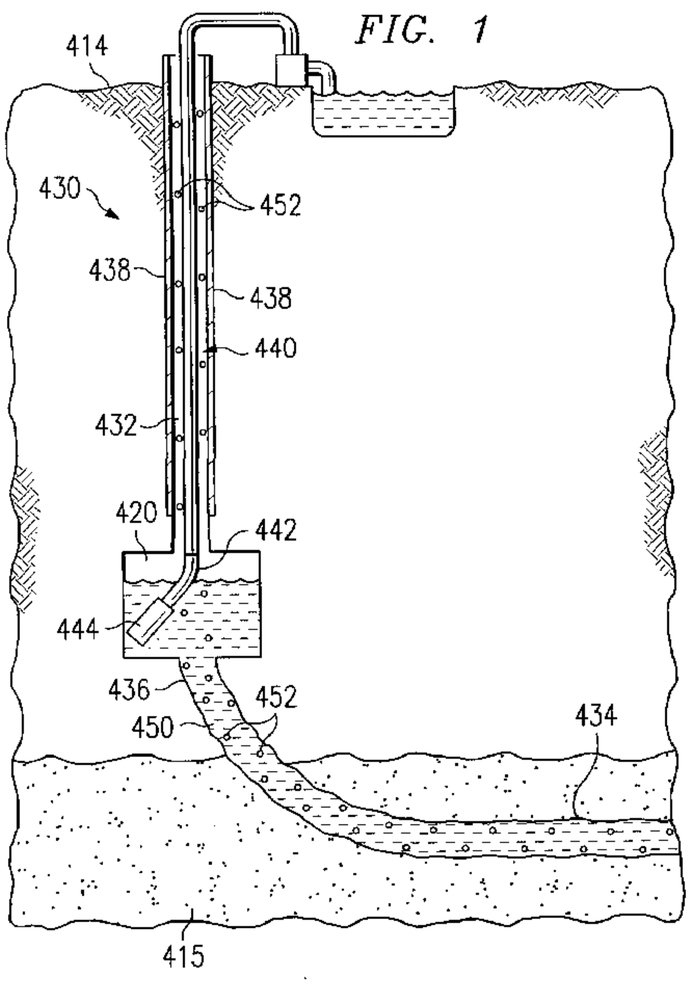
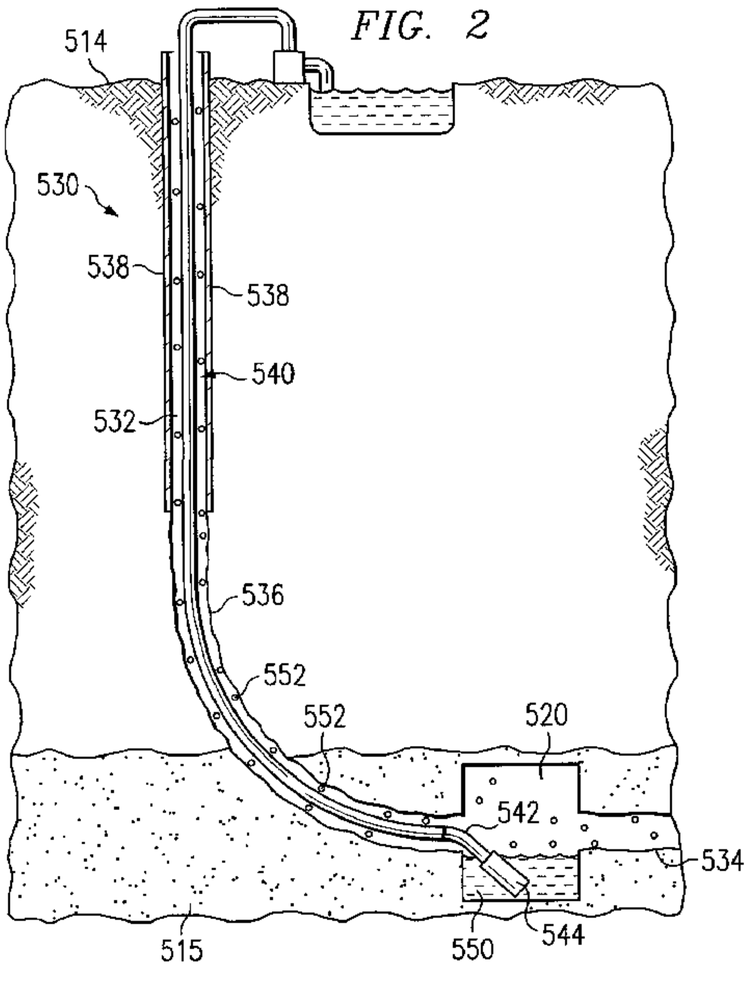


FIG. 2



(57) Abstract: A method for removing fluid from a subterranean zone includes drilling a well bore from a surface to the subterranean zone and forming an enlarged cavity (420, 520, 620, 220, 120) in the well bore (430, 530, 630, 230, 130) such that the enlarged cavity acts as a chamber to separate liquid from gas flowing from the subterranean zone (415, 515, 615, 215, 115) through the well bore. The method includes positioning a pump (444, 544, 644, 244, 144) inlet within the enlarged cavity and operating a pumping unit to produce the liquid through the pump inlet. The well bore may comprise an articulated well bore.

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METHOD AND SYSTEM FOR REMOVING FLUID FROM A SUBTERRANEAN ZONE USING AN ENLARGED CAVITY

TECHNICAL FIELD OF THE INVENTION

The present invention relates generally to the recovery of subterranean deposits, and more particularly to a method and system for removing fluid from a subterranean zone using an enlarged cavity.

BACKGROUND OF THE INVENTION

Subterranean zones, such as coal seams, contain substantial quantities of entrained methane gas. Subterranean zones are also often associated with liquid, such as water, which must be drained from the zone in order to produce the methane. When removing such liquid, entrained coal fines and other fluids from the subterranean zone through pumping, methane gas may enter the pump inlet which reduces pump efficiency.

SUMMARY OF THE INVENTION

The present invention provides a method and system for removing fluid from a subterranean zone using an enlarged cavity that substantially eliminates or reduces at least some of the disadvantages and problems associated with previous methods and systems.

In accordance with a particular embodiment of the present invention, a method for removing fluid from a subterranean zone includes drilling a well bore from a surface to the subterranean zone and forming an enlarged cavity in the well bore such that the enlarged cavity acts as a chamber to separate liquid from gas flowing from the subterranean zone through the well bore. The method includes positioning a pump inlet within the

enlarged cavity and operating a pumping unit to produce the liquid through the pump inlet.

The well bore may comprise an articulated well bore. Positioning a pump inlet within the enlarged cavity may comprise positioning a pump inlet within the enlarged cavity such that the pump inlet is offset from the flow of gas through the well bore. Forming an enlarged cavity in the well bore may comprise forming an enlarged cavity in a substantially vertical portion of the articulated well bore. The pump inlet may be horizontally offset from a longitudinal axis of the substantially vertical portion of the articulated well bore.

In accordance with another embodiment, a system for removing fluid from a subterranean zone includes a well bore extending from a surface to the subterranean zone and an enlarged cavity formed in the well bore. The enlarged cavity is configured to act as a chamber to separate liquid from gas flowing from the subterranean zone through the well bore. The system includes a pumping unit having a pump inlet positioned within the enlarged cavity. The pumping unit is operable to produce the liquid through the pump inlet.

Technical advantages of particular embodiments of the present invention include forming an enlarged cavity of an articulated well bore that enables liquid to separate from gas in the flow of fluid from a subterranean zone through the well bore at the enlarged cavity. The enlarged cavity also enables a user to position a pump inlet offset from the flow of gas through the articulated well bore. Thus, fluids and entrained coal fines pumped from the subterranean zone through the articulated well bore will contain less gas, resulting in greater pump efficiency.

The enlarged cavity may be formed in a substantially horizontal portion or a substantially vertical portion of the articulated well bore. If the enlarged cavity is formed in a substantially horizontal portion of the articulated well bore, the pump inlet may be positioned within the enlarged cavity such that it is vertically offset from the longitudinal axis of the substantially horizontal portion. If the enlarged cavity is formed in a substantially vertical portion of the articulated well bore, the pump inlet may be positioned within the enlarged cavity such that it is horizontally offset from the longitudinal axis of the substantially vertical portion. Positioning the pump inlet in this manner allows gas of a subterranean zone to bypass the pump inlet when fluids and/or entrained coal fines are pumped through the articulated well bore.

Other technical advantages will be readily apparent to one skilled in the art from the following figures, descriptions and claims. Moreover, while specific advantages have been enumerated above, various embodiments may include all, some or none of the enumerated advantages.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of particular embodiments of the invention and their advantages, reference is now made to the following descriptions, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 illustrates an example well system for removing fluid from a subterranean zone utilizing an enlarged cavity in a substantially vertical portion of an

articulated well bore, in accordance with an embodiment of the present invention;

FIGURE 2 illustrates an example well system for removing fluid from a subterranean zone utilizing an enlarged cavity in a substantially horizontal portion of an articulated well bore, in accordance with an embodiment of the present invention;

FIGURE 3 illustrates an example well system for removing fluid from a subterranean zone utilizing an enlarged cavity in a curved portion of an articulated well bore, in accordance with an embodiment of the present invention;

FIGURE 4 illustrates an example well system for removing fluid from a subterranean zone utilizing an enlarged cavity and a branch sump of an articulated well bore, in accordance with an embodiment of the present invention;

FIGURE 5 illustrates an example underreamer used to form an enlarged cavity, in accordance with an embodiment of the present invention;

FIGURE 6 illustrates the underreamer of FIGURE 5 with cutters in a semi-extended position, in accordance with an embodiment of the present invention;

FIGURE 7 illustrates the underreamer of FIGURE 5 with cutters in an extended position, in accordance with an embodiment of the present invention; and

FIGURE 8 is an isometric diagram illustrating an enlarged cavity having a generally cylindrical shape, in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIGURE 1 illustrates an example well system for removing fluid from a subterranean zone. An articulated

well bore 430 extends from surface 414 to subterranean zone 415. In this embodiment, subterranean zone 415 comprises a coal seam, however subterranean zones in accordance with other embodiments may comprise other compositions, such as shale.

Articulated well bore 430 includes a substantially vertical portion 432, a substantially horizontal portion 434 and a curved or radiused portion 436 interconnecting vertical and horizontal portions 432 and 434. Horizontal portion 434 lies substantially in the horizontal plane of subterranean zone 415. In particular embodiments, articulated well bore 430 may not include a horizontal portion, for example, if subterranean zone 415 is not horizontal. In such cases, articulated well bore 430 may include a portion substantially in the same plane as subterranean zone 415. Articulated well bore 430 may be drilled using an articulated drill string. Articulated well bore 430 may be lined with a suitable casing 438.

Articulated well bore 430 also includes an enlarged cavity 420 formed in substantially vertical portion 432. In this embodiment, enlarged cavity 420 comprises a generally cylindrical shape; however, enlarged cavities in accordance with other embodiments may comprise other shapes. Enlarged cavity 420 may be formed using suitable underreaming techniques and equipment, as described in further detail below with respect to FIGURES 5-7.

Articulated well bore 430 includes fluids 450. Fluids 450 may comprise drilling fluid and/or drilling mud used in connection with drilling articulated well bore 430, water, gas, for example methane gas released from subterranean zone 415, or other liquids and/or gases. In the illustrated embodiment, methane gas 452 is released

from subterranean zone 415 after articulated well bore 430 is drilled.

Enlarged cavity 420 acts as a chamber for the separation of gas and liquid since the cross-sectional area of enlarged cavity 420 is larger than the cross-sectional area of other portions of articulated well bore 430. This allows gas 452 to flow through and up the articulated well bore 430 while liquid separates out from the gas and remains in the enlarged cavity for pumping. Such separation occurs because the velocity of the gas flowing up through the articulated well bore decreases at enlarged cavity 420 below a velocity at which the gas can entrain liquid, thus allowing for the separation of the gas and liquid at enlarged cavity 420. This decrease in velocity results from the larger cross-sectional area of enlarged cavity 420 relative to the cross-sectional area of other portions of articulated well bore 430 through which the gas flows. An enlarged cavity having a larger cross-sectional area may lead to a greater reduction in velocity of the gas flowing up and through the well bore.

A pumping unit 440 is disposed within articulated well bore 430. In this embodiment, pumping unit 440 includes a bent sub section 442 and a pump inlet 444 disposed within enlarged cavity 420. Pumping unit 440 is operable to drain liquid, entrained coal fines and other fluids from articulated well bore 430. As discussed above, such liquid separates from the flow of gas 452 through articulated well bore 430 at enlarged cavity 420. Bent sub section 442 of pumping unit 440 enables pump inlet 444 to be disposed within enlarged cavity 420 at a position that is horizontally offset from the flow of gas 452 through articulated well bore 430 at enlarged cavity 420. In this embodiment, pump inlet 444 is horizontally

offset from the longitudinal axis of vertical portion 432 of articulated well bore 430. This position decreases the amount of gas 452 pumped through pump inlet 444 because gas 452 may bypass pump inlet 444 when it releases from subterranean zone 430 and flows through and up articulated well bore 430 where it may be flared, released or recovered. If pump inlet 444 was not horizontally offset from the flow of gas 452 through articulated well bore 430 at enlarged cavity 420, gas 452 may flow into pump inlet 444 when it released from subterranean zone 450. In that case the pump efficiency of the system would be reduced.

Thus, forming enlarged cavity 420 of articulated well bore 430 enables liquid of fluids 450 to separate out from the flow of gas 452 through the well bore. Enlarged cavity 420 also enables a user to position pump inlet 444 offset from the flow of gas 452 through articulated well bore 430 at enlarged cavity 420. Thus, the fluids and entrained coal fines pumped from subterranean zone 415 through articulated well bore 430 will contain less gas, resulting in greater pump efficiency.

FIGURE 2 illustrates another example well system for removing fluid from a subterranean zone. An articulated well bore 530 extends from surface 514 to subterranean zone 515. Articulated well bore 530 includes a substantially vertical portion 532, a substantially horizontal portion 534 and a curved portion 536 interconnecting vertical and horizontal portions 532 and 534. Articulated well bore 530 is lined with a suitable casing 538. Articulated well bore 530 also includes an enlarged cavity 520 formed in substantially horizontal portion 534.

Articulated well bore 530 includes fluids 550. Fluids 550 may comprise drilling fluid and/or drilling mud used in connection with drilling articulated well bore 530, water, gas, for example methane gas released from subterranean zone 515, or other liquids and/or gases. In the illustrated embodiment, methane gas 552 is released from subterranean zone 515 after articulated well bore 530 is drilled. Enlarged cavity 520 acts as a chamber for the separation of gas and liquid much like enlarged cavity 420 of FIGURE 1 discussed above.

A pumping unit 540 is disposed within articulated well bore 530. In this embodiment, pumping unit 540 includes a bent sub section 542 and a pump inlet 544 disposed within enlarged cavity 520. Pumping unit 540 is operable to drain liquid, entrained coal fines and other fluid from articulated well bore 530. As discussed above, such liquid separates from the flow of gas 552 through articulated well bore 530 at enlarged cavity 520. Bent sub section 542 of pumping unit 540 enables pump inlet 544 to be disposed within enlarged cavity 520 at a position that is vertically offset from the flow of gas 552 through articulated well bore 530 at enlarged cavity 520. In this embodiment, pump inlet 544 is vertically offset from the longitudinal axis of horizontal portion 534 of articulated well bore 530. This position decreases the amount of gas 552 pumped through pump inlet 544 because gas 552 may bypass pump inlet 544 when it releases from subterranean zone 530 and flows through and up articulated well bore 530. If pump inlet 544 was not vertically offset from the flow of gas 552 through articulated well bore 530 at enlarged cavity 520, gas 552 would likely flow into pump inlet 544 when it released

from subterranean zone 550. In that case the pump efficiency of the system would be reduced.

Enlarged cavity 520 also enables a user to position pump inlet 544 offset from the flow of gas 552 through articulated well bore 530 at enlarged cavity 520. Thus, the fluids and entrained coal fines pumped from subterranean zone 515 through articulated well bore 530 will contain less gas, resulting in greater pump efficiency.

FIGURE 3 illustrates another example well system for removing fluid from a subterranean zone. An articulated well bore 230 extends from surface 214 to subterranean zone 215. Articulated well bore 230 includes a substantially vertical portion 232, a substantially horizontal portion 234 and a curved portion 236 interconnecting vertical and horizontal portions 232 and 234.

Articulated well bore 230 includes an enlarged cavity 220 formed in curved portion 236. Articulated well bore 230 includes fluids 250. Fluids 250 may comprise drilling fluid and/or drilling mud used in connection with drilling articulated well bore 230, water, gas, for example methane gas released from subterranean zone 215, or other liquids and/or gases. In the illustrated embodiment, methane gas 252 is released from subterranean zone 215 after articulated well bore 230 is drilled. Enlarged cavity 220 acts as a chamber for the separation of gas and liquid much like enlarged cavity 420 of FIGURE 1 discussed above.

A pumping unit 240 is disposed within articulated well bore 230. Pumping unit 240 includes a pump inlet 244 disposed within enlarged cavity 220. Pumping unit 240 is operable to drain liquid, entrained coal fines and

other fluids from articulated well bore 230. As discussed above, such liquid separates from the flow of gas 252 through articulated well bore 230 at enlarged cavity 220. As illustrated, pump inlet 244 is offset from the flow of gas 252 through articulated well bore 230 at enlarged cavity 220. This decreases the amount of gas 252 pumped through pump inlet 244 because gas 252 may bypass pump inlet 244 when it releases from subterranean zone 230 and flows through and up articulated well bore 230.

Thus, forming enlarged cavity 220 of articulated well bore 230 enables liquids of fluids 250 to separate out from the flow of gas 252 through the well bore. Enlarged cavity 220 also enables a user to position pump inlet 244 offset from the flow of gas 252 through articulated well bore 230 at enlarged cavity 220. Thus, the fluids and entrained coal fines pumped from subterranean zone 215 through articulated well bore 230 will contain less gas, resulting in greater pump efficiency.

FIGURE 4 illustrates another example well system for removing fluid from a subterranean zone. An articulated well bore 130 extends from surface 114 to subterranean zone 115. Articulated well bore 130 includes a substantially vertical portion 132, a substantially horizontal portion 134, a curved portion 136 interconnecting vertical and horizontal portions 132 and 134, and a branch sump 137.

Articulated well bore 130 includes an enlarged cavity 120. Enlarged cavity 220 acts a chamber for the separation of gas 152 and liquid 153 which are included in fluids released from subterranean zone 115 after articulated well bore 130 is drilled. This allows gas

152 to flow through and up the articulated well bore 130 while liquid 153 separates out from the gas and remains in enlarged cavity 120 and branch sump 137 for pumping. Branch sump 137 provides a collection area from which liquid 153 may be pumped.

A pumping unit 140 is disposed within articulated well bore 130. Pumping unit 140 includes a pump inlet 144 disposed within branch sump 137. Pumping unit 140 is operable to drain liquid 153 and entrained coal fines from articulated well bore 130. As discussed above, such liquid 153 separates from the flow of gas 152 through articulated well bore 130. Thus, forming enlarged cavity 120 of articulated well bore 130 enables liquid 153 to separate out from the flow of gas 152 through the well bore. Thus, the fluids and entrained coal fines pumped from subterranean zone 115 through articulated well bore 130 will contain less gas, resulting in greater pump efficiency.

As described above, FIGURES 1-4 illustrate enlarged cavities formed in a substantially vertical portion, a substantially horizontal portion and a curved portion of an articulated well bore. It should be understood that embodiments of this invention may include an enlarged cavity formed in any portion of an articulated well bore, any portion of a substantially vertical well bore, any portion of a substantially horizontal well bore or any portion of any other well bore, such as a slant well bore.

FIGURE 5 illustrates an example underreamer 610 used to form an enlarged cavity, such as enlarged cavity 420 of FIGURE 1. Underreamer 610 includes two cutters 614 pivotally coupled to a housing 612. Other underreamers which may be used to form enlarged cavity 420 may have

one or more than two cutters 614. In this embodiment, cutters 614 are coupled to housing 612 via pins 615; however, other suitable methods may be used to provide pivotal or rotational movement of cutters 614 relative to housing 612. Housing 612 is illustrated as being substantially vertically disposed within a well bore 611; however, underreamer 610 may form an enlarged cavity while housing 612 is disposed in other positions as well. For example, underreamer 610 may form an enlarged cavity such as enlarged cavity 520 of FIGURE 2 while in a substantially horizontal position.

Underreamer 610 includes an actuator 616 with a portion slidably positioned within a pressure cavity 622 of housing 612. Actuator 616 includes a fluid passage 621. Fluid passage 621 includes an outlet 625 which allows fluid to exit fluid passage 621 into pressure cavity 622 of housing 612. Pressure cavity 622 includes an exit vent 627 which allows fluid to exit pressure cavity 622 into well bore 611. In particular embodiments, exit vent 627 may be coupled to a vent hose in order to transport fluid exiting through exit vent 627 to the surface or to another location. Actuator 616 also includes an enlarged portion 620 which, in this embodiment, has a beveled portion 624. However, other embodiments may include an actuator having an enlarged portion that comprises other angles, shapes or configurations, such as a cubical, spherical, conical or teardrop shape. Actuator 616 also includes pressure grooves 631.

Cutters 614 are illustrated in a retracted position, nesting around actuator 616. Cutters 614 may have a length of approximately two to three feet; however the length of cutters 614 may be different in other

embodiments. Cutters 614 are illustrated as having angled ends; however, the ends of cutters 614 in other embodiments may not be angled or they may be curved, depending on the shape and configuration of enlarged portion 620. Cutters 614 include side cutting surfaces 654 and end cutting surfaces 656. Cutters 614 may also include tips which may be replaceable in particular embodiments as the tips get worn down during operation. In such cases, the tips may include end cutting surfaces 656. Cutting surfaces 654 and 656 and the tips may be dressed with a variety of different cutting materials, including, but not limited to, polycrystalline diamonds, tungsten carbide inserts, crushed tungsten carbide, hard facing with tube barium, or other suitable cutting structures and materials, to accommodate a particular subsurface formation. Additionally, various cutting surfaces 654 and 656 configurations may be machined or formed on cutters 614 to enhance the cutting characteristics of cutters 614.

In operation, a pressurized fluid is passed through fluid passage 621 of actuator 616. Such disposition may occur through a drill pipe connector connected to housing 612. The pressurized fluid flows through fluid passage 621 and exits the fluid passage through outlet 625 into pressure cavity 622. Inside pressure cavity 622, the pressurized fluid exerts a first axial force 640 upon an enlarged portion 637 of actuator 616. Enlarged portion 637 may be encircled by circular gaskets in order to prevent pressurized fluid from flowing around enlarged portion 637. The exertion of first axial force 640 on enlarged portion 637 of actuator 616 causes movement of actuator 616 relative to housing 612. Such movement causes beveled portion 624 of enlarged portion 620 to

contact cutters 614 causing cutters 614 to rotate about pins 615 and extend radially outward relative to housing 612. Through the extension of cutters 614, underreamer 610 forms an enlarged cavity as cutting surfaces 654 and 656 of cutters 614 come into contact with the surfaces of well bore 611.

Housing 612 may be rotated within well bore 611 as cutters 614 extend radially outward to aid in forming an enlarged cavity 642. Rotation of housing 612 may be achieved using a drill string coupled to the drill pipe connector; however, other suitable methods of rotating housing 612 may be utilized. For example, a downhole motor in well bore 611 may be used to rotate housing 612. In particular embodiments, both a downhole motor and a drill string may be used to rotate housing 612. The drill string may also aid in stabilizing housing 612 in well bore 611.

FIGURE 6 is a diagram illustrating underreamer 610 of FIGURE 5 in a semi-extended position. In FIGURE 6, cutters 614 are in a semi-extended position relative to housing 612 and have begun to form an enlarged cavity 642. When first axial force 640 (illustrated in FIGURE 5) is applied and actuator 616 moves relative to housing 612, enlarged portion 637 of actuator 616 will eventually reach an end 644 of pressure cavity 622. At this point, enlarged portion 620 is proximate an end 617 of housing 612. Cutters 614 are extended as illustrated and an angle 646 will be formed between them. In this embodiment, angle 646 is approximately sixty degrees, but angle 646 may be different in other embodiments depending on the angle of beveled portion 624 or the shape or configuration of enlarged portion 620. As enlarged portion 637 of actuator 616 reaches end 644 of pressure

cavity 622, the fluid within pressure cavity 622 may exit pressure cavity 622 into well bore 611 through pressure grooves 631. Fluid may also exit pressure cavity 622 through exit vent 627. Other embodiments of the present invention may provide other ways for the pressurized fluid to exit pressure cavity 622.

FIGURE 7 is a diagram illustrating underreamer 610 of FIGURE 6 in an extended position. Once enough first axial force 640 has been exerted on enlarged portion 637 of actuator 616 for enlarged portion 637 to contact end 644 of pressure cavity 622 thereby extending cutters 614 to a semi-extended position as illustrated in FIGURE 6, a second axial force 648 may be applied to underreamer 610. Second axial force 648 may be applied by moving underreamer 610 relative to well bore 611. Such movement may be accomplished by moving the drill string coupled to the drill pipe connector or by any other technique. The application of second axial force 648 forces cutters 614 to rotate about pins 615 and further extend radially outward relative to housing 612. The application of second axial force 648 may further extend cutters 614 to a position where they are approximately perpendicular to a longitudinal axis of housing 612, as illustrated in FIGURE 7. Housing 612 may include a bevel or "stop" in order to prevent cutters 614 from rotating passed a particular position, such as an approximately perpendicular position to a longitudinal axis of housing 612 as illustrated in FIGURE 7.

As stated above, housing 612 may be rotated within well bore 611 when cutters 614 are extended radially outward to aid in forming enlarged cavity 642. Underreamer 610 may also be raised and lowered within well bore 611 to further define and shape cavity 642. It

should be understood that a subterranean cavity having a shape other than the shape of cavity 642 may be formed with underreamer 610.

FIGURE 8 is an isometric diagram illustrating an enlarged cavity 660 having a generally cylindrical shape which may be formed using underreamer 610 of FIGURES 5-7. Enlarged cavity 660 may be formed by raising and/or lowering the underreamer in the well bore and by rotating the underreamer. Enlarged cavity 660 is also an example of cavity 420 of FIGURE 1.

Although enlarged cavities having a generally cylindrical shape have been illustrated, it should be understood that an enlarged cavity having another shape may be used in accordance with particular embodiments of the present invention. Furthermore, an enlarged cavity may be formed by using an underreamer as described herein or by using other suitable techniques or methods, such as blasting or solution mining.

Although the present invention has been described in detail, various changes and modifications may be suggested to one skilled in the art. It is intended that the present invention encompass such changes and modifications as falling within the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A method for removing fluid from a subterranean zone, comprising:

drilling an articulated well bore from a surface to the subterranean zone;

forming an enlarged cavity in the articulated well bore such that the enlarged cavity acts as a chamber to separate liquid from gas flowing from the subterranean zone through the articulated well bore;

inserting a portion of a pumping unit having a pump inlet through the articulated well bore;

positioning the pump inlet within the enlarged cavity; and

operating the pumping unit to produce the liquid through the pump inlet.

2. The method of Claim 1, wherein positioning a pump inlet within the enlarged cavity comprises positioning a pump inlet within the enlarged cavity such that the pump inlet is offset from the flow of gas through the articulated well bore.

3. **(Canceled)**

4. The method of Claim 1, wherein:

the articulated well bore comprises a substantially vertical portion;

forming an enlarged cavity in the articulated well bore comprises forming an enlarged cavity in the substantially vertical portion of the articulated well bore; and

positioning a pump inlet within the enlarged cavity comprises positioning a pump inlet such that the pump inlet is horizontally offset from a longitudinal axis of the substantially vertical portion of the articulated well bore.

5. The method of Claim 1, wherein:

the articulated well bore comprises a substantially horizontal portion;

forming an enlarged cavity in the articulated well bore comprises forming an enlarged cavity in the substantially horizontal portion of the articulated well bore; and

positioning a pump inlet within the enlarged cavity comprises positioning a pump inlet such that the pump inlet is vertically offset from a longitudinal axis of the substantially horizontal portion of the articulated well bore.

6. The method of Claim 1, wherein:

the articulated well bore comprises a curved portion;

forming an enlarged cavity in the articulated well bore comprises forming an enlarged cavity in the curved portion of the articulated well bore; and

positioning a pump inlet within the enlarged cavity comprises positioning a pump inlet such that the pump inlet is offset from the flow of gas through the curved portion.

7. A system for removing fluid from a subterranean zone, comprising:

an articulated well bore extending from a surface to the subterranean zone;

an enlarged cavity formed in the articulated well bore, the enlarged cavity configured to act as a chamber to separate liquid from gas flowing from the subterranean zone through the articulated well bore;

a pumping unit having a pump inlet, the pumping unit having a portion extending from the surface through the articulated well bore such that the pump inlet is positioned within the enlarged cavity; and

wherein the pumping unit is operable to produce the liquid through the pump inlet.

8. The system of Claim 7, wherein the pump inlet is positioned offset from the flow of gas through the articulated well bore.

9. **(Canceled)**

10. The system of Claim 7, wherein:

the articulated well bore comprises a substantially vertically portion;

an enlarged cavity formed in the articulated well bore comprises an enlarged cavity formed in the substantially vertical portion of the articulated well bore; and

the pump inlet is horizontally offset from a longitudinal axis of the substantially vertical portion of the articulated well bore.

11. The system of Claim 7, wherein:

the articulated well bore comprises a substantially horizontal portion;

an enlarged cavity formed in the well bore comprises an enlarged cavity formed in the substantially horizontal portion of the articulated well bore; and

the pump inlet is vertically offset from a longitudinal axis of the substantially horizontal portion of the articulated well bore.

12. The system of Claim 7, wherein:

the articulated well bore comprises a curved portion;

an enlarged cavity formed in the articulated well bore comprises an enlarged cavity formed in the curved portion of the articulated well bore; and

the pump inlet is offset from the flow of gas through the curved portion.

13. A method for removing fluid from a subterranean zone, comprising:

drilling an articulated well bore from a surface to the subterranean zone;

forming an enlarged cavity in the articulated well bore;

inserting a portion of a pumping unit having a pump inlet through the articulated well bore;

positioning the pump inlet within the enlarged cavity such that the pump inlet is offset from the flow of gas from the subterranean zone through the well bore; and

operating a pumping unit to produce liquid through the pump inlet.

14. **(Canceled)**

15. **(Canceled)**

16. The method of Claim 13, wherein:

the articulated well bore comprises a substantially vertical portion;

forming an enlarged cavity in the articulated well bore comprises forming an enlarged cavity in the substantially vertical portion of the articulated well bore; and

positioning a pump inlet within the enlarged cavity such that the pump inlet is offset from the flow of gas from the subterranean zone through the articulated well bore comprises positioning the pump inlet such that the pump inlet is horizontally offset from a longitudinal axis of the substantially vertical portion of the articulated well bore.

17. The method of Claim 13, wherein:

the articulated well bore comprises a substantially horizontal portion;

forming an enlarged cavity in the articulated well bore comprises forming an enlarged cavity in the substantially horizontal portion of the articulated well bore; and

positioning a pump inlet within the enlarged cavity such that the pump inlet is offset from the flow of gas from the subterranean zone through the well bore comprises positioning the pump inlet such that the pump inlet is vertically offset from a longitudinal axis of the substantially horizontal portion of the articulated well bore.

18. The method of Claim 13, wherein:

the articulated well bore comprises a curved portion; and

forming an enlarged cavity in the articulated well bore comprises forming an enlarged cavity in the curved portion of the articulated well bore.

19. A system for removing fluid from a subterranean zone, comprising:

an articulated well bore extending from a surface to the subterranean zone;

an enlarged cavity formed in the well bore;

a pumping unit having a pump inlet, the pumping unit having a portion extending from the surface through the articulated well bore such that the pump inlet is positioned within the enlarged cavity such that the pump inlet is offset from the flow of gas from the subterranean zone through the well bore; and

wherein the pumping unit is operable to produce liquid through the pump inlet.

20. **(Canceled)**

21. **(Canceled)**

22. The system of Claim 19, wherein:

the articulated well bore comprises a substantially vertical portion;

an enlarged cavity formed in the articulated well bore comprises an enlarged cavity formed in the substantially vertical portion of the articulated well bore; and

the pump inlet is horizontally offset from a longitudinal axis of the substantially vertical portion of the articulated well bore.

23. The system of Claim 19, wherein:

the articulated well bore comprises a substantially horizontal portion;

an enlarged cavity formed in the articulated well bore comprises an enlarged cavity formed in the substantially horizontal portion of the articulated well bore; and

the pump inlet is vertically offset from a longitudinal axis of the substantially horizontal portion of the articulated well bore.

24. The system of Claim 19, wherein:

the articulated well bore comprises a curved portion; and

an enlarged cavity formed in the articulated well bore comprises an enlarged cavity formed in the curved portion of the articulated well bore.

25. A method for removing fluid from a subterranean zone, comprising:

drilling an articulated well bore from a surface to the subterranean zone;

forming an enlarged cavity in the articulated well bore such that the enlarged cavity acts as a chamber to separate liquid from gas flowing from the subterranean zone through the articulated well bore;

inserting a portion of a pumping unit having a pump inlet through the articulated well bore;

positioning the pump inlet within a portion of the well bore; and

operating the pumping unit to produce the liquid through the pump inlet.

26. The method of Claim 25, wherein:

the articulated well bore comprises a branch sump that collects the liquid separated from gas at the enlarged cavity; and

positioning a pump inlet within a portion of the articulated well bore comprises positioning a pump inlet within the branch sump of the articulated well bore.

27. A system for removing fluid from a subterranean zone, comprising:

an articulated well bore extending from a surface to the subterranean zone;

an enlarged cavity formed in the well bore, the enlarged cavity configured to act as a chamber to separate liquid from gas flowing from the subterranean zone through the well bore;

a pumping unit having a pump inlet, the pumping unit having a portion extending from the surface through the articulated well bore such that the pump inlet is positioned within the articulated well bore; and

wherein the pumping unit is operable to produce the liquid through the pump inlet.

28. The system of Claim 27, wherein:

the articulated well bore comprises a branch sump configured to collect the liquid that separates from gas at the enlarged cavity; and

the pump inlet is positioned within the branch sump of the articulated well bore.

29. A method for removing fluid from a subterranean zone, comprising:

drilling an articulated well bore from a surface to the subterranean zone;

forming an enlarged cavity in the articulated well bore apart from any intersection with any wellbore from the surface, the enlarged cavity adapted to act as a chamber to separate liquid from gas flowing from the subterranean zone through the articulated well bore;

positioning a pump inlet within a portion of the articulated well bore; and

operating a pumping unit to produce the liquid through the pump inlet.

30. The method of Claim 29, wherein positioning a pump inlet within the enlarged cavity comprises positioning a pump inlet within the enlarged cavity such that the pump inlet is offset from the flow of gas through the articulated well bore.

31. The method of Claim 29, wherein positioning a pump inlet within a portion of the articulated well bore comprises positioning the pump inlet within the enlarged cavity.

32. The method of Claim 29, wherein:

the articulated well bore comprises a branch sump that collects the liquid separated from gas at the enlarged cavity; and

positioning a pump inlet within a portion of the well bore comprises positioning a pump inlet within the branch sump of the articulated well bore.

33. The method of Claim 29, wherein:

the articulated well bore comprises a substantially vertical portion;

forming an enlarged cavity in the articulated well bore comprises forming an enlarged cavity in the substantially vertical portion of the articulated well bore; and

positioning a pump inlet within a portion of the articulated well bore comprises positioning a pump inlet such that the pump inlet is horizontally offset from a longitudinal axis of the substantially vertical portion of the articulated well bore.

34. The method of Claim 29, wherein:

the articulated well bore comprises a substantially horizontal portion;

forming an enlarged cavity in the articulated well bore comprises forming an enlarged cavity in the substantially horizontal portion of the articulated well bore; and

positioning a pump inlet within a portion of the articulated well bore comprises positioning a pump inlet such that the pump inlet is vertically offset from a longitudinal axis of the substantially horizontal portion of the articulated well bore.

35. The method of Claim 29, wherein:

the articulated well bore comprises a curved portion;

forming an enlarged cavity in the articulated well bore comprises forming an enlarged cavity in the curved portion of the articulated well bore; and

positioning a pump inlet within a portion of the articulated well bore comprises positioning a pump inlet such that the pump inlet is offset from the flow of gas through the curved portion.

36. A system for removing fluid from a subterranean zone, comprising:

an articulated well bore extending from a surface to the subterranean zone;

an enlarged cavity formed in the articulated well bore apart from any intersection with any other well bore from the surface, the enlarged cavity configured to act as a chamber to separate liquid from gas flowing from the subterranean zone through the articulated well bore;

a pumping unit having a pump inlet positioned within the well bore; and

wherein the pumping unit is operable to produce the liquid through the pump inlet.

37. The system of Claim 36, wherein positioning a pump inlet within the enlarged cavity comprises positioning a pump inlet within the enlarged cavity such that the pump inlet is offset from the flow of gas through the articulated well bore.

38. The system of Claim 36, wherein the pump inlet is positioned within the enlarged cavity.

39. The system of Claim 36, wherein:

the well bore comprises an articulated well bore comprising a branch sump configured to collect the liquid that separates from gas at the enlarged cavity; and

the pump inlet is positioned within the branch sump of the articulated well bore.

40. The system of Claim 36, wherein:

the articulated well bore comprises a substantially vertically portion;

an enlarged cavity formed in the articulated well bore comprises an enlarged cavity formed in the substantially vertical portion of the articulated well bore; and

the pump inlet is horizontally offset from a longitudinal axis of the substantially vertical portion of the articulated well bore.

41. The system of Claim 36, wherein:

the articulated well bore comprises a substantially horizontal portion;

an enlarged cavity formed in the well bore comprises an enlarged cavity formed in the substantially horizontal portion of the articulated well bore; and

the pump inlet is vertically offset from a longitudinal axis of the substantially horizontal portion of the articulated well bore.

42. The system of Claim 36, wherein:

the articulated well bore comprises a curved portion;

an enlarged cavity formed in the articulated well bore comprises an enlarged cavity formed in the curved portion of the articulated well bore; and

the pump inlet is offset from the flow of gas through the curved portion.

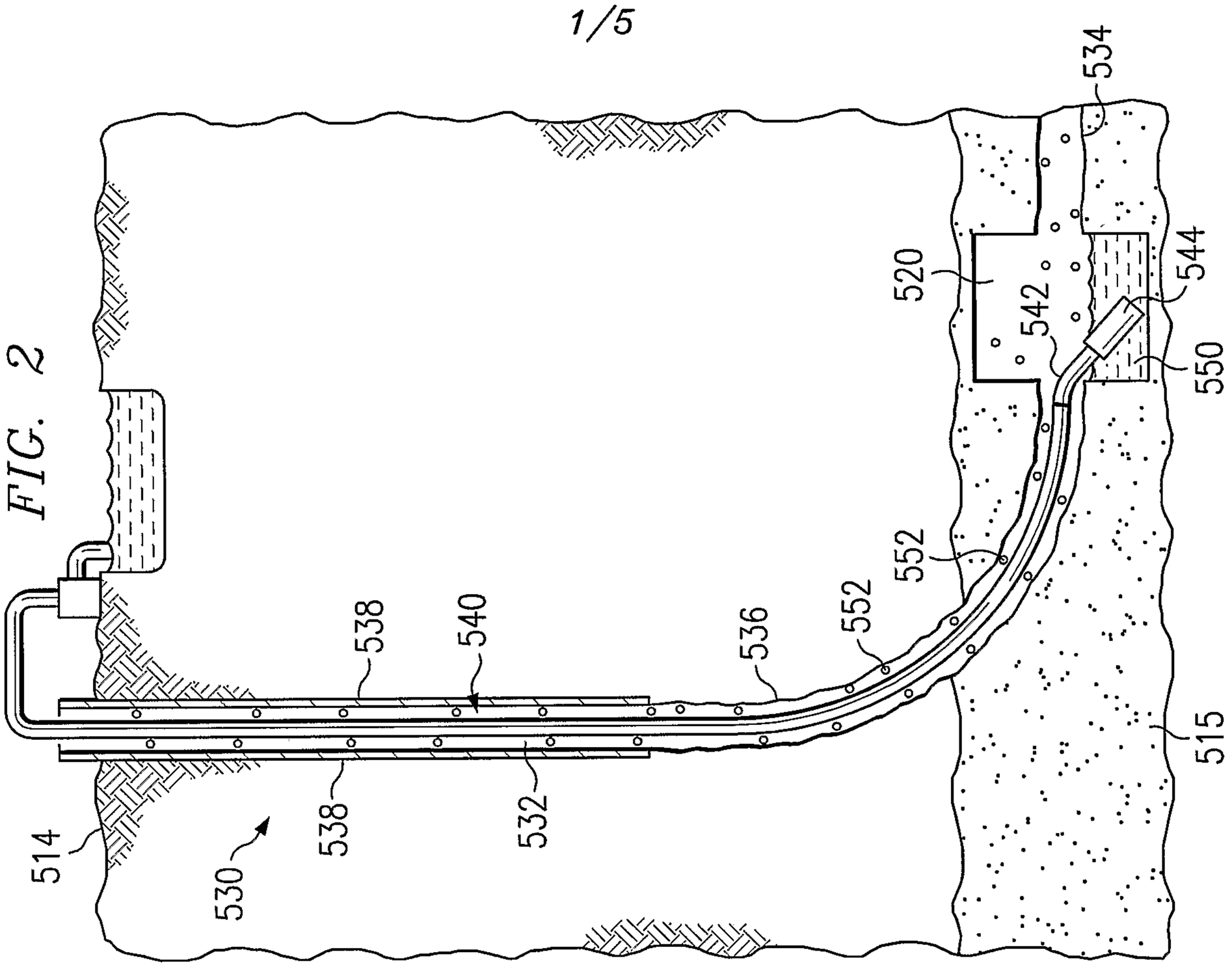
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FIG. 2

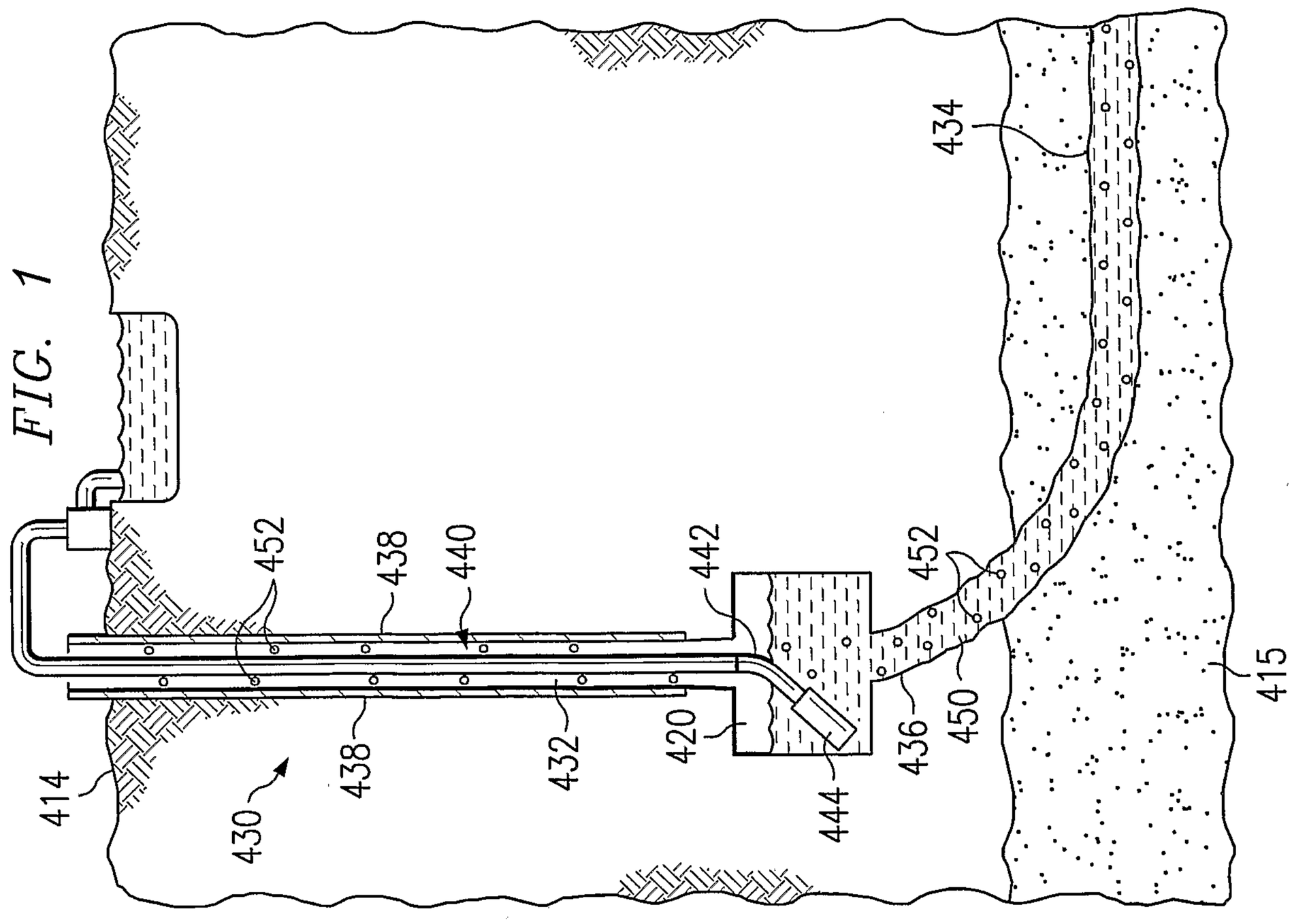
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FIG. 1

FIG. 4

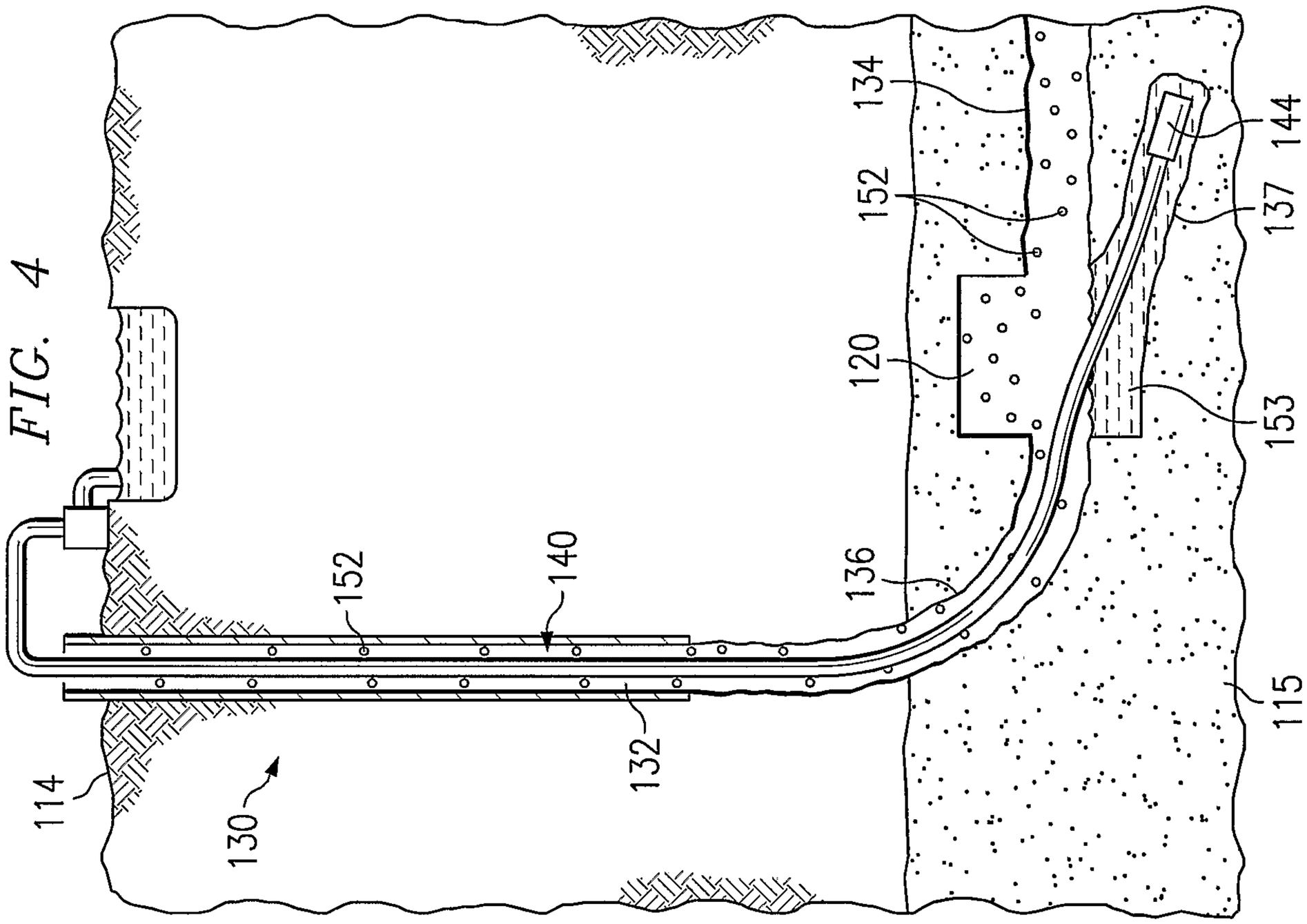
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FIG. 3

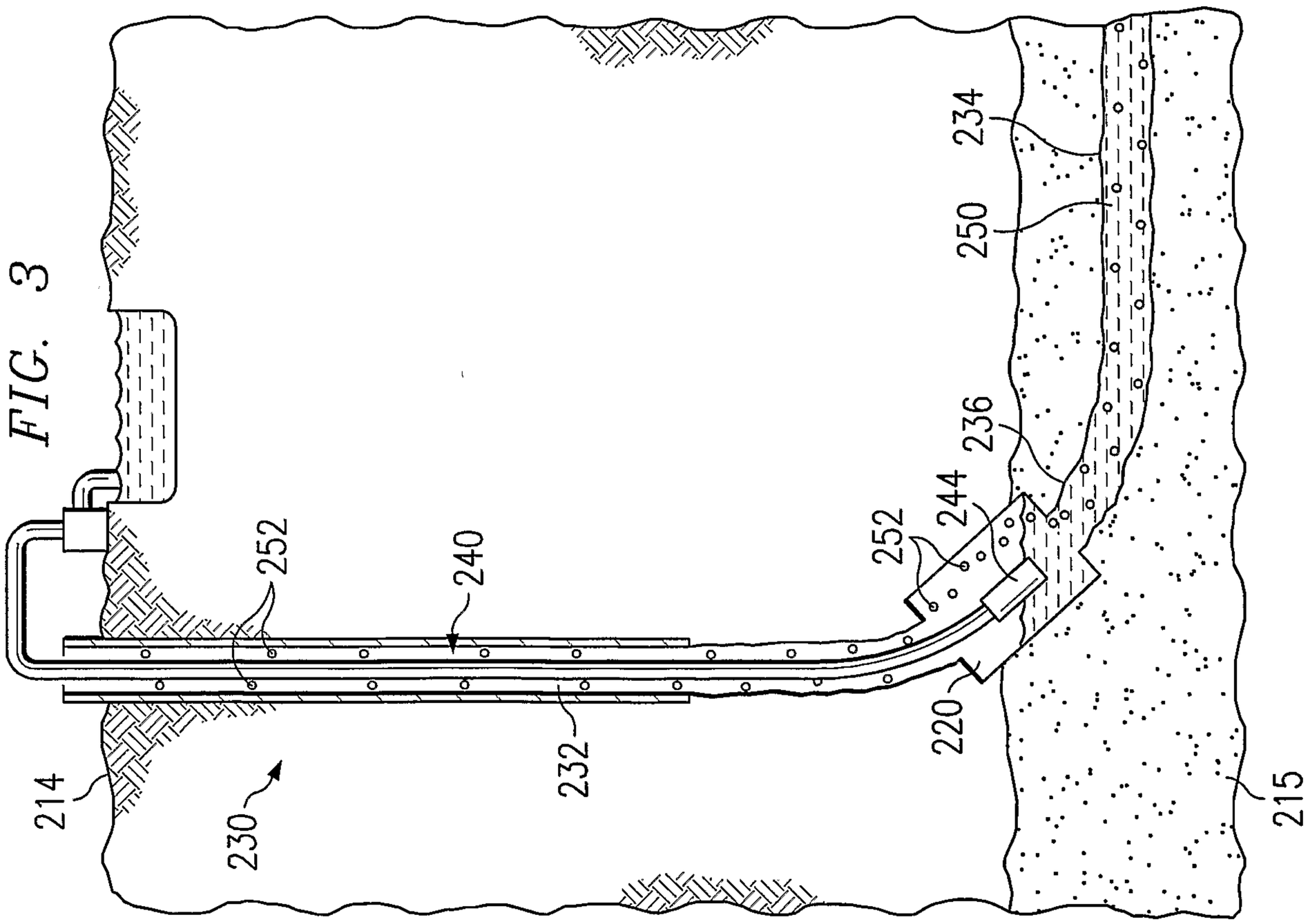
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FIG. 5

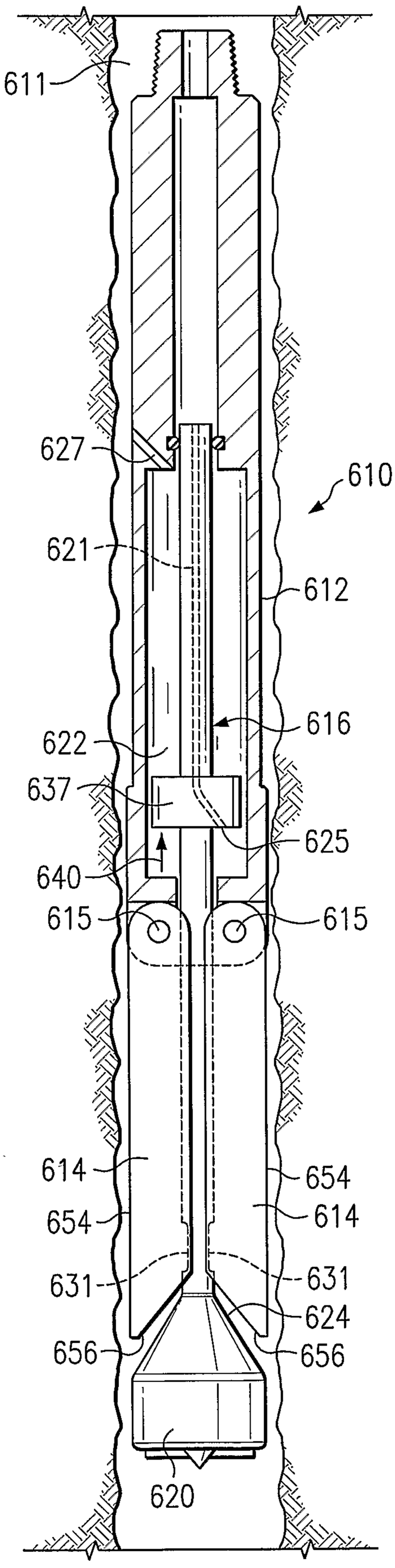
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FIG. 6

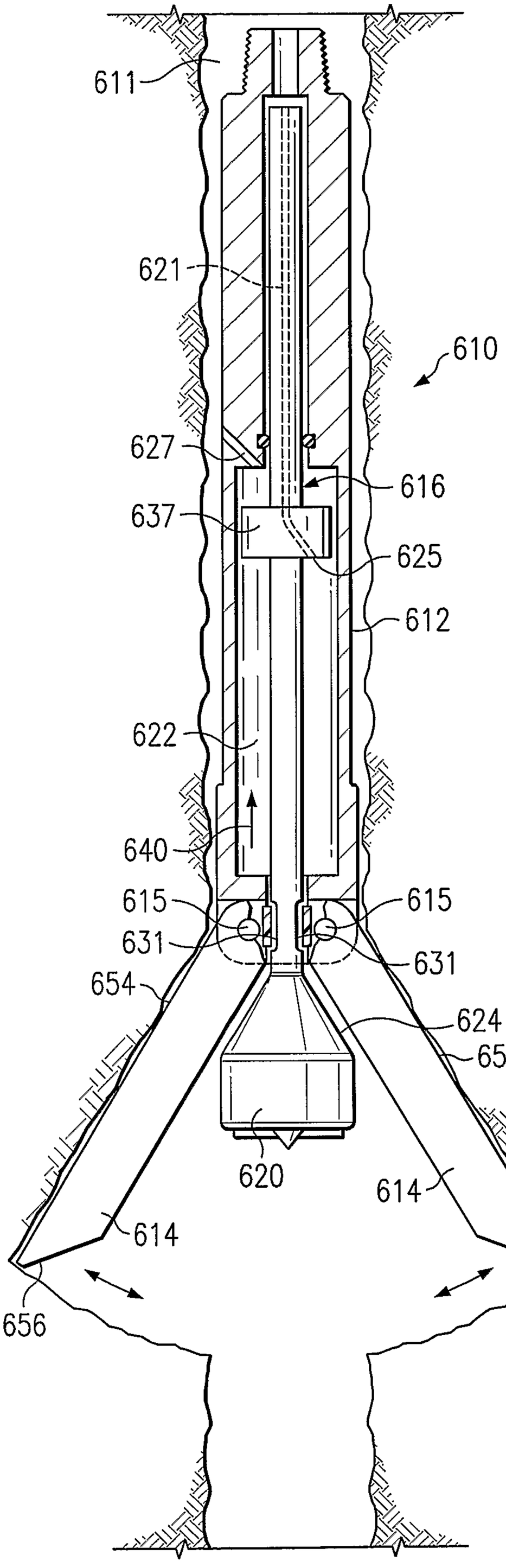
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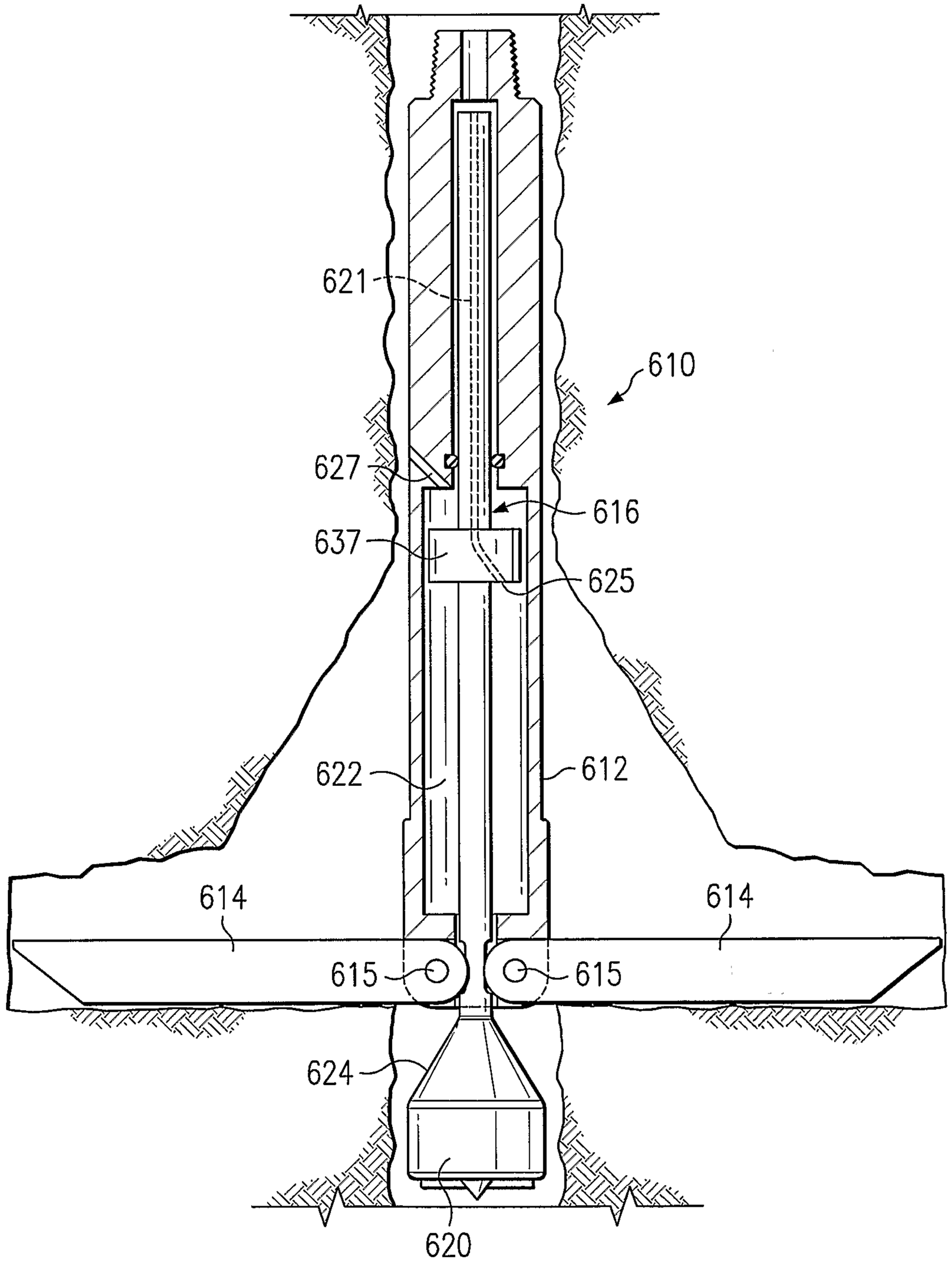
FIG. 7



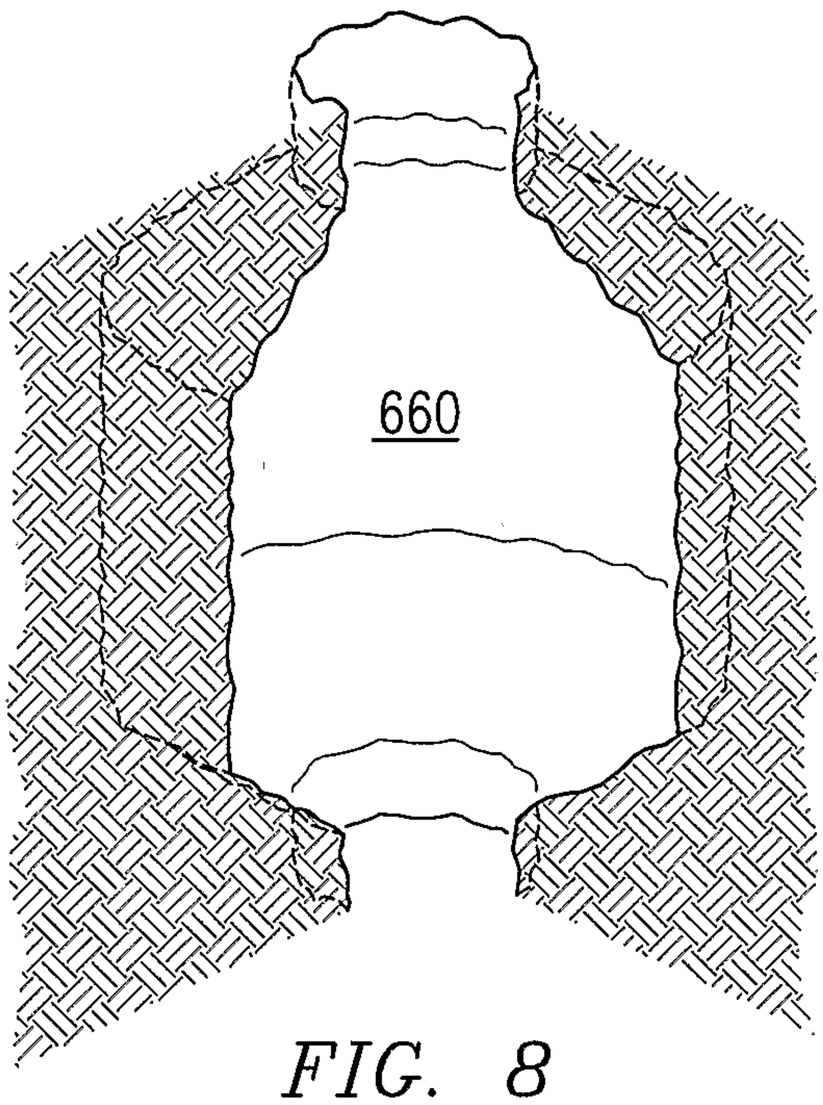


FIG. 8

FIG. 1

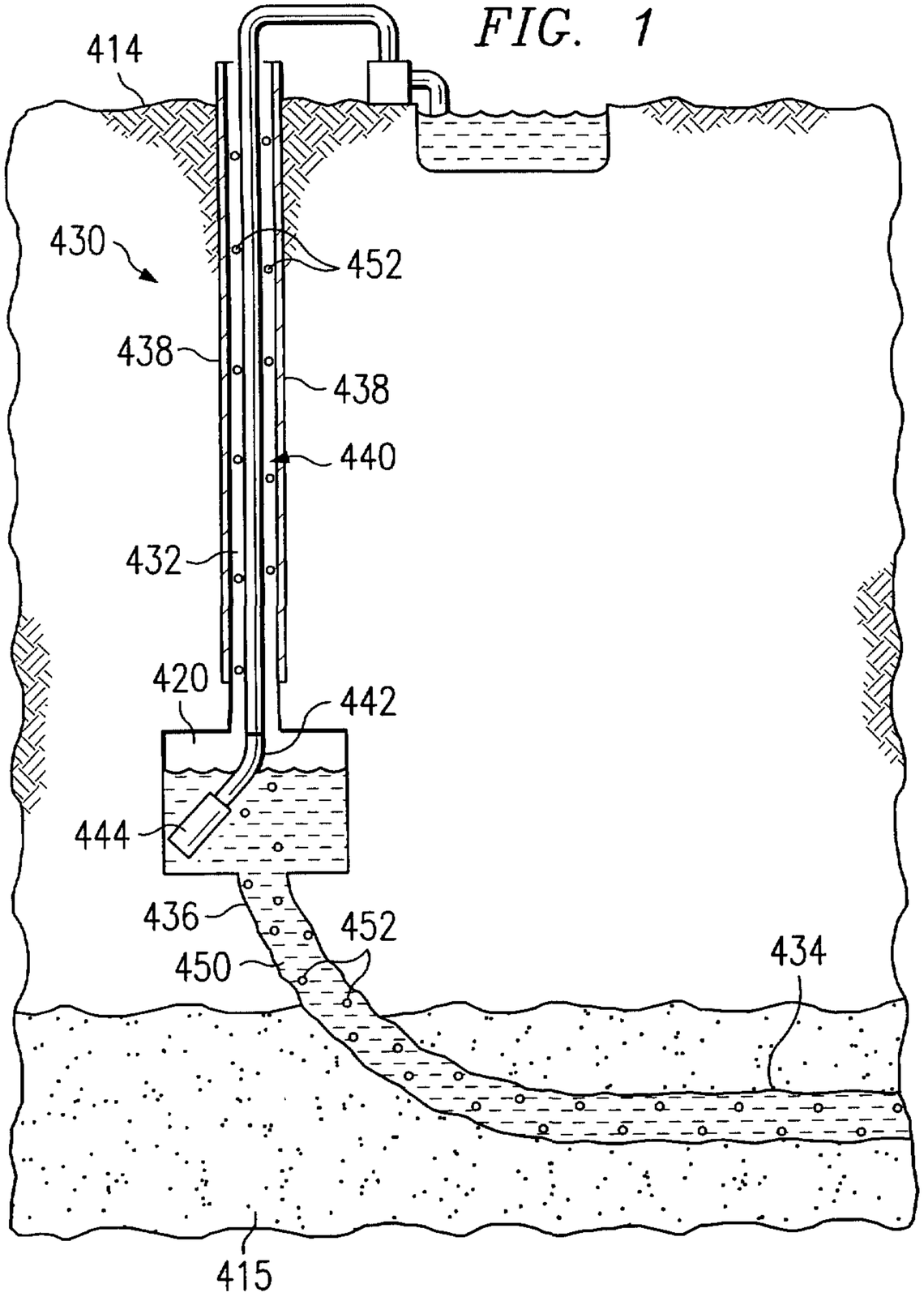

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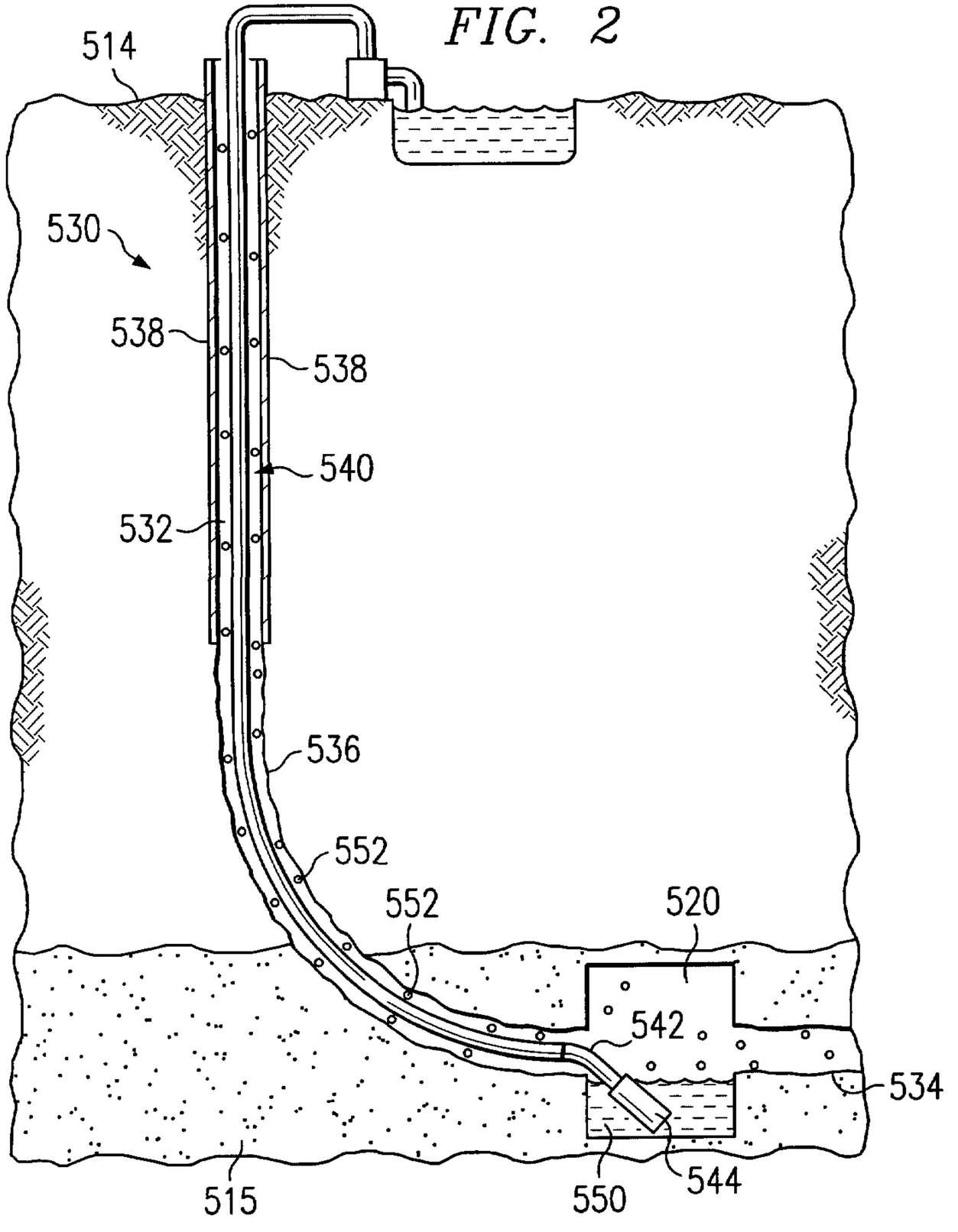
FIG. 2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