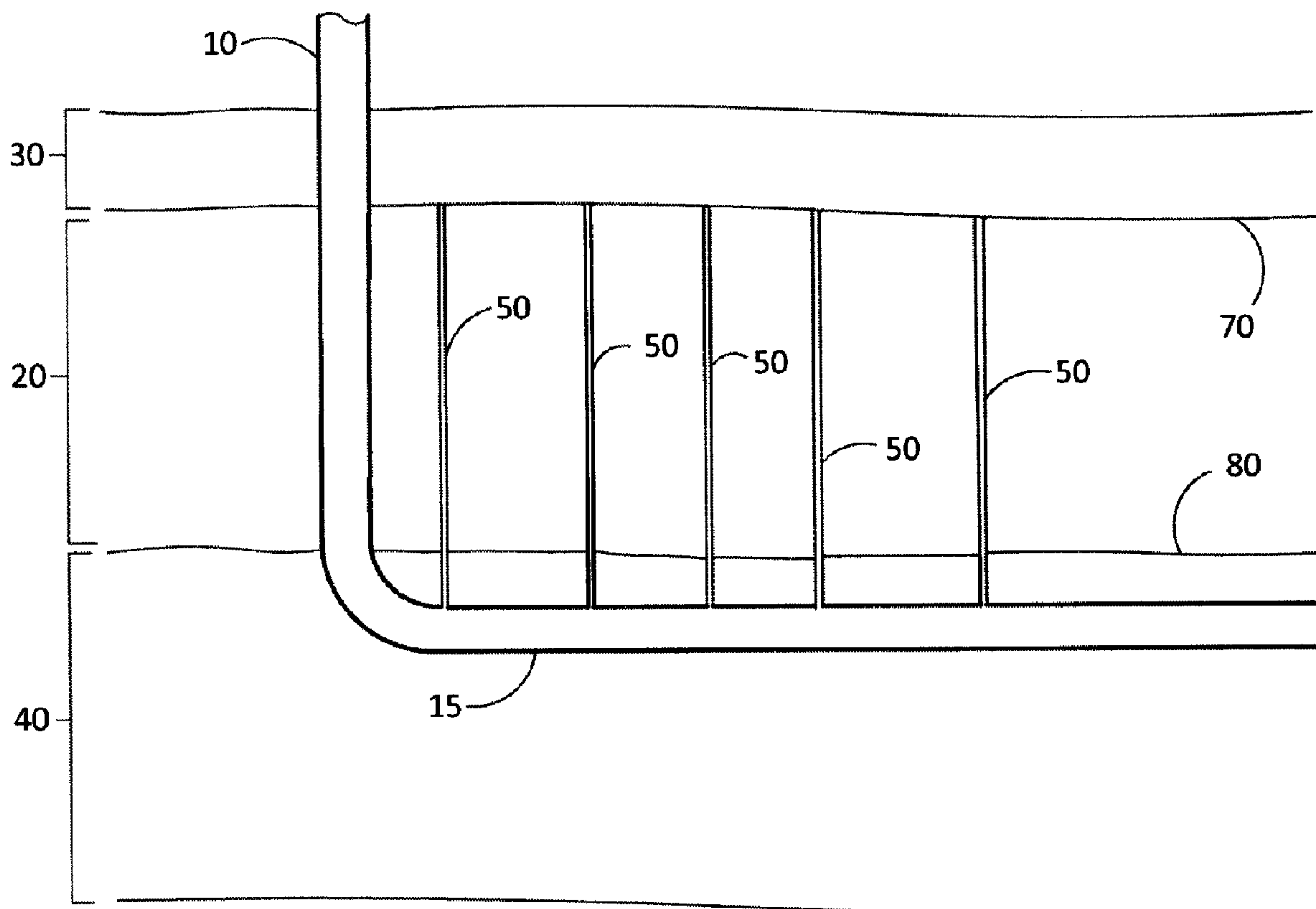




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(54) Titre : PROCÉDE DE RECUPERATION D'HYDROCARBURES A PARTIR D'UN RESERVOIR SOUTERRAIN  
(54) Title: METHOD FOR RECOVERING HYDROCARBONS FROM A SUBTERRANEAN RESERVOIR



(57) Abrégé/Abstract:

Oil and/or gas are produced from a subterranean reservoir by placing a horizontal well in the adjacent barrier rock and creating fractures that vertically extend into the hydrocarbon-bearing reservoir to produce hydrocarbons therefrom.

**ABSTRACT**

Oil and/or gas are produced from a subterranean reservoir by placing a horizontal well in the adjacent barrier rock and creating fractures that vertically extend into the hydrocarbon-bearing reservoir to produce hydrocarbons therefrom.

## **METHOD FOR RECOVERING HYDROCARBONS FROM A SUBTERRANEAN RESERVOIR**

### **FIELD OF THE INVENTION**

**[0001]** The present invention relates to the formation of vertical fractures in subterranean earth formations, and particularly for the purpose of secondary or tertiary recovery of hydrocarbons.

### **BACKGROUND OF THE INVENTION**

**[0002]** It is a common practice to treat subterranean formations to increase the gross permeability or conductivity of such formations with procedures which are identified generally as fracturing processes. For example, it is a conventional practice to hydraulically fracture a well in order to produce one or more cracks or "fractures" in the surrounding formation by a mechanical breakdown of the formation. Fracturing may be carried out in wells which are completed in subterranean formations for virtually any purpose. The usual candidates for fracturing, or other stimulation procedures, are production wells completed in oil or gas containing formations. However, injection wells used in secondary or tertiary operations, for example, for the injection of water or gas, may also be fractured in order to facilitate the injection of fluids into such subterranean formations.

**[0003]** Hydraulic fracturing may be propagated from vertical or horizontal wells and is accomplished by injecting a hydraulic fracturing fluid into the well and imposing sufficient pressure on the fracturing fluid to cause the formation to breakdown with the attendant formation of one or more fractures. The fracture or fractures formed may be vertical or horizontal with the former usually predominating and with the tendency towards vertical fracture orientation increasing with the depth of the formation being fractured.

**[0004]** Fracturing techniques and the challenges that arise with such techniques are well known to those skilled in the art. Fracturing in unconsolidated formations wherein

the earthen particles are not cemented together but are loosely associated, in particular, present several difficulties. For example, fracturing in such formations are difficult to complete due to the tendency of unconsolidated formations to collapse into the fracture when the pressure is removed. As well, due to the loose nature of the formation, earthen particles tend to be produced into the well with produced fluids. Production of such earthen particles can result in numerous problems including plugging the fracture and filling the well which can result in shortening the life of pumping equipment.

**[0005]** To address these challenges, a thickened carrier fluid having a propping agent such as sand or other particulate material suspended therein is typically introduced into the fracture simultaneously with or subsequent to its formation. The propping agent is deposited within the fracture and serves to hold the fracture open after the pressure is released and the fracturing fluid withdrawn back into the well. Even with the addition of such propping agents, the challenges encountered with fracturing in unconsolidated formations often persists.

**[0006]** United States Patent No. 6,644,407 describes a method for indirectly fracturing an unconsolidated subterranean formation to avoid the production of particulates from the unconsolidated formation. A vertical lined and cemented well is perforated to induce a horizontal fracture in the consolidated reservoir region, creating a region of disturbance that extends to some extent into the nearby unconsolidated region. Propping agent is utilized in the consolidated region to hold back sand from the unconsolidated region from entering the wellbore. By only directly fracturing the consolidated region, the unconsolidated region is disturbed to a lesser degree thereby reducing the production of particles. The method requires that the reservoir has at least one consolidated region near the unconsolidated formation of interest. Accordingly, the method cannot be applied to reservoirs that contain completely unconsolidated regions as occurs commonly in heavy oil and shallow gas reservoirs. This limitation further limits the possible number of horizontal fractures to the number of identified regions of consolidated rock. Moverover, the method is further limited to application in a vertical well process that can vertically traverse through consolidated and unconsolidated regions in a formation. As a result, the difficulties related to fracturing unconsolidated formations remains unaddressed in particular in horizontal well processes.

**[0007]** Directional or horizontal wells, as is well known by persons of skill in the art, can result in higher production than a vertical well. As the reservoir rocks which contain hydrocarbons are usually horizontal, or sub-horizontal; a horizontal well placed in a production zone has more surface area in the production zone than a vertical well, and in this way allows for far greater exposure to a production zone than a vertical well.

**[0008]** Hydraulic fracturing of a horizontal well usually occurs in a number of stages to create multiple fractures along the length of the horizontal well, extending through the production zone. The method by which the fractures are placed along the well is most commonly achieved by one of two methods, known as “plug and perforate sequence” and “sliding sleeve” which can allow for more than 30 vertical fractures to be pumped into the horizontal section of a single well, which may be up to 10,000 feet in length, as compared to the single fracture provided by a vertical well.

**[0009]** Horizontal wells, unlike vertical wells, typically traverse through a homogenous region or zone, oftentimes an unconsolidated formation comprising low-permeability formations such as shales containing oil and/or gas and having no bottom water. Accordingly, while technological advancements in vertical well fracturing have been made, these advancements may not be applicable to the unique challenges presented by horizontal well processes.

**[0010]** This background information is provided for the purpose of making known information believed by the applicant to be of possible relevance to the present invention. No admission is necessarily intended, nor should be construed, that any of the preceding information constitutes prior art against the present invention.

### **SUMMARY OF THE INVENTION**

**[0011]** An object of the present invention is to provide a method for recovering hydrocarbons from a subterranean reservoir. In accordance with one aspect of the invention, there is provided a method for recovering hydrocarbons from a subterranean reservoir, said reservoir being contained between a pair of barrier rocks above and

below said reservoir, said method comprising: drilling a horizontal well in a first barrier rock of said pair, said first barrier rock adjacent to said reservoir to form a first interface, and wherein said horizontal well is positioned to horizontally traverse through said first barrier rock; establishing at least one fracture propogated from said horizontal well, said fracture vertically extending from said first barrier rock into said reservoir towards a second barrier rock adjacent to said reservoir opposite to said first barrier rock, said second barrier rock forming a second interface with said adjacent reservoir, wherein said fracture terminates at said second interface; and producing hydrocarbons recovered from said horizontal well.

**[0012]** In accordance with another aspect of the invention, there is provided a method for recovering hydrocarbons from a subterranean reservoir, said reservoir being contained between a cap rock and a basement rock, said method comprising: drilling a horizontal well in said basement rock, said basement rock adjacent to a bottom portion of said reservoir to form an interface, and wherein said horizontal well is positioned to horizontally traverse through said basement rock below said interface; establishing at least one fracture propogated from said horizontal well, said fracture vertically extending upwards from said basement rock into said reservoir and terminating at said cap rock adjacent to a top portion of said reservoir opposite to said basement rock; and producing hydrocarbons recovered from said horizontal well.

**[0013]** In accordance with another aspect of the invention, there is provided a method for recovering hydrocarbons from a subterranean reservoir, said reservoir being contained between a cap rock and a basement rock, said method comprising: drilling a horizontal well in said cap rock, said cap rock adjacent to a top portion of said reservoir to form an interface, and wherein said horizontal well is positioned to horizontally traverse through said cap rock above said interface; establishing at least one fracture propogated from said horizontal well, said fracture vertically extending downwards from said cap rock into said reservoir and terminating at said basement rock adjacent to a bottom portion of said unconsolidated region opposite to said cap rock; and producing hydrocarbons recovered from said horizontal well.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0014] These and other features of the invention will become more apparent in the following detailed description in which reference is made to the appended drawings.

[0015] **Figure 1** is a schematic diagram of a typical prior art fracturing method in vertical well processes;

[0016] **Figure 2** is a schematic diagram of a typical prior art fracturing method in horizontal well processes;

[0017] **Figure 3** is a schematic diagram of a prior art method for indirectly fracturing an unconsolidated subterranean formation in vertical well processes;

[0018] **Figure 4** is a schematic diagram of a fractured horizontal well for recovering hydrocarbons from a subterranean formation, according to embodiments of the present invention; and

[0019] **Figure 5** is a schematic diagram of a fractured horizontal well for recovering hydrocarbons from a subterranean formation, according to embodiments of the present invention.

### DETAILED DESCRIPTION OF THE INVENTION

#### *Definitions*

[0020] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs.

[0021] As is known by persons skilled in the art, there are essentially two basic types of geologic formations, consolidated and unconsolidated formations. As used herein, the term “consolidated formation” refers to a homogeneous layer composed of solid rock or cemented earthen material. The term “unconsolidated formation” refers to loose, unsorted earthen materials, or particles such as clay, silt, sand, gravel, or stones and, as used herein, encompasses partially consolidated formations.

[0022] The terms “barrier rock” or “barrier zone” are used interchangeably herein to refer to strongly consolidated rock formations that resist fracturing when fractures are formed in formations below or above the barrier rock or barrier zone. For this reason, as is known by those of skill in the art, most fracturing operations are conducted in subterranean formations between or beneath a barrier rock/zone. Barrier rock, as used herein, can further be distinguished as “cap rock” and “basement rock” to refer to barrier rock located above and below a target reservoir, respectively.

[0023] As used herein, the term “about” refers to an approximately +/-10% variation from a given value. It is to be understood that such a variation is always included in any given value provided herein, whether or not it is specifically referred to.

[0024] Insufficient permeability and/or reservoir pressure are typically the factors inhibiting the flow of natural gas and oil from subterranean reservoirs into a well. Hydraulic fracturing is used to increase or restore the rate at which fluids, such as petroleum and natural gas can be recovered from these subterranean reservoirs. By creating fractures from a well drilled into a reservoir rock formation, a conductive path is provided that connects a larger volume of the reservoir to the well and, thereby, releases formerly inaccessible hydrocarbons for extraction to further increase efficiency of hydrocarbon production from the well.

[0025] Fractures may be propagated from vertical or horizontal wells. As shown in **Fig. 1**, a vertical well **5** process vertically penetrates a subterranean formation to extract hydrocarbons from a target reservoir **20**. Access to a target reservoir **20** in such vertical well processes is limited to the thickness of the target reservoir **20**. While hydraulic fracturing can be used to improve the efficiency of hydrocarbon extraction, the amount of fracturing is also limited to the single region in the target reservoir **20** accessed by the vertical well **5**. Accordingly, the ability of fracturing to improve the efficiency of hydrocarbon recovery, in such prior art systems, is limited.

[0026] By utilizing horizontal wells where the terminal drillhole is completed as a “lateral” that intersects a target reservoir parallel to its plane of more extensive dimension, a greater region of the target reservoir is exposed and made accessible to the

well than would be the case with a vertical well that penetrates the reservoir perpendicular to its plane of more extensive dimension. The efficiency of such horizontal wells **10**, as shown in **Fig. 2**, is further improved by allowing for multiple vertical fractures **50** to be created from the horizontal section **15** of the well into the target reservoir **20**.

[0027] Both vertical **5** and horizontal **10** well processes, as shown in **Figs. 1** and **2**, respectively, typically intersect the target reservoir **20**. The target reservoir **20** may be either a consolidated or unconsolidated formation. When the target reservoir **20** is an unconsolidated formation, hydraulic fracturing can result in a number of challenges to the efficiency of hydrocarbon recovery. For example, fracturing in such formations is difficult to complete due to the tendency of unconsolidated formations to collapse into the fracture when the pressure is removed. As well, due to the loose nature of the formation, earthen particles tend to be produced into the well with produced fluids. Production of such earthen particles can result in numerous problems including plugging the fracture and filling the well which can result in shortening the life of pumping equipment.

[0028] Indirectly fracturing unconsolidated formations can avoid such challenges. As shown in **Fig. 3**, by initiating a horizontal fracture **55** into a consolidated formation **35**, nearby unconsolidated formations **25** may be indirectly fractured. Specifically, the initial fracture **55** horizontally extends from the consolidated formation **35** in an oval manner into nearby unconsolidated formations **25**. The scope of the extended oval fracture **60** expands into nearby unconsolidated formations **25**, thereby, indirectly fracturing such unconsolidated formations **25** while avoiding the difficulties arising from directly fluidizing the particulate matter in the unconsolidated formation **25**. The unconsolidated formation **25** is, therefore, disturbed to a lesser degree and the production of earthen particles is reduced.

[0029] Such indirect fracturing methods can be used to improve the efficiencies of hydraulic fracturing into unconsolidated formations, however, its requirement for at least one consolidated region near the unconsolidated formation of interest limits its application. Specifically, such methods cannot be applied to reservoirs that contain

completely unconsolidated formations as occurs commonly in heavy oil and shallow gas reservoirs. As such, the method is limited to application in vertical well processes that can vertically traverse through both consolidated and unconsolidated formations in a subterranean reservoir. The extent of indirectly fracturing into unconsolidated formations is further limited by the impedance caused by the high parting pressure of the consolidated formation. As shown in Fig. 3, once initiated the fracture 60 extends into the unconsolidated formation 20 to a limited degree thus the extent of fracturing into the unconsolidated formations 25 is limited.

**[0030]** The method according to embodiments of the present invention relates to the recovery of hydrocarbons from a subterranean reservoir. In particular, the method relates to horizontal well processes for maximizing hydrocarbon recovery by permitting access to a greater region of a target reservoir and further permitting multiple vertical fractures to be established from a single (horizontal) well into the reservoir of interest.

**[0031]** According to embodiments of the present invention, the horizontal well is drilled into barrier rock defining the target reservoir. Fracturing is initiated in the barrier rock and extends into the target reservoir to create open-flow pathways through the reservoir to the horizontal well, facilitating the recovery of hydrocarbons produced through the well. The direction and the extent of the fracturing, according to such embodiments, can be controlled by the vertical depth positioning of the well relative to the interface between the barrier rock and the target reservoir. In this way, embodiments of the present invention permit fracturing to be targeted to the reservoir of interest, thereby, maximizing fracturing into the target reservoir and minimizing fracturing into areas of non-interest.

**[0032]** According to some embodiments, the method of the present invention is adaptable to existing fracturing technologies commonly used in horizontal well processes such as, for example, the “plug and perforate sequence” and “sliding sleeve” technologies well known to those of skill in the art. As such, embodiments of the present invention can be applied to fracturing completely unconsolidated or partially unconsolidated rock formations. Moreover, the challenges encountered in fracturing in such formations are addressed by embodiments of the present invention. For example,

embodiments can include the use of propping agents to assist in maintaining the open-flow pathway from an unconsolidated reservoir to the horizontal well and further prevent the flow of earthen particles into the well.

[0033] Referring now to **Figs. 4 and 5**, the method of the present invention comprises drilling a horizontal well **10** to recover hydrocarbons from a target reservoir **20** in a subterranean formation. In some embodiments, the target reservoir **20** is in a consolidated formation. In other embodiments, the target reservoir **20** is in an unconsolidated formation. The target reservoir **20** comprising hydrocarbons, will typically be bounded by barrier rock **30, 40** above and below the target reservoir **20** namely cap rock **30** and basement rock **40**, respectively.

*Drilling the Horizontal Well into Barrier Rock*

[0034] The horizontal well **10** is drilled such that the horizontal section **15** is positioned in the barrier rock **30, 40** and runs parallel to the plane of the target reservoir **20**. In one embodiment, as shown in **Fig. 4**, the horizontal section **15** is drilled into the basement rock **40**. In other embodiments, as shown in **Fig. 5**, horizontal section **15** can be drilled into the cap rock **30**. The horizontal section **15** may be open-hole or completed with cement and a liner according to techniques known in the art.

[0035] Once the horizontal well **15** is in place in the barrier rock **30, 40**, one or more fractures **50** are propagated from the horizontal section of the well **15**. The horizontal section **15** may be fractured or multi-fractured by any of the techniques well known to those skilled in the art. Non-limiting examples include, the open-hole StackFrac<sup>TM</sup> sliding sleeve process practiced by Packers Plus<sup>TM</sup>, and the cemented liner sequential isolate-and-perforate process practiced by Haliburton<sup>TM</sup>. The fracturing fluid may be water-based, but in certain embodiments, particularly for oil recovery, the fracturing fluid may contain a solvent such as light hydrocarbons or CO<sub>2</sub>. Once the fractures **50** are established, primary production of hydrocarbon fluids may begin. Production techniques well known to those skilled in the art may be used to produce hydrocarbons from the fractured well. In some embodiments, a cyclic injection-production fluid

recovery process may be undertaken. In other embodiments, production of hydrocarbon fluids may be undertaken using a fluid-drive enhanced hydrocarbon recovery process.

[0036] Irrespective of the fracturing technique used, the fracture or fractures **50** will initially vertically extend from the horizontal section **15** in both the upwards and downwards direction. The extent to which a fracture **50** can penetrate and extend through a formation, however, will be determined by the parting pressure of the particular formation. Accordingly, the high parting pressure of barrier rock **30, 40** will impede penetration of the fracture **50** into the barrier rock **30, 40**. In this way, extension of the fracture **50** into barrier rock **30, 40** is limited. In contrast, a target reservoir **20**, whether a consolidated or unconsolidated formation, will have a lower parting pressure than the barrier rock **30, 40** which will permit the fracture **50** to more easily extend into the target reservoir **20**. This parting pressure differential between the barrier rock **30, 40** and target reservoir **20** is utilized in embodiments of the present invention to control the direction of fracturing into the target reservoir **20**.

[0037] For example, as shown in Fig. 4, fractures **50** are propagated from the horizontal well **15** and initially may extend vertically in both directions through the basement rock **40**, in which the well **15** is situated. As the fracture **50** extends upwards through the basement rock **40** and reaches the target reservoir **20**, the lower parting pressure of the target reservoir **20** takes over such that further fracture **50** extension will be only upwards into the target reservoir **20** which provides a path of less resistance. As a result, the fractures **50** will not penetrate to the bottom of the basement rock **40** and will be directed into the target reservoir **20**.

[0038] In some embodiments, particularly in unconsolidated formations, a propping agent as known to those skilled in the art can be used to maintain the open-flow pathway of the fracture **50** from the target reservoir **20** to the horizontal well **15**. In such embodiments, the propping agent can prevent collapse of the fracture **50** when the pressure is removed and propping agent within the basement rock **40** can further serve to prevent the flow of fine particles from a target reservoir **20**, i.e., unconsolidated formation, into the horizontal well **15**. Suitable propping agents are well known to

persons skilled in the art and may include, for example, sand, resin products, ceramics, small steel balls, ground walnut hulls, and resin-coated inorganic particulates.

[0039] Referring to **Fig. 5**, certain embodiments of the present invention may be adapted for gas recovery, for example in some embodiments the present invention may be adapted for methane recovery from coal-beds. As shown in **Fig. 5**, the horizontal well **15** may be emplaced in the cap rock **30**, with the fractures **50** extending downward into the target reservoir **20** comprising the gas zone. As discussed above, in reference to **Fig. 4**, the direction that the fractures **50** extend from the well **15** can be controlled by the parting pressure differential between the cap rock **30** and the target reservoir **20**.

*Vertical Depth Positioning of the Horizontal Well*

[0040] As described, the parting pressure differential between the barrier rock **30, 40** and the target reservoir **20** allows fracturing to be directed to the target reservoir **20**. The horizontal section **15** of the well **10** should be positioned within the barrier rock **30, 40** nearer to the interface **70, 80** with the target reservoir **20** so that the fractures **50** will propagate easily into the target reservoir **20** without breaking through the barrier rock **30, 40**. To illustrate, for example, in a barrier rock **30, 40** that is 50 meters thick in which the horizontal section **15** of the well **10** is positioned 5-meters from the interface **70, 80** of the barrier rock with the target reservoir, a fracture **50** need only propagate 5-meters vertically before reaching the lower parting pressure of the target reservoir **20**. Once reaching the target reservoir **20**, the injection pressure of the fracturing fluid will be relieved on account of the plastic nature of the target reservoir **20** allowing the fracture to continue extending into the target reservoir **20** in preference to the barrier rock **30, 40**.

[0041] According to some embodiments, the horizontal section **15** of the well **10** is positioned in the barrier rock **30, 40** at a vertical depth from the interface **70, 80** that will permit a fracture **50** to propagate primarily into the target reservoir **20**. In some embodiments, the vertical depth of the horizontal section **15** of the well **10** is between about 1 to about 10 meters from the interface **70, 80** into the barrier rock **30, 40**. In other embodiments, the vertical depth of the horizontal section **15** of the well **10** is

about 8 meters from the interface 70, 80 into the barrier rock 30, 40. In other embodiments, the vertical depth of the horizontal section 15 of the well 10 is about 6 meters from the interface 70, 80 into the barrier rock 30, 40. In other embodiments, the vertical depth of the horizontal section 15 of the well 10 is about 5 meters from the interface 70, 80 into the barrier rock 30, 40. In other embodiments, the vertical depth of the horizontal section 15 of the well 10 is about 4 meters from the interface 70, 80 into the barrier rock 30, 40. In still other embodiments, the vertical depth of the horizontal section 15 of the well 10 is about 2 meters from the interface 70, 80 into the barrier rock 30, 40.

[0042] In further embodiments, the vertical depth of the horizontal section 15 of the well 10 is between about 1% and 10% the thickness of the barrier rock 30, 40.

[0043] It will be understood by persons of skill in the art that the direction and extent of fractures 50 may be adjusted by varying the vertical depth of the horizontal section 15 of the well 10 within the barrier rock 30, 40.

[0044] The disclosures of all patents, patent applications, publications and database entries referenced in this specification are hereby specifically incorporated by reference in their entirety to the same extent as if each such individual patent, patent application, publication and database entry were specifically and individually indicated to be incorporated by reference.

[0045] Although the invention has been described with reference to certain specific embodiments, various modifications thereof will be apparent to those skilled in the art without departing from the spirit and scope of the invention. All such modifications as would be apparent to one skilled in the art are intended to be included within the scope of the following claims.

**THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:**

1. A method for recovering hydrocarbons from a subterranean reservoir, said reservoir being contained between a pair of barrier rocks above and below said reservoir, said method comprising:

drilling a horizontal well in a first barrier rock of said pair, said first barrier rock adjacent to said reservoir to form a first interface, and wherein said horizontal well is positioned to horizontally traverse through said first barrier rock;

establishing at least one fracture propogated from said horizontal well, said fracture vertically extending from said first barrier rock into said reservoir towards a second barrier rock adjacent to said reservoir opposite to said first barrier rock, said second barrier rock forming a second interface with said adjacent reservoir, wherein said fracture terminates at said second interface; and

producing hydrocarbons recovered from said horizontal well.

2. The method of claim 1, wherein said horizontal well is positioned to horizontally traverse through said first barrier rock at a vertical depth from said first interface that will permit said fracture to propogate primarily into said reservoir.

3. The method of claim 2, wherein said vertical depth is 1 to 10 meters from said first interface.

4. The method of claim 3, wherein said vertical depth is 5 meters from said first interface.

5. The method of claim 2, wherein said vertical depth is between 1% and 10% the thickness of said first barrier rock.

6. A method for recovering hydrocarbons from a subterranean reservoir, said reservoir being contained between a cap rock and a basement rock, said method comprising:

drilling a horizontal well in said basement rock, said basement rock adjacent to a bottom portion of said reservoir to form an interface, and wherein said horizontal well is positioned to horizontally traverse through said basement rock below said interface;

establishing at least one fracture propogated from said horizontal well, said fracture vertically extending upwards from said basement rock into said reservoir and terminating at said cap rock adjacent to a top portion of said reservoir opposite to said basement rock; and

producing hydrocarbons recovered from said horizontal well.

7. The method of claim 6, wherein said horizontal well is positioned to horizontally traverse through said basement rock at a vertical depth from said interface that will permit said fracture to propogate primarily upwards into said reservoir.

8. The method of claim 7, wherein said vertical depth is 1 to 10 meters below said interface.

9. The method of claim 8, wherein said vertical depth is 5 meters below said interface.

10. The method of claim 7, wherein said vertical depth is between 1% and 10% the thickness of said basement rock.

11. A method for recovering hydrocarbons from a subterranean reservoir, said reservoir being contained between a cap rock and a basement rock, said method comprising:

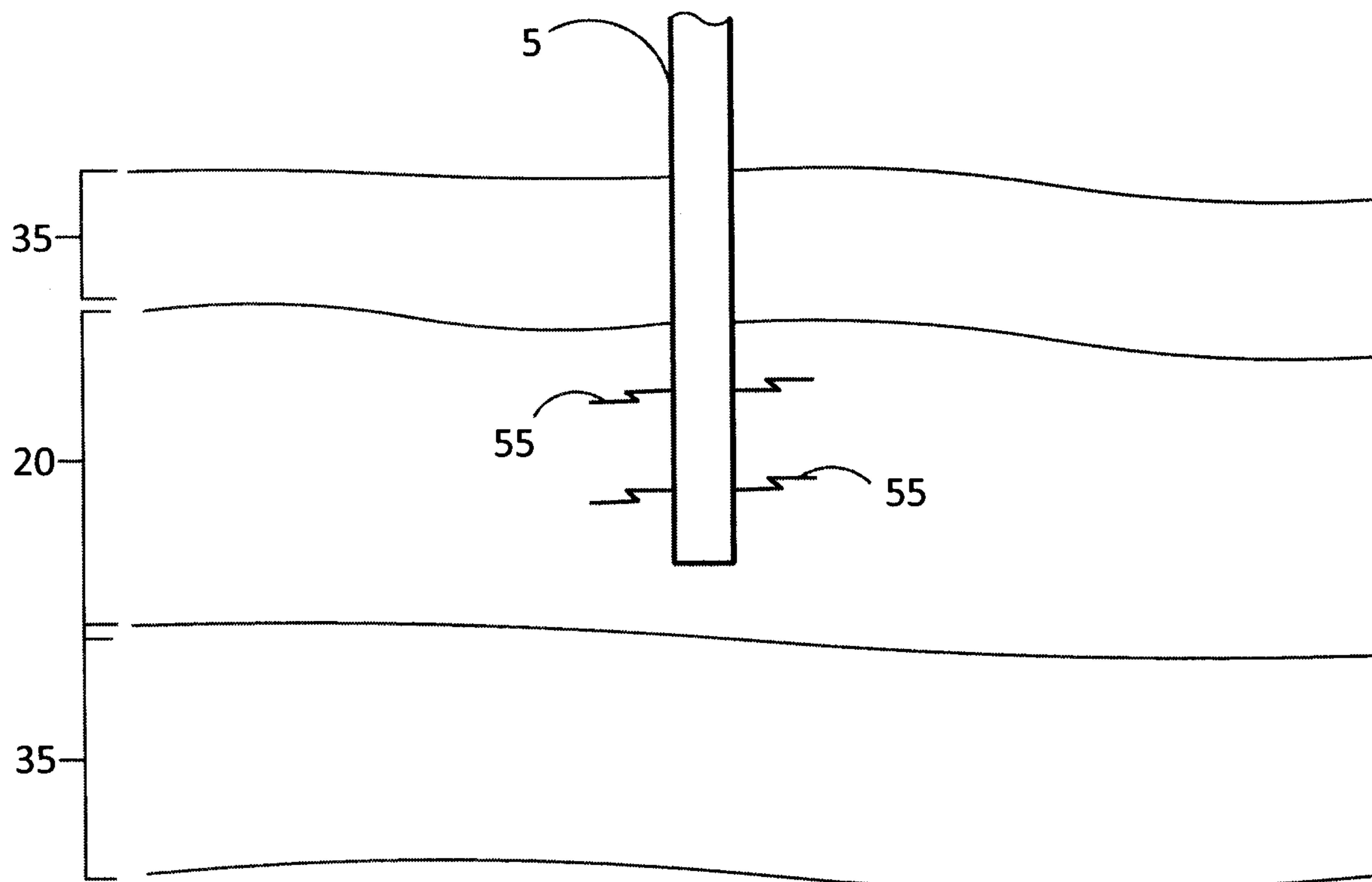
drilling a horizontal well in said cap rock, said cap rock adjacent to a top portion of said reservoir to form an interface, and wherein said horizontal well is positioned to horizontally traverse through said cap rock above said interface;

establishing at least one fracture propogated from said horizontal well, said fracture vertically extending downwards from said cap rock into said reservoir and terminating at said basement rock adjacent to a bottom portion of said unconsolidated region opposite to said cap rock; and

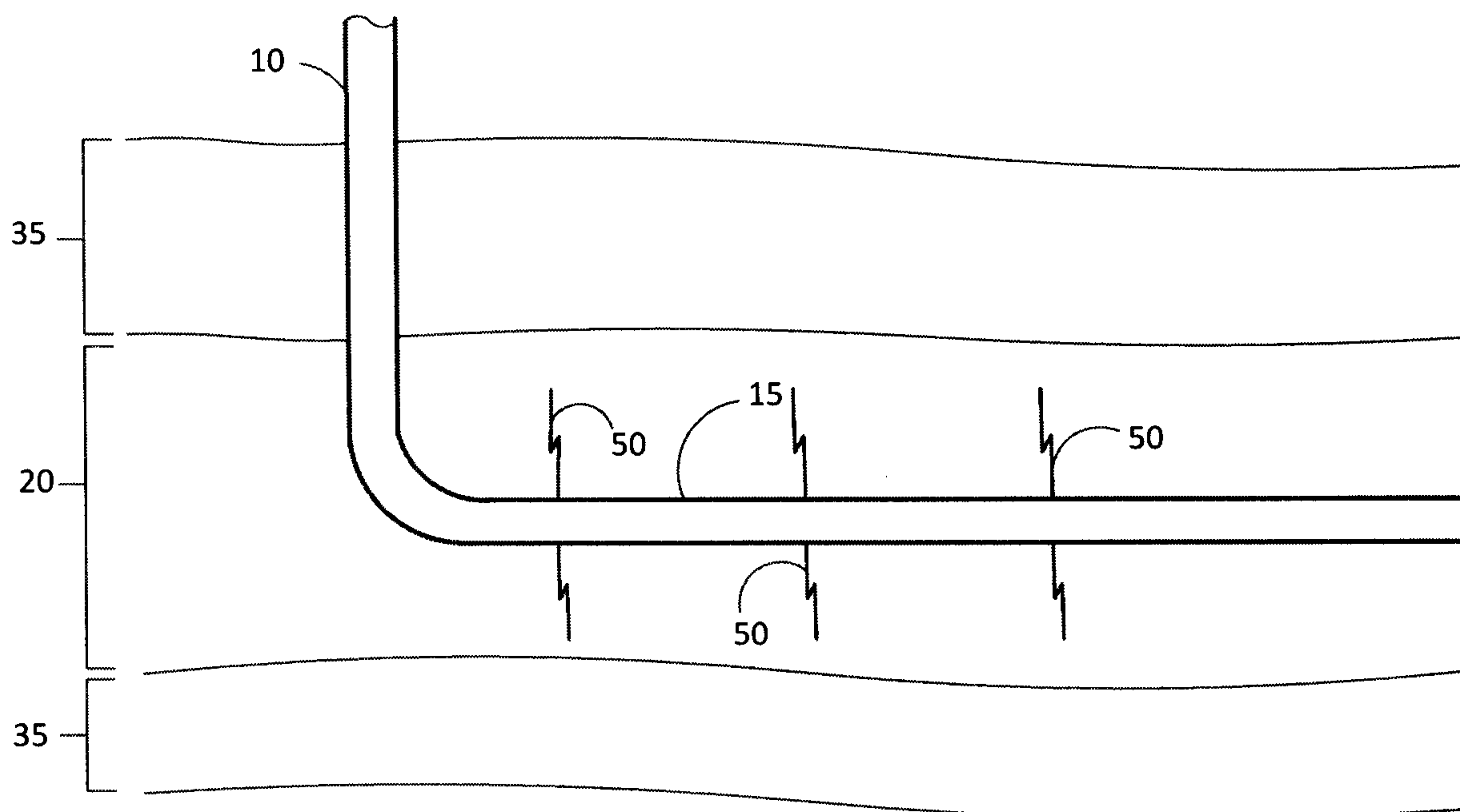
producing hydrocarbons recovered from said horizontal well.

12. The method of claim 11, wherein said horizontal well is positioned to horizontally traverse through said cap rock at a vertical depth from said interface that will permit said fracture to propagate primarily downwards into said reservoir.
13. The method of claim 12, wherein said vertical depth is 1 to 10 meters above said interface.
14. The method of claim 13, wherein said vertical depth is 5 meters above said interface.
15. The method of claim 12, wherein said vertical depth is between 1% and 10% the thickness of said cap rock.
16. The method of any one of claims 1 to 15, wherein said reservoir is an unconsolidated formation.
17. The method of any one of claims 1 to 15, wherein said reservoir is a consolidated formation.
18. The method of any one of claims 1 to 17, wherein said horizontal well is an open-hole well.
19. The method of any one of claims 1 to 17, wherein said horizontal well is a cased well.
20. The method of any one of claims 1 to 19, wherein a plurality of vertical fractures is established from said horizontal well.
21. The method of any one of claims 1 to 20, further comprising positioning a propping agent in said fractures.
22. The method of claim 21, wherein said propping agent is selected from the group consisting of sand, resin products, ceramics, small steel balls, ground walnut hulls, and resin-coated inorganic particulates.

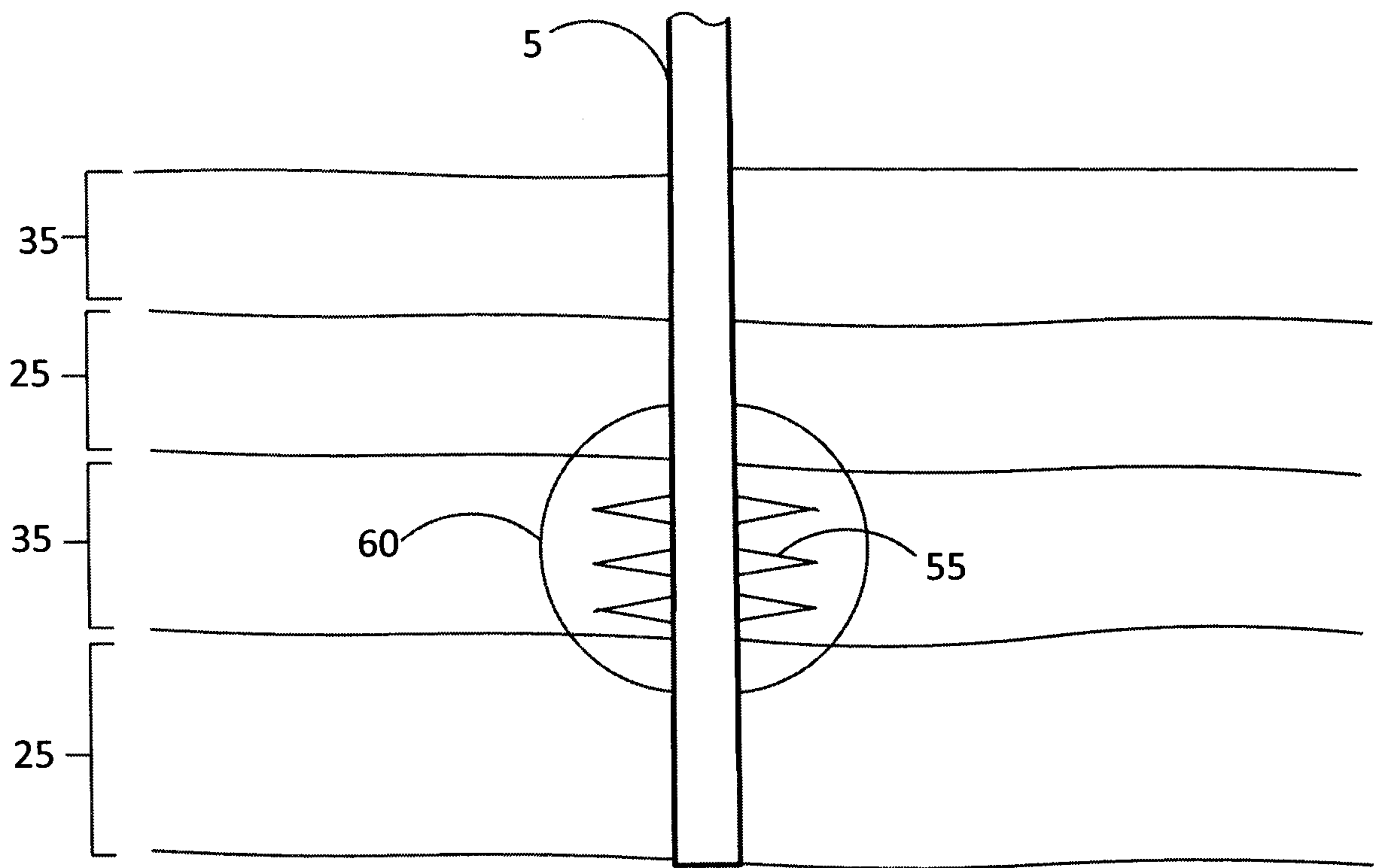
23. The method of any one of claims 1 to 22, wherein said method produces fluids comprising at least one hydrocarbon gas.
24. The method of claim 23, wherein the hydrocarbon gas is coal-bed methane.
25. The method of any one of claims 1 to 22, wherein said method produces fluids comprising at least one hydrocarbon liquid.



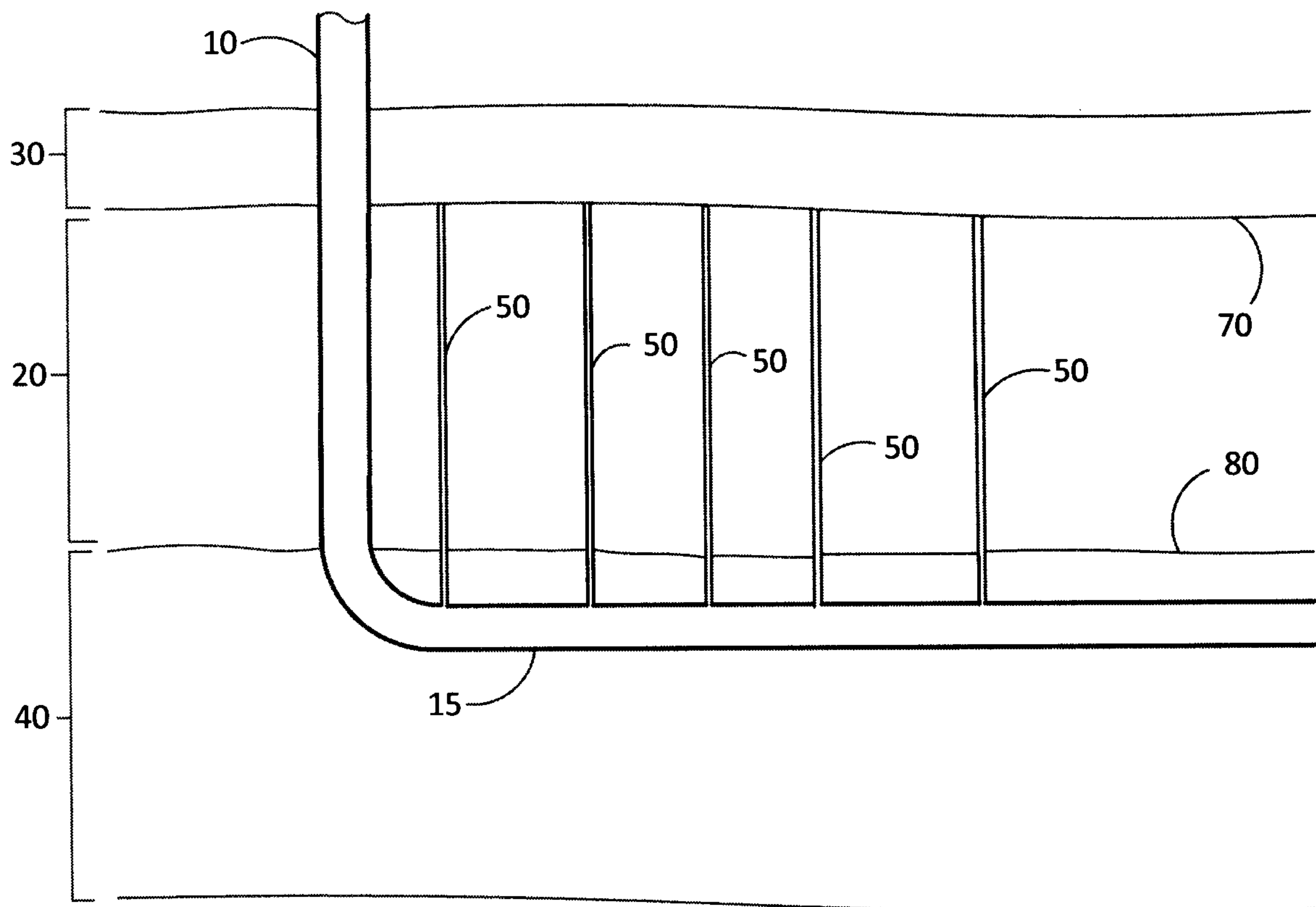
**Figure 1**  
**(Prior Art)**



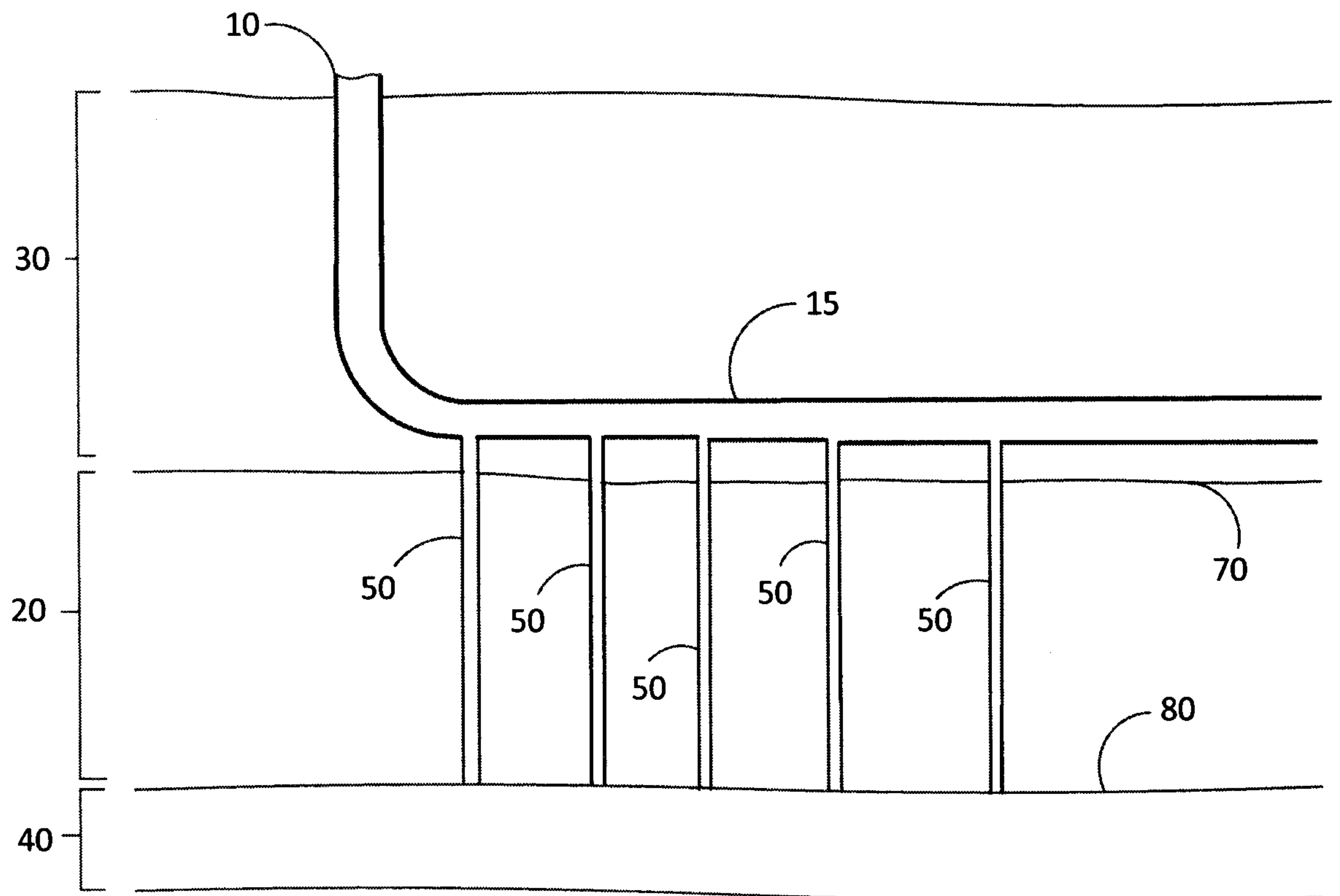
**Figure 2**  
**(Prior Art)**



**Figure 3**  
**(Prior Art)**



**Figure 4**



**Figure 5**

