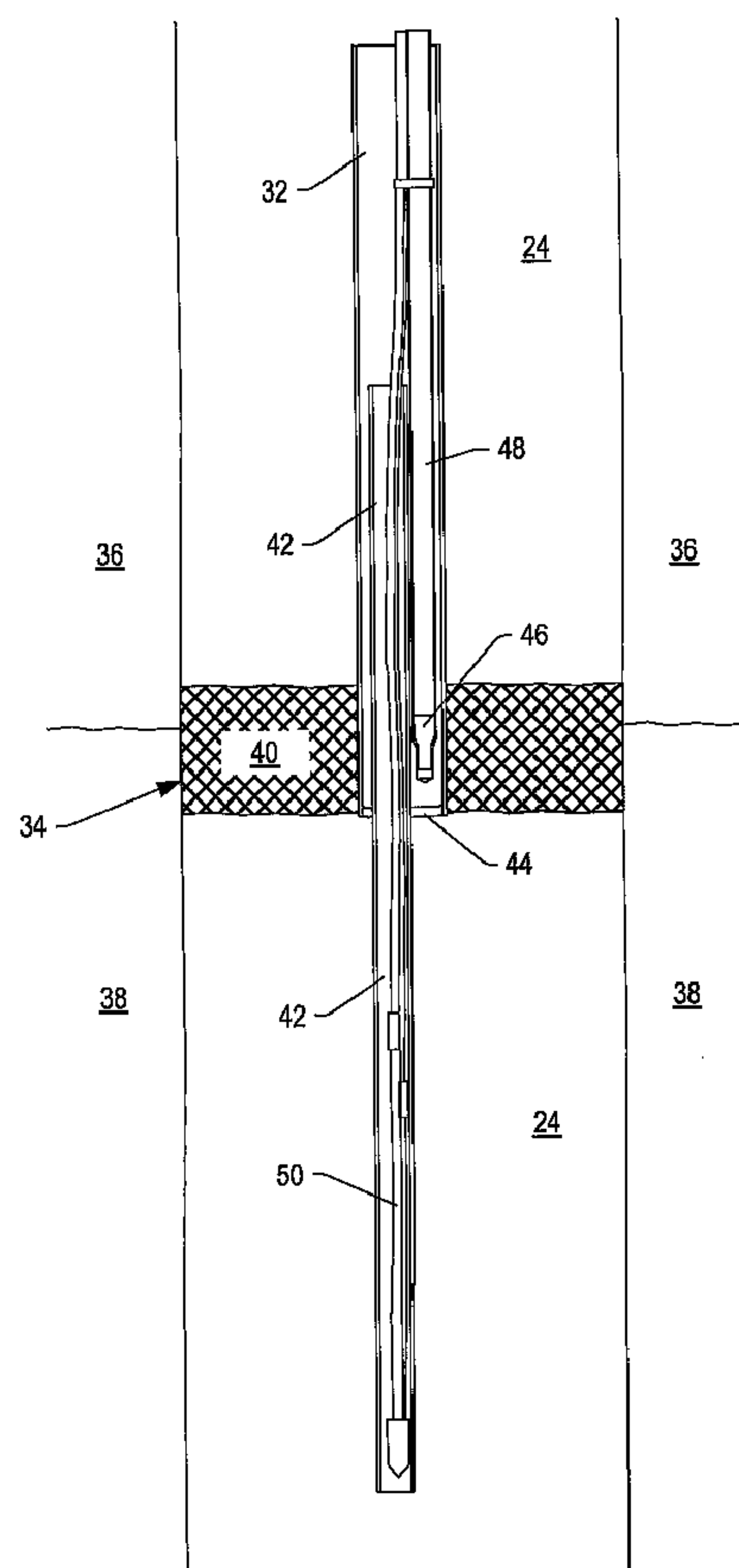




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(54) Titre : INHIBITION DU REFLUX DANS UN Puits CHAUFFE D'UN SYSTEME DE CONVERSION SUR PLACE
(54) Title: INHIBITING REFLUX IN A HEATED WELL OF AN IN SITU CONVERSION SYSTEM



(57) Abrégé/Abstract:

The invention provides a method for using heaters to form a heated portion of the formation. A production conduit is used to direct formation fluid in a vapor phase from the heated portion of the formation towards a surface of the formation. A diverter directs

(57) **Abrégé(suite)/Abstract(continued):**

condensate of the vapor phase formation fluid to a desired location. In some embodiments, the condensate is directed to a location above the heated portion of the formation. In some embodiments, the condensate is directed below the heated portion of the formation. The condensate may be pumped from the formation to the surface.

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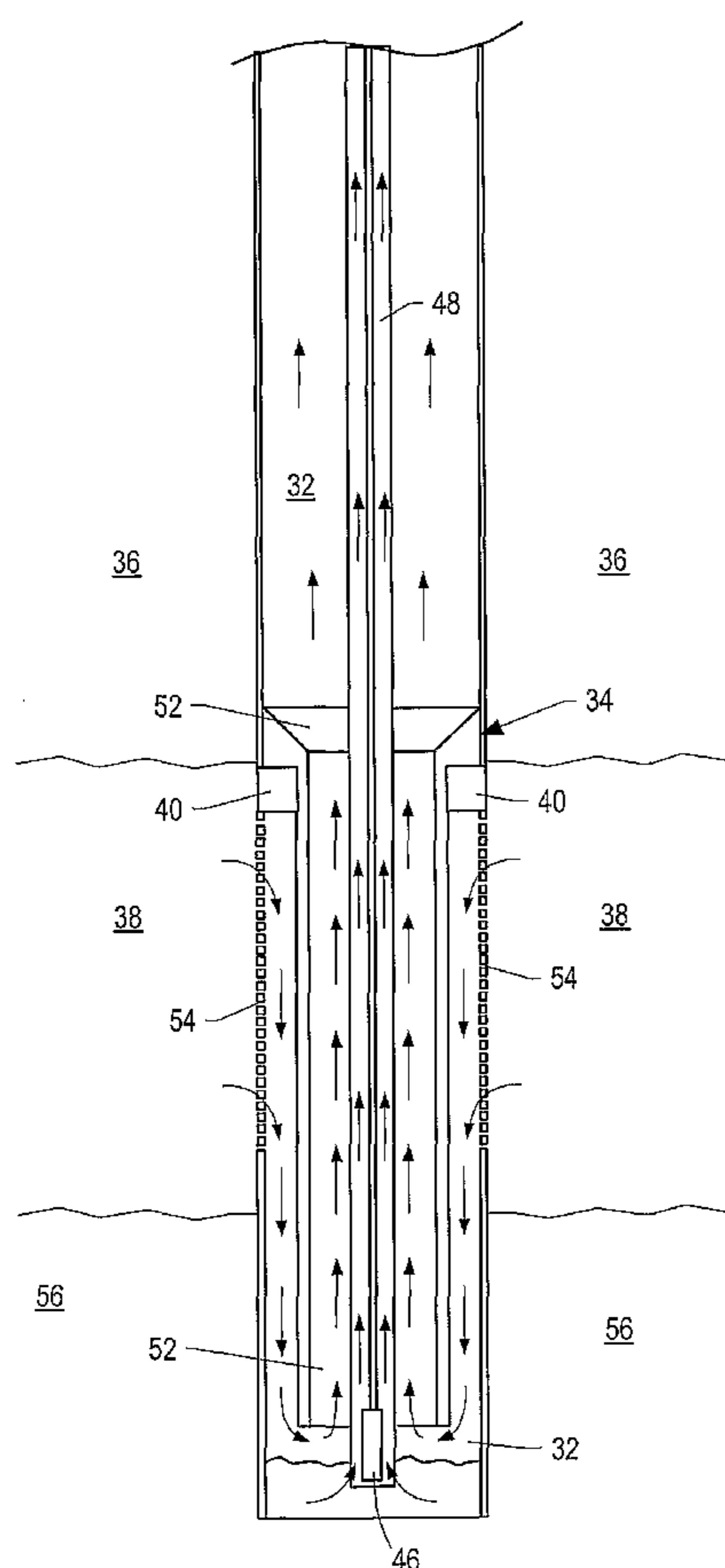
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(54) Title: INHIBITING REFLUX IN A HEATED WELL OF AN IN SITU CONVERSION SYSTEM



(57) Abstract: The invention provides a method for using heaters to form a heated portion of the formation. A production conduit is used to direct formation fluid in a vapor phase from the heated portion of the formation towards a surface of the formation. A diverter directs condensate of the vapor phase formation fluid to a desired location. In some embodiments, the condensate is directed to a location above the heated portion of the formation. In some embodiments, the condensate is directed below the heated portion of the formation. The condensate may be pumped from the formation to the surface.

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INHIBITING REFLUX IN A HEATED WELL OF AN IN SITU CONVERSION SYSTEM

BACKGROUND

Field of the Invention

The present invention relates generally to methods and systems for production of hydrocarbons, hydrogen, and/or other products from hydrocarbon containing formations. Certain embodiments relate to inhibiting reflux of material into a heated portion of the formation.

Description of Related Art

Hydrocarbons obtained from subterranean formations are often used as energy resources, as feedstocks, and as consumer products. Concerns over depletion of available hydrocarbon resources and changes in the overall quality of produced hydrocarbons have led to development of processes for more efficient recovery, processing and/or use of available hydrocarbon resources. In situ processes may be used to remove hydrocarbon materials from subterranean formations. Chemical and/or physical properties of hydrocarbon material within a subterranean formation may need to be changed to allow hydrocarbon material to be more easily removed from the subterranean formation. Chemical and physical changes may include in situ reactions that produce removable fluids, composition changes, solubility changes, density changes, phase changes, and/or viscosity changes of the hydrocarbon material within the formation. A fluid may be, but is not limited to, a gas, a liquid, an emulsion, a slurry, and/or a stream of solid particles that has flow characteristics similar to liquid flow.

Application of heat to oil shale formations is described in U.S. Patent Nos. 2,923,535 to Ljungstrom and 4,886,118 to Van Meurs et al. Heat may be applied to the oil shale formation to pyrolyze kerogen within the oil shale formation. The heat may also fracture the formation to increase permeability of the formation. The increased permeability may allow formation fluid to travel to a production well where the fluid is removed from the oil shale formation. In a process disclosed by Ljungstrom, an oxygen containing gaseous medium is introduced to a permeable stratum, preferably while the permeable stratum is still hot from a preheating step, to initiate combustion to heat the permeable stratum.

As outlined above, there has been a significant amount of effort to develop methods and systems to economically produce hydrocarbons, hydrogen, and/or other products from formations that contain hydrocarbons. To economically produce hydrocarbons, hydrogen, and/or other products from heated formations, limiting heat loss from heated portions of the formation is necessary. Limiting heat loss from heated portions of the formation has the technical advantage of reducing the number and/or the heating duty of the heaters needed to raise or maintain the temperature of the heated portion of the formation.

SUMMARY OF THE INVENTION

The invention provides a method for treating a formation, comprising: using heaters to form a heated portion of the subsurface formation; using a production conduit to direct formation fluid in a vapor phase from the heated portion of the subsurface formation towards a surface of the subsurface formation; forming condensate of the vapor phase formation fluid in or near the production conduit; and diverting condensate of the vapor phase formation fluid to a desired location.

Thus, in one aspect of the invention, there is provided a method for treating a subsurface formation, comprising: using heaters to form a heated portion of the subsurface formation; using a production conduit to direct formation fluid in a vapor phase from the heated portion of the subsurface formation towards a surface of the subsurface formation; forming condensate of the vapor phase formation fluid in or near the production conduit; and diverting condensate of the vapor phase formation fluid to a location below the heated portion of the formation.

In another aspect of the invention, there is provided a method for treating a subsurface formation, the method comprising the steps of: using heaters to form a heated portion of the subsurface formation; using a production conduit to direct formation fluid in a vapor phase from the heated portion of the subsurface formation towards a surface of the subsurface formation through an overburdon; forming condensate of the vapor phase formation fluid in or near the production conduit within the overburdon; and preventing the condensate from returning back to the heated portion of the subsurface formation.

In some embodiments, the collection device includes a riser that transfers formation fluid in the vapor phase to a production conduit. Condensate in the production conduit is inhibited from flowing past the heated portion of the formation. The liquid is pumped or gas lifted from the production conduit.

In some embodiments, the collection device includes a baffle that directs condensate below the heated portion of the formation. Liquid is directed along the baffle so that the liquid does not absorb heat from the formation as the liquid passes through the production well adjacent to the heated portion of the formation.

BRIEF DESCRIPTION OF THE DRAWINGS

Advantages of the present invention will become apparent to those skilled in the art with the benefit of the following detailed description of the preferred embodiments and upon reference to the accompanying drawings in which:

FIG. 1 depicts an illustration of stages of heating hydrocarbons in the formation.

FIG. 2 shows a schematic view of an embodiment of a portion of the in situ conversion system for treating hydrocarbons in the formation.

FIG. 3 depicts a schematic representation of an embodiment of the collection device in the production well.

FIG. 4 depicts a schematic representation of an embodiment of the baffle in the production well.

FIG. 5 depicts a schematic representation of an embodiment of the baffle in the production well.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and may herein be described in detail. The drawings may not be to scale. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

DETAILED DESCRIPTION

The following description generally relates to systems and methods for treating hydrocarbons in the formations. Such formations may be treated to yield hydrocarbon products, hydrogen, and other products.

“Hydrocarbons” are generally defined as molecules formed primarily by carbon and hydrogen atoms. Hydrocarbons may also include other elements such as, but not limited to, halogens, metallic elements, nitrogen, oxygen, and/or sulfur. Hydrocarbons may be, but are not limited to, kerogen, bitumen, pyrobitumen, oils, natural mineral waxes, and asphaltites. Hydrocarbons may be located in or adjacent to mineral matrices in the earth. Matrices may include, but are not limited to, sedimentary rock, sands, silicilytes, carbonates, diatomites, and other porous media. “Hydrocarbon fluids” are fluids that include hydrocarbons. Hydrocarbon fluids may include, entrain, or be entrained in non-hydrocarbon fluids (for example, hydrogen, nitrogen, carbon monoxide, carbon dioxide, hydrogen sulfide, water, and ammonia).

A “formation” includes one or more hydrocarbon containing layers, one or more non-hydrocarbon layers, an overburden, and/or an underburden. The “overburden” and/or the “underburden” include one or more different types of impermeable materials. For example, overburden and/or underburden may include rock, shale, mudstone, or wet/tight carbonate. In some embodiments of in situ conversion processes, the overburden and/or the underburden may include a hydrocarbon containing layer or hydrocarbon containing layers that are

relatively impermeable and are not subjected to temperatures during in situ conversion processing that results in significant characteristic changes of the hydrocarbon containing layers of the overburden and/or the underburden. For example, the underburden may contain shale or mudstone, but the underburden is not allowed to heat to pyrolysis temperatures during the in situ conversion process. In some cases, the overburden and/or the underburden may be somewhat permeable.

“Formation fluids” and “produced fluids” refer to fluids removed from the formation and may include pyrolyzation fluid, synthesis gas, mobilized hydrocarbon, and water (steam). Formation fluids may include hydrocarbon fluids as well as non-hydrocarbon fluids.

A “heat source” is any system for providing heat to at least a portion of the formation substantially by conductive and/or radiative heat transfer. For example, the heat source may be an electric heater such as an insulated conductor, an elongated member, and/or a conductor disposed within a conduit. Some heat sources may generate heat by burning a fuel external to or within the formation. Such heat sources may include, but are not limited to, surface burners, downhole gas burners, flameless distributed combustors, and natural distributed combustors.

A “heater” is any system for generating heat in a well or a near wellbore region. Heaters may be, but are not limited to, electric heaters, circulated heat transfer fluid or steam, burners, combustors that react with material in or produced from the formation, and/or combinations thereof. The term “wellbore” refers to a hole in the formation made by drilling or insertion of a conduit into the formation. As used herein, the terms “well” and “opening”, when referring to an opening in the formation, may be used interchangeably with the term “wellbore”.

“Pyrolysis” is the breaking of chemical bonds due to the application of heat. Pyrolysis includes transforming a compound into one or more other substances by heat alone. Heat may be transferred to a section of the formation to cause pyrolysis. “Pyrolyzation fluids” or “pyrolysis products” refers to fluid produced during pyrolysis of hydrocarbons. Fluid produced by pyrolysis reactions may mix with other fluids in the formation. The mixture would be considered pyrolyzation fluid or pyrolyzation product. Pyrolyzation fluids include, but are not limited to, hydrocarbons, hydrogen, carbon dioxide, carbon monoxide, hydrogen sulfide, ammonia, nitrogen, water, and mixtures thereof.

“Condensable hydrocarbons” are hydrocarbons that condense at 25 °C at 101 kPa absolute pressure. Condensable hydrocarbons may include a mixture of hydrocarbons having carbon numbers greater than 4.

“Non-condensable hydrocarbons” are hydrocarbons that do not condense at 25 °C and 101 kPa absolute pressure. Non-condensable hydrocarbons may include hydrocarbons having carbon numbers less than 5.

Hydrocarbons in formations may be treated in various ways to produce many different products. In certain embodiments, such formations are treated in stages. FIG. 1 illustrates several stages of heating a portion of the formation that contains hydrocarbons. FIG. 1 also depicts an example of yield (“Y”) in barrels of oil equivalent per ton (y axis) of formation fluids from the formation versus temperature (“T”) of the heated formation in degrees Celsius (x axis).

Desorption of methane and vaporization of water occurs during stage 1 heating. Heating the formation through stage 1 may be performed as quickly as possible. When the formation is initially heated, hydrocarbons in the formation desorb adsorbed methane. The desorbed methane may be produced from the formation. If the formation is heated further, water in the formation is vaporized. Water may occupy, in some formations,

between 10% and 50% of the pore volume in the formation. In other formations, water occupies larger or smaller portions of the pore volume. Water typically is vaporized in the formation between 160 °C and 285 °C at pressures of 600 kPa absolute to 7000 kPa absolute. In some embodiments, the vaporized water produces wettability changes in the formation and/or increased formation pressure. The wettability changes and/or increased pressure may affect pyrolysis reactions or other reactions in the formation. In certain embodiments, the vaporized water is produced from the formation. In other embodiments, the vaporized water is used for steam extraction and/or distillation in the formation or outside the formation. Removing the water from the formation and increasing the pore volume in the formation increases the storage space for hydrocarbons in the pore volume.

In certain embodiments, after stage 1 heating, the portion of the formation is heated further, such that the temperature in the portion of the formation reaches (at least) an initial pyrolyzation temperature (such as a temperature at the lower end of the temperature range shown as stage 2). Hydrocarbons in the formation may be pyrolyzed throughout stage 2. A pyrolysis temperature range varies depending on the types of hydrocarbons in the formation. A pyrolysis temperature range may include temperatures between 250 °C and 900 °C. The pyrolysis temperature range for producing desired products may extend through only a portion of the total pyrolysis temperature range. In some embodiments, the pyrolysis temperature range for producing desired products may include temperatures between 250 °C and 400 °C, temperatures between 250 °C and 350 °C, or temperatures between 325 °C and 400 °C. If the temperature of hydrocarbons in the formation is slowly raised through the temperature range from 250 °C to 400 °C, production of pyrolysis products may be substantially complete when the temperature approaches 400 °C. Heating the formation with a plurality of heat sources may establish thermal gradients around the heat sources that slowly raise the temperature of hydrocarbons in the formation through the pyrolysis temperature range.

In some in situ conversion embodiments, a portion of the formation is heated to the desired temperature instead of slowly heating the temperature through the pyrolysis temperature range. In some embodiments, the desired temperature is 300 °C. In some embodiments, the desired temperature is 325 °C. In some embodiments, the desired temperature is 350 °C. Other temperatures may be selected as the desired temperature. Superposition of heat from heat sources allows the desired temperature to be relatively quickly and efficiently established in the formation. Energy input into the formation from the heat sources may be adjusted to maintain the temperature in the formation at the desired temperature. The heated portion of the formation is maintained substantially at the desired temperature until pyrolysis declines such that production of desired formation fluids from the formation becomes uneconomical. Parts of the formation that are subjected to pyrolysis may include regions brought into the pyrolysis temperature range by heat transfer from only one heat source.

In certain embodiments, formation fluids including pyrolyzation fluids are produced from the formation. As the temperature of the formation increases, the amount of condensable hydrocarbons in the produced formation fluid may decrease. At high temperatures, the formation may produce mostly methane and/or hydrogen. If the hydrocarbon containing formation is heated throughout an entire pyrolysis range, the formation may produce only small amounts of hydrogen towards an upper limit of the pyrolysis range. After most of the available hydrogen is depleted, a minimal amount of fluid production will typically occur from the formation.

After pyrolysis of hydrocarbons, a large amount of carbon and some hydrogen may still be present in the heated portion of the formation. A significant portion of carbon remaining in the heated portion of the formation may be produced from the formation in the form of synthesis gas. Synthesis gas generation may take place during stage 3 heating depicted in FIG. 1. Stage 3 may include heating the heated portion of the formation to a temperature sufficient to allow synthesis gas generation. For example, synthesis gas may be produced in a temperature range from 400 °C to 1200 °C, 500 °C to 1100 °C, or 550 °C to 1000 °C. The temperature of the heated portion of the formation when the synthesis gas generating fluid is introduced to the formation determines the composition of synthesis gas produced in the formation. The generated synthesis gas may be removed from the formation through one or more production wells.

FIG. 2 depicts a schematic view of an embodiment of a portion of the in situ conversion system for treating the formation that contains hydrocarbons. Heat sources 20 are placed in at least a portion of the formation. Heat sources 20 may include electric heaters such as insulated conductors, conductor-in-conduit heaters, surface burners, flameless distributed combustors, and/or natural distributed combustors. Heat sources 20 may also include other types of heaters. Heat sources 20 provide heat to at least a portion of the formation to heat hydrocarbons in the formation. Energy may be supplied to heat sources 20 through supply lines 22. Supply lines 22 may be structurally different depending on the type of heat source or heat sources used to heat the formation. Supply lines 22 for heat sources may transmit electricity for electric heaters, may transport fuel for combustors, or may transport heat exchange fluid that is circulated in the formation.

Production wells 24 are used to remove formation fluid from the formation. Formation fluid produced from production wells 24 may be transported through collection piping 26 to treatment facilities 28. Formation fluids may also be produced from heat sources 20. For example, fluid may be produced from heat sources 20 to control pressure in the formation adjacent to the heat sources. Fluid produced from heat sources 20 may be transported through tubing or piping to collection piping 26 or the produced fluid may be transported through tubing or piping directly to treatment facilities 28. Treatment facilities 28 may include separation units, reaction units, upgrading units, fuel cells, turbines, storage vessels, and/or other systems and units for processing produced formation fluids.

The in situ conversion system for treating hydrocarbons may include barrier wells 30. Barrier wells are used to form a barrier around a treatment area. The barrier inhibits fluid flow into and/or out of the treatment area. Barrier wells include, but are not limited to, dewatering wells, vacuum wells, capture wells, injection wells, grout wells, freeze wells, or combinations thereof. In some embodiments, barrier wells 30 are dewatering wells. Dewatering wells may remove liquid water and/or inhibit liquid water from entering a portion of the formation to be heated, or to the formation being heated. In the embodiment depicted in FIG. 2, the dewatering wells are shown extending only along one side of heat sources 20, but dewatering wells typically encircle all heat sources 20 used, or to be used, to heat the formation.

As shown in FIG. 2, in addition to heat sources 20, one or more production wells 24 are placed in the formation. Formation fluids may be produced through production well 24. In some embodiments, production well 24 includes a heat source. The heat source in the production well may heat one or more portions of the formation at or near the production well and allow for vapor phase removal of formation fluids. The need for high temperature pumping of liquids from the production well may be reduced or eliminated. Avoiding or limiting high temperature pumping of liquids may significantly decrease production costs. Providing heating at

or through the production well may: (1) inhibit condensation and/or refluxing of production fluid when such production fluid is moving in the production well proximate the overburden, (2) increase heat input into the formation, and/or (3) increase formation permeability at or proximate the production well. In some in situ conversion process embodiments, an amount of heat supplied to the formation from a production well per meter of the production well is less than the amount of heat applied to the formation from a heat source that heats the formation per meter of the heat source.

A potential source of heat loss from a heated formation is reflux in a well. Refluxing occurs when vapors condense in the well and flow into a portion of the well adjacent to the heated portion of the formation. Vapors may condense in a well adjacent to the overburden of the formation to form condensed fluid.

Condensed fluid flowing into the well adjacent to the heated formation absorbs heat from the formation. Heat absorbed by condensed fluids cools the formation and necessitates additional energy input into the formation to maintain the formation at a desired temperature. Some fluids condensed in the overburden and flowing into the portion of the well adjacent to the heated formation may react to produce undesired compounds and/or coke. Inhibiting fluids from refluxing may significantly improve the thermal efficiency of the in situ conversion system and/or the quality of the product produced from the in situ conversion system.

For some well embodiments, the portion of the well adjacent to the overburden section of the formation is cemented to the formation. In some well embodiments, the well includes packing material placed near the transition from the heated section of the formation to the overburden. The packing material inhibits formation fluid from passing from the heated section of the formation into the section of the wellbore adjacent to the overburden. Cables, conduits, devices, and/or instruments may pass through the packing material, but the packing material inhibits formation fluid from passing up the wellbore adjacent to the overburden section of the formation.

The flow of production fluid up the well to the surface is desired for some types of wells, especially for production wells. Flow of production fluid up the well is also desirable for some heater wells that are used to control pressure in the formation. The overburden, or a conduit in the well used to transport formation fluid from the heated portion of the formation to the surface may be heated to inhibit condensation on or in the conduit. Providing heat in the overburden, however, may be costly and/or may lead to increased cracking or coking of formation fluid as the formation fluid is being produced from the formation.

To avoid the need to heat the overburden or to heat the conduit passing through the overburden, one or more diverters may be placed in the wellbore to inhibit fluid from refluxing into the wellbore adjacent to the heated portion of the formation. In some embodiments, the diverter retains fluid above the heated portion of the formation. Fluids retained in the diverter may be removed from the diverter using a pump, gas lifting, and/or other fluid removal technique. In some embodiments, the diverter directs fluid to a pump, gas lift assembly, or other fluid removal device located below the heated portion of the formation.

FIG. 3 depicts an embodiment of a diverter in a production well. Production well 24 includes conduit 32. In some embodiments, diverter 34 is coupled to or located proximate production conduit 32 in overburden 36. In some embodiments, the diverter is placed in the heated portion of the formation. Diverter 34 may be located at or near an interface of overburden 36 and hydrocarbon layer 38. Hydrocarbon layer 38 is heated by heat sources located in the formation. Diverter 34 may include packing 40, riser 42, and seal 44 in production conduit 32. Formation fluid in the vapor phase from the heated formation moves from hydrocarbon layer 38

into riser 42. In some embodiments, riser 42 is perforated below packing 40 to facilitate movement of fluid into the riser. Packing 40 inhibits passage of the vapor phase formation fluid into an upper portion of production well 24. Formation fluid in the vapor phase moves through riser 42 into production conduit 32. A non-condensable portion of the formation fluid rises through production conduit 32 to the surface. The vapor phase formation fluid in production conduit 32 may cool as it rises towards the surface in the production conduit. If a portion of the vapor phase formation fluid condenses to liquid in production conduit 32, the liquid flows by gravity towards seal 44. Seal 44 inhibits liquid from entering the heated portion of the formation. Liquid collected above seal 44 is removed by pump 46 through conduit 48. Pump 46 may be, but is not limited to being, a sucker rod pump, an electrical pump, or a progressive cavity pump (Moyno style). In some embodiments, liquid above seal 44 is gas lifted through conduit 48. Producing condensed fluid may reduce costs associated with removing heat from fluids at the wellhead of the production well.

In some embodiments, production well 24 includes heater 50. Heater 50 provides heat to vaporize liquids in a portion of production well 24 proximate hydrocarbon layer 38. Heater 50 may be located in production conduit 32 or may be coupled to the outside of the production conduit. In embodiments where the heater is located outside of the production conduit, a portion of the heater passes through the packing material.

In some embodiments, a diluent may be introduced into production conduit 32 and/or conduit 48. The diluent is used to inhibit clogging in production conduit 32, pump 46, and/or conduit 48. The diluent may be, but is not limited to being, water, an alcohol, a solvent, or a surfactant.

In some embodiments, riser 42 extends to the surface of production well 24. Perforations and a baffle in riser 42 located above seal 44 direct condensed liquid from the riser into production conduit 32.

In certain embodiments, two or more diverters may be located in the production well. Two or more diverters provide a simple way of separating initial fractions of condensed fluid produced from the in situ conversion system. A pump may be placed in each diverters to remove condensed fluid from the diverters.

In some embodiments, fluids (gases and liquids) may be directed towards the bottom of the production well using the diverter. The fluids may be produced from the bottom of the production well. FIG. 4 depicts an embodiment of the diverter that directs fluid towards the bottom of the production well. Diverter 34 may include packing material 40 and baffle 52 positioned in production conduit 32. Baffle may be a pipe positioned around conduit 48. Production conduit 32 may have openings 54 that allow fluids to enter the production conduit from hydrocarbon layer 38. In some embodiments, all or a portion of the openings are adjacent to a non-hydrocarbon layer of the formation through which heated formation fluid flows. Openings 54 include, but are not limited to, screens, perforations, slits, and/or slots. Hydrocarbon layer 38 may be heated using heaters located in other portions of the formation and/or a heater located in production conduit 32.

Baffle 52 and packing material 40 direct formation fluid entering production conduit 32 to unheated zone 56. Unheated zone 56 is in the underburden of the formation. A portion of the formation fluid may condense on the outer surface of baffle 52 or on walls of production conduit 32 adjacent to unheated zone 56. Liquid fluid from the formation and/or condensed fluid may flow by gravity to a bottom portion of production conduit 32. Liquid and condensate in the bottom portion of production conduit 32 may be pumped to the surface through conduit 48 using pump 46. Pump 46 may be placed 1 m, 5 m, 10 m, 20 m or more into the underburden. In some embodiments, the pump may be placed in a non-cased (open) portion of the wellbore. Non-condensed fluid initially travels through the annular space between baffle 52 and conduit 48, and then

through the annular space between production conduit 32 and conduit 48 to the surface, as indicated by arrows in FIG. 4. If a portion of the non-condensed fluid condenses adjacent to overburden 36 while traveling to the surface, the condensed fluid will flow by gravity toward the bottom portion of production conduit 32 to the intake for pump 46. Heat absorbed by the condensed fluid as the fluid passes through the heated portion of the formation is from contact with baffle 52, not from direct contact with the formation. Baffle 52 is heated by formation fluid and radiative heat transfer from the formation. Significantly less heat from the formation is transferred to the condensed fluid as the fluid flows through baffle 52 adjacent to the heated portion than if the condensed fluid was able to contact the formation. The condensed fluid flowing down the baffle may absorb enough heat from the vapor in the wellbore to condense a portion of the vapor on the outer surface of baffle 52. The condensed portion of the vapor may flow down the baffle to the bottom portion of the wellbore.

In some embodiments, diluent may be introduced into production conduit 32 and/or conduit 48. The diluent is used to inhibit clogging in production conduit 32, pump 46, and conduit 48. The diluent may include, but is not limited to, water, an alcohol, a solvent, a surfactant, or combinations thereof. Different diluents may be introduced at different times. For example, a solvent may be introduced when production first begins to put into solution high molecular weight hydrocarbons that are initially produced from the formation. At a later time, water may be substituted for the solvent.

In some embodiments, a separate conduit may introduce the diluent to the wellbore near the underburden, as depicted in FIG. 5. Production conduit 32 directs vapor produced from the formation to the surface through overburden 36. If a portion of the vapor condenses in production conduit 32, the condensate can flow down baffle 52 to the intake for pump 46. Diverter 34, comprising packing material 40 and baffle 52, directs formation fluid flow from heated hydrocarbon layer 38 to unheated zone 56. Liquid formation fluid is transported by pump 46 through conduit 48 to the surface. Vapor formation fluid is transported through baffle 52 to production conduit 32. Conduit 58 may be strapped to baffle 52. Conduit 58 may introduce the diluent to wellbore 60 adjacent to unheated zone 56. The diluent may promote condensation of formation fluid and/or inhibit clogging of pump 46. Diluent in conduit 58 may be at a high pressure. If the diluent changes phase from liquid to vapor while passing through the heated portion of the formation, the change in pressure as the diluent leaves conduit 58 allows the diluent to condense.

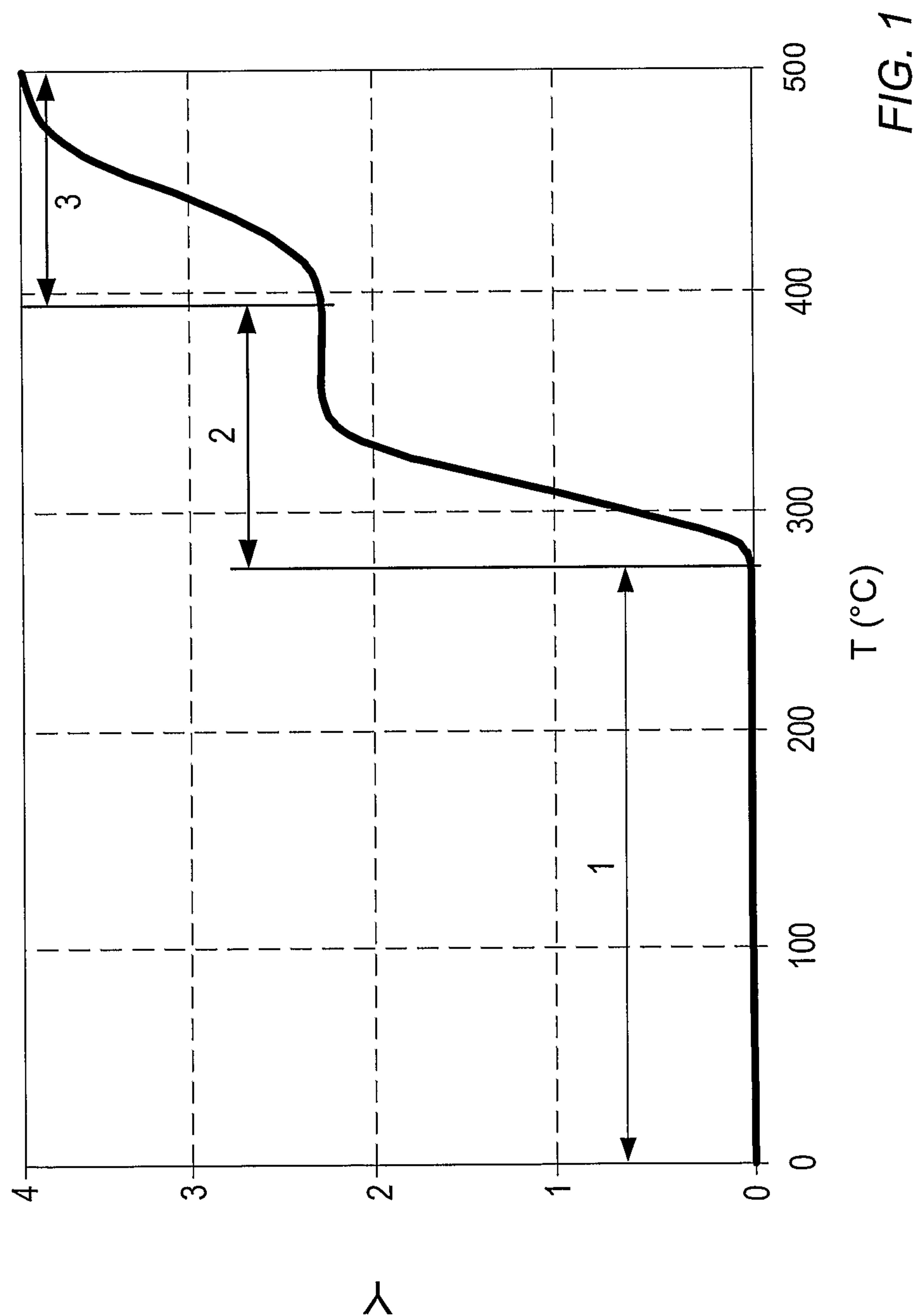
Further modifications and alternative embodiments of various aspects of the invention may be apparent to those skilled in the art in view of this description. Accordingly, this description is to be construed as illustrative only and is for the purpose of teaching those skilled in the art the general manner of carrying out the invention. It is to be understood that the forms of the invention shown and described herein are to be taken as the presently preferred embodiments. Elements and materials may be substituted for those illustrated and described herein, parts and processes may be reversed, and certain features of the invention may be utilized independently, all as would be apparent to one skilled in the art after having the benefit of this description of the invention. Changes may be made in the elements described herein without departing from the spirit and scope of the invention as described in the following claims. In addition, it is to be understood that features described herein independently may, in certain embodiments, be combined.

CLAIMS:

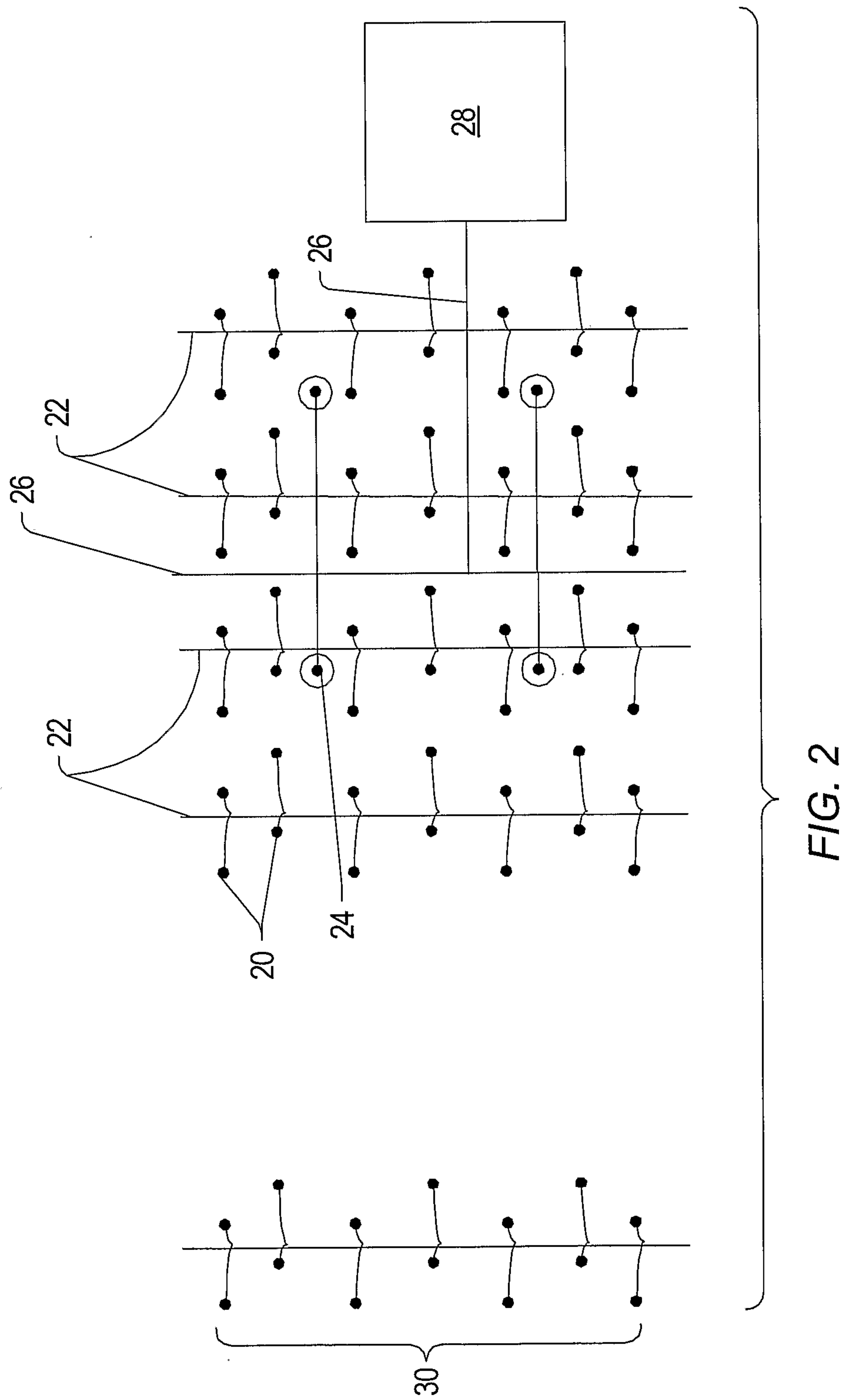
1. A method for treating a subsurface formation, comprising:
 - using heaters to form a heated portion of the subsurface formation;
 - using a production conduit to direct formation fluid in a vapor phase from the heated portion of the subsurface formation towards a surface of the subsurface formation;
 - forming condensate of the vapor phase formation fluid in or near the production conduit; and
 - diverting condensate of the vapor phase formation fluid to a location below the heated portion of the formation.
2. The method as claimed in claim 1, the method further comprising pumping the liquid from the production conduit.
3. The method as claimed in claim 1, the method further comprises gas lifting the liquid from the production conduit.
4. The method as claimed in claim 2 or 3, wherein the liquid is removed through a conduit.
5. The method as claimed in claim 4, the method further comprises adding a diluent to the conduit.
6. The method as claimed in any one of claims 1 to 5, the method further comprising adding a diluent to the production conduit.
7. The method as claimed in any one of claims 1 to 6, further comprising using a riser to divert the condensate from the heated portion of the formation.

8. The method as claimed of claim 7, wherein a portion of the riser is heated to ensure formation fluid passing through the riser is vapor.
9. The method as claimed in claim 1, the method further comprising pumping the liquid with a pump located below the heated portion of the formation.
10. The method as claimed in claim 9, the method further comprising introducing a diluent below the heated portion of the formation.
11. A method for treating a subsurface formation, the method comprising the steps of:
- using heaters to form a heated portion of the subsurface formation;
 - using a production conduit to direct formation fluid in a vapor phase from the heated portion of the subsurface formation towards a surface of the subsurface formation through an overburdon;
 - forming condensate of the vapor phase formation fluid in or near the production conduit within the overburdon; and
 - preventing the condensate from returning back to the heated portion of the subsurface formation.

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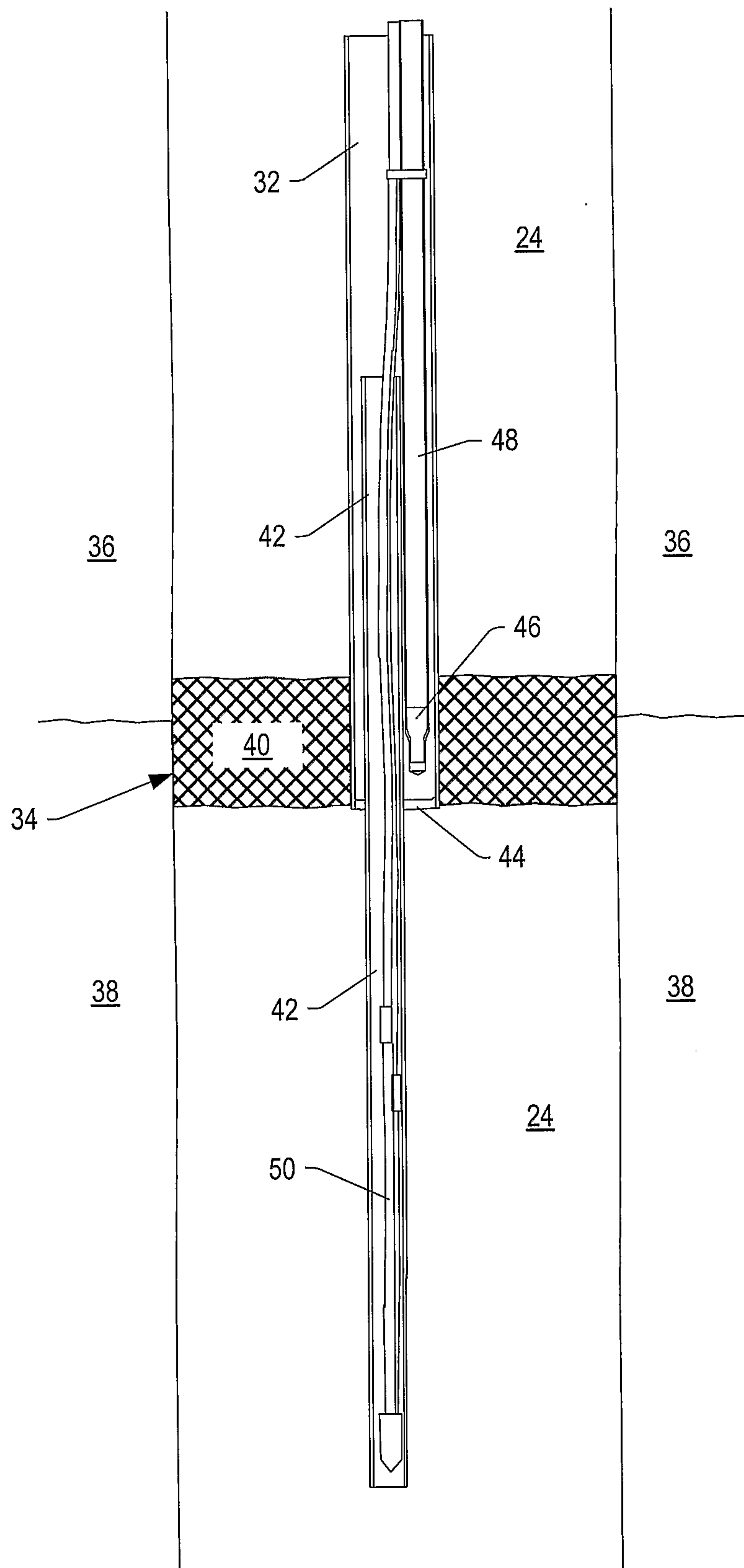


FIG. 3

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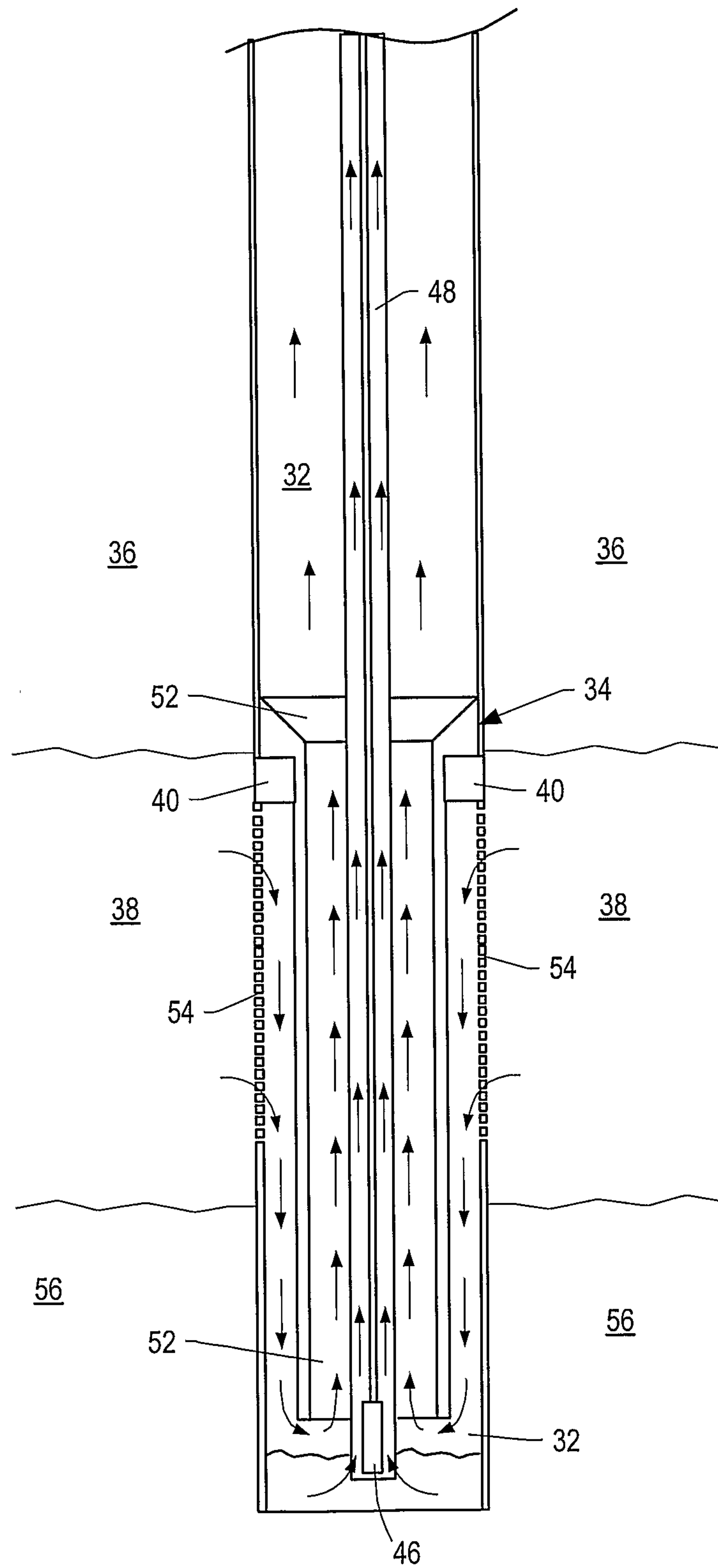


FIG. 4

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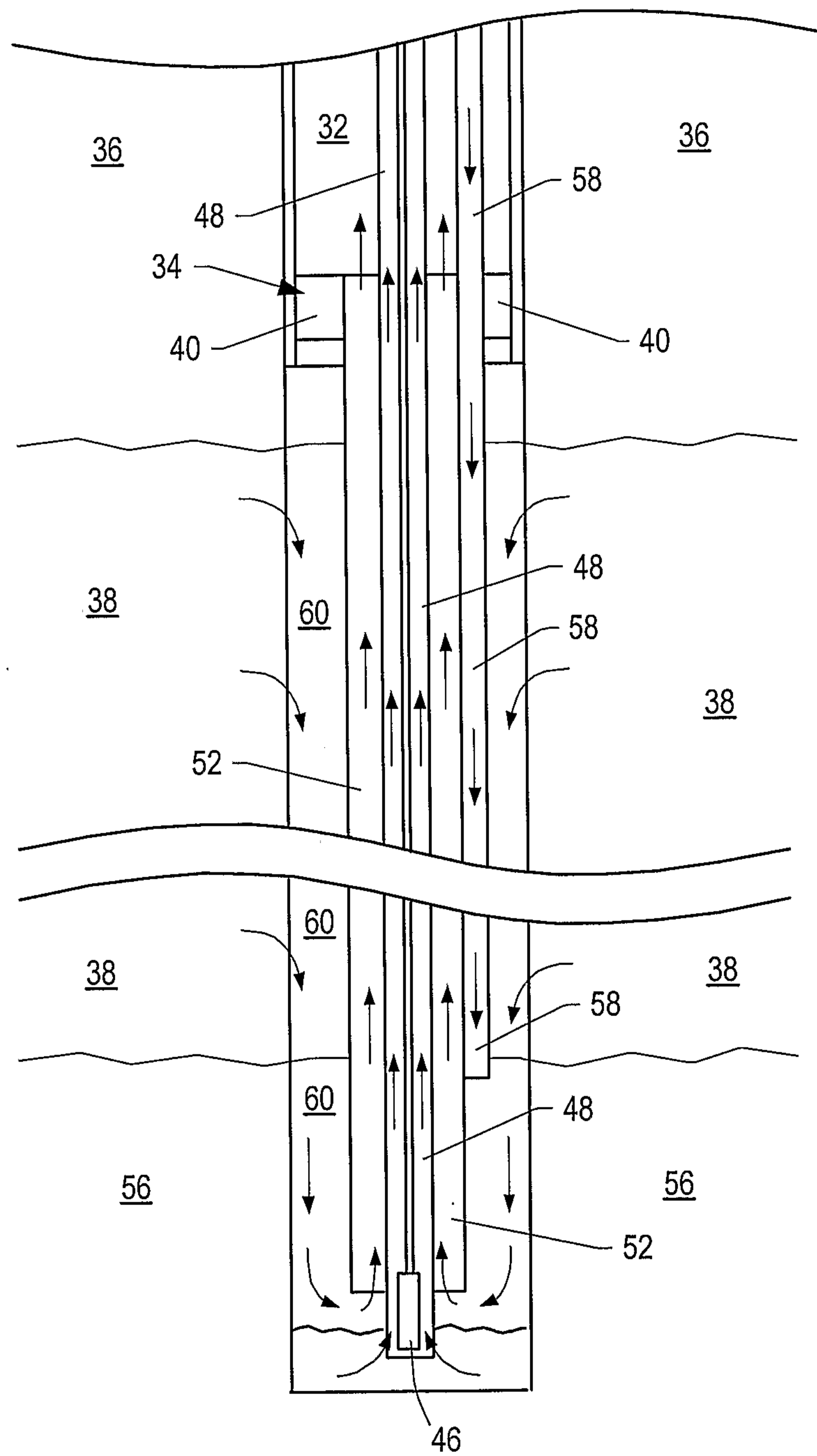


FIG. 5

