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(54) **FRACTURING OF SHALE AND OIL SANDS USING A CLEAN PROCESSING SYSTEM AND METHOD**

(57) The invention provides a system and method for providing a clean, non-contaminating process for producing fracturing of shale, limestone, sands and other geo-

logical and mining formations using high-pressure steam and CO₂ to release natural gas, oil and minerals within a formation.

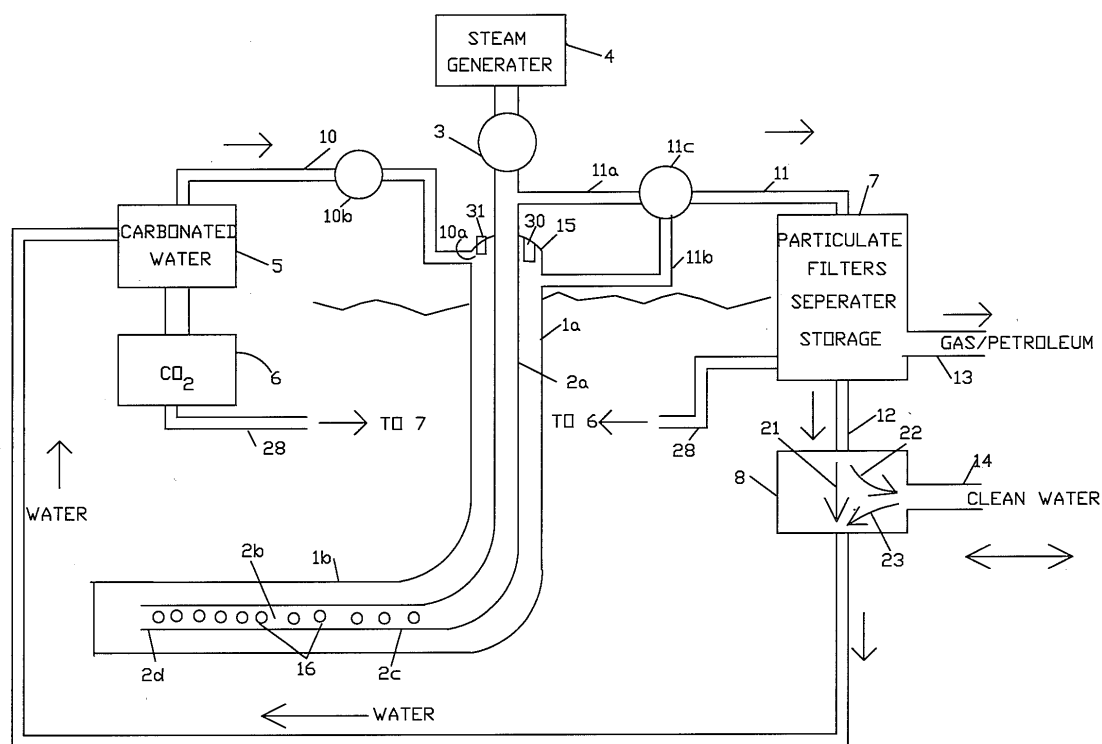


FIGURE 1

Description**FIELD OF THE INVENTION**

[0001] The invention relates to a method and system for producing fracturing of shale and oil sands, and mineral containing material to release natural gases and oil utilizing CO₂ and a steam process without using other chemical contaminants.

BACKGROUND OF THE INVENTION

[0002] Most fracturing processes use various chemicals in their process to recover gas and oil. For example, U.S. Patent 8,733,439 uses CO₂, but also used H₂O₂ (hydrogen peroxide) which, when used medically in small amounts, is considered a mild antiseptic, and can be used as a bleaching agent. Hydrogen peroxide can be used for certain industrial or environmental purposes as well, because it can provide the effects of bleaching without the potential damage of chlorine-based agents. Because this substance can be unstable in high concentrations, it must be used with care. In higher concentrations, it can create strong chemical reactions when it interacts with other agents, and it can damage the skin or eyes of persons working with it. The use in wells may contaminate underground water if there is seepage into ground water. This patent also uses other chemicals such as Fe, Co, Ni and similar chemicals.

[0003] Other processes also use various chemicals, particulate material, and other catalysts which can contaminate water sources such as wells and aquifers. These processes utilize a large amount of water which often is not or cannot be recycled because of the toxic chemicals contained therein.

SUMMARY OF THE INVENTION

[0004] An object of the invention is to provide a clean, noncontaminating process for producing fracturing of shale, limestone, sands, and other geological and mining formations to release natural gas and oil within a well, and to break up any mineral containing material.

[0005] Another object of the invention is to provide a system to produce on site the energy required to induce fracturing, removing natural gas and oil, and to recycle fluids used in fracturing for additional use.

[0006] Another object of the invention is to provide for movable storage of fracturing liquids for additional use at one or more sites.

[0007] The technical advance represented by the invention as well as the objects thereof will become apparent from the following description of a preferred embodiment of the invention when considered in conjunction with the accompanying drawings, and the novel features set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS**[0008]**

FIGURE 1 illustrates a diagram of the basis system of the invention and the process associated therewith.

FIGURE 2 illustrates additional features which may be utilized with the present invention.

Figure 3 illustrates a well configuration in which frozen CO₂ is inserted into a well and then expanded by pressurized steam to cause fracturing of the walls of the well.

Figures 4a and 4b illustrate two types of insertion tubes.

DESCRIPTION OF A PREFERRED EMBODIMENT

[0009] Figure 1 illustrates the system and method for producing clean fracturing in a natural gas and oil well. The well has a vertical drill bore and or pipe casing 1a and a horizontal drill bore or pipe casing 1b extending horizontally from the lower end of vertical drill bore and or pipe casing 1a. This is the standard method of drilling wells. Inserted in the well is vertical pipe or tube 2a which extends the length of vertical well bore 1a and then extends horizontally, 2b, into the horizontal well bore 1b. Well bore 1a is then capped at the top with seal 15. This is to prevent any gasses or other material from escaping out into the atmosphere and surrounding area. This system is an example that can be used with the claimed fracturing process. Modification of the system and other configurations may be used with the fracturing process.

[0010] The rest of the system is described as follows. Clean water is supplied through input 14 through a processing system 8, which includes a three way valve. The water is directed through 23 into pipe 9 and then in to storage container 5, which carbonates the water, using the CO₂ from portable storage container 6.

[0011] The carbonated water from container 5 is then directed, through pipe 10 and valve 10b, into the well at opening 10a. This carbonated water flows downward into the well and fills the horizontal portion 1b with carbonated water. The carbonated water in container 5 may be refrigerated to keep the carbonated water cool, or partially frozen so as to prevent vaporization of the CO₂ from the water while it is being injected into the well. The carbonated water may be lightly frozen to provide an icy slush. Sand can be injected into the wellbore alone, or with the carbonated water to aid in the fracturing process.

[0012] Once the well, particularly the horizontal portion 1b is filled with the carbonated water, then high pressure steam, generated in steam generator 4, is injected into the well through valve 3 into pipes or tubes 2a and 2b. Pipe/tube 2b has openings 16 around its periphery and along its length to distribute the steam throughout horizontal well bore 1b. The high pressure steam causes the carbonated water to literally explode creating, a great

pressure in the well causing fracturing of the walls of the well bore, thus releasing natural gas/oil from the underground sources. To keep all of the pressurized steam from exiting through the first holes at the beginning 2c of horizontal pipe 2b, there are fewer holes at the start of horizontal pipe 2c to prevent exiting of a large quantity of pressurized gas. The number of holes increases towards the 2d end of the horizontal pipe. This progressive increasing of holes helps to evenly distribute the pressurized gas throughout the horizontal portion 1b of the well.

[0013] After the fracturing process, the remaining carbonated water, any loose sand, and the gas/oil is then pumped upward through well bore 1a and pipe 2a through pipes 11a and 11b to valve 11c and through pipe 11 into processing unit 7, which may have storage capacity. Processing unit 7 filters out any particulate material and separates the gas/oil and CO₂ from the remaining water. The CO₂ can be returned through pipe 28 to the CO₂ storage tank 6 for reuse. The gas/oil is then stored or directed out pipe 13 for storage and/or transportation to another storage facility.

[0014] To prevent the particulate filter 7 from becoming clogged with particulate material, there could be at least two parallel particulate filters. One would be used at a time. When the flow of gas/petroleum/CO₂ decreases to a lower determined level through the particulate filter, a sensor would detect this lower level and would switch the flow through a parallel filter. There would be a notification of this change, and the clogged filter could be cleaned to remove the particulate for use again.

[0015] The separated water is then passed through pipe 12 into processing system 8. The water can be directed back into the system through valve 21 for reuse, as needed, for additional fracturing of the well. The water can also be processed to clean it, removing any and all chemical and/or foreign matter from the well and then sent through pipe 14 for storage and/or another use.

[0016] All of the units, Steam generator 4, carbonated water unit 5, CO₂ unit 6, separator 7 and processing system may all be portable units for use at other locations. The units may be incorporated in one movable unit for movement to other drilling sites.

[0017] To prevent excess pressure that would cause over fracturing in the well, a pressure sensor 30 measures the pressure. If the pressure exceeds a predetermined amount, then release valve 31 would open, and stay open, as long as the pressure exceeds the predetermined amount. When the pressure is reduced, then valve 31 would close.

[0018] As an alternative to using carbonated water, refrigerated CO₂ can be injected into the well bore and then expanded with the pressurized steam. This would limit the amount of carbonated water needed in the well bore. Since steam is vaporized water, after the steam is injected into the refrigerated CO₂, it would cool and become carbonated water. Additional steam injected into the refrigerated CO₂ would cause it to expand and cause fracturing. This would limit the amount of carbonated water

to be removed from the well for cleaning and future use.

[0019] Figure 2 illustrates the system and method for producing clean fracturing in a natural gas and oil well as in Figure 1 with the following differences in the system and method. In the vertical part of the wellbore 1a, an isolation plug 19 is placed near the bottom of the vertical portion 1a of the well bore, or in any part of horizontal well bore 1b. The location of the isolation plug is determined where the fracturing of the well is to begin. Since carbonated water cannot be inserted into the well after the isolation plug seal 19 is in place, the valve 3 of Figure 1 is replaced with valve 20. The carbonated water is then passed through pipe 17 into valve 20 into pipe 2a to insert the carbonated water into the well bore. The carbonated water will flow downward through pipe 2a and horizontal pipe 2b and into the well out openings 16 and out the end 2d of horizontal pipe 2b into the well bore. The pressurized steam from steam generator 4 is directed through valve 20 into pipe 2a and 2b. The steam is then evenly distributed into horizontal well bore 1b through openings 16, as in Figure 1, providing pressure to producing the fracturing required to release the natural gas or oil from the surrounding areas. The advantage of using isolation plug 19 is that the pressure cannot pass upward into vertical well bore 1a, or unwanted areas of 1b, providing a greater pressure in the localized horizontal portion of 1b of the well bore, increasing the fracturing pressure and increasing the result of the fracturing, releasing more natural gas and/or oil.

[0020] Isolation plug 19 could include a pressure sensor 38 and release valve 39 to prevent the pressure from exceeding a predetermined amount, to prevent over fracturing. The isolation plug can be later removed or drilled out to allow flow in well bore 1a.

[0021] After the fracturing process, the remaining carbonated water, any loose sand or other particulate material, and the gas/oil may be pumped upward through pipe 2a and well bore 1a through pipes 11a and 11b to valve 11c, and then through pipe 11 into processing unit 7.

[0022] Figure 3 illustrates a well configuration in which frozen CO₂ is inserted into a pipe 45 and then expanded by pressurized steam to cause fracturing of the walls of the well bore 1b. This configuration involves cooling CO₂ in unit 50 to below its freezing temperature of 109.3 degrees F and injecting a snow like compound into well bore 1b. This is achieved through a flexible composite material or metal alloy insertion hose or tube 51 and 45, which can be the same as tube 2a, Figure 2, attached via a delivery hose or tubing from the surface. The cooled CO₂ is released into the well bore through the perforations 43 in the insertion tube 42, or by use of, or with a perforating gun. When sufficient amounts of cooled CO₂ are achieved, a CO₂ sensor and release valve 41 immediately closes off the CO₂ induction and triggers a steam pressure sensor and release valve 40 for high pressure steam to immediately be injected through the same flexible perforated composite or metal alloy insertion tube

45. A pressure containment plate 46 seals the lower portion of the well to prevent pressure from rising upward to the top of the well. This process creates a catalytic reaction that rapidly heats and expands the cooled CO₂ causing the fracturing of the shale or other geological formation being addressed. This process can be carried out in one large stage or in multiple stages, depending upon the specific characteristics of the geological formation being fractured, and can be repeated until the required desire of fracturing is achieved. This configuration can be used in combination with the basic system shown in Figure 2 where the assembly in Figure 3 replaces the structure at the lower end of tube 2a, or any part of horizontal 1b of Figure 2.

[0023] Pipe 45, in Figure 3 may have several configurations and partitions for inserting the fracturing materials into the well. Figures 4a and 4b below, shows two possible configurations. Other configurations are possible to individually insert the fracturing materials in the order necessary to provide the fracturing.

[0024] The carbonated water, frozen CO₂, and steam are alternately inserted through valve 20a.

[0025] The system of Figure 1 could be used to extract minerals other than gas and oil. In this configuration, there would be extreme fracturing to break up the mineral containing soil/rock in the structure. The mineral containing soil/rock would be vacuumed up out of the structure where the minerals could be separated from the soil/rock. This process would use a vacuum system similar to that used to mine minerals from the sea bottom. In this instance, the pressure system and release valves would not be used.

[0026] Figures 4a and 4b illustrate two types of insertion tubes. Figures 4a and 4b are cross sectional views taken at A-A in Figure 3.

[0027] Figure 4a shows concentric used to insert particulate frozen CO₂, pressurized steam and carbonated water and fracking sand as needed. The outer structure is the well bore structure into which the concentric tubes are inserted.

[0028] Figure 4b shows parallel tubes into which pressurized steam, carbonated water and particulate frozen CO₂ are injected into the well bore structure.

[0029] These two configurations are examples for inducing the fracturing material. Other configurations may be used, for example some of the tubes may be used for more than one insertion path, different injection materials may be switched between the injection paths.

[0030] The valves 3, 20, 20a, 10b and 11c and tubes 2a and 2b in Figures 1, 2 and 3 may remain onsite for future use.

Claims

1. A method of providing fracturing in a well bore, to produce at least one of natural gas and oil, having vertical and horizontal well bore regions,

injecting carbonated water into the well bore; and injecting high pressure steam into the carbonated water to cause fracturing of the walls of the well.

2. The method according to Claim 1, wherein the well bore has vertical and horizontal portions and a pipe in the well extends into the vertical and horizontal portions of the well bore;
Wherein, pressurized steam is injected into the horizontal region of the well bore through peripheral openings in the pipe in the horizontal region of the well bore; and
Fracking sand is inserted as needed.
3. The method according to Claim 1 wherein the carbonated water is refrigerated prior to injecting it into the well.
4. The method according to Claim 1, wherein at least one of natural gas and oil, the carbonated water, and any released CO₂ are removed from the well, the carbonated water and CO₂ being separated from at least one of natural gas and oil, and processed for further use.
5. The method according to Claim 1, wherein a seal is placed in the well bore to limit the pressurized region of the well bore to increase the pressure therein, thereby increasing the fracturing pressure; and at least one pressure sensor and pressure release valve is placed in the well to prevent the pressure produced by the carbonated water and pressured steam from exceeding a predetermined value.
6. A method of providing fracturing in a well bore, to produce at least one of natural gas and oil; injecting at least one of refrigerated carbonized water and frozen CO₂ into the well bore; injecting pressurized steam into a region of the well bore through peripheral openings in a pipe extending downward into the well bore and into the horizontal region of the well bore.
7. The method according to Claim 6, wherein the peripheral openings in the pipe are spaced apart to maximize the insertion of the pressurized steam in equal portions along the length of the horizontal portion of the pipe.
8. The method according to Claim 6 wherein the CO₂ is cooled below its freezing temperature to produce a snow like material which is injected into the well bore through a tube and is released into the well bore through perforations in the tube; and injecting pressurized steam after a sufficient amount of cooled CO₂ is released into the well to create a catalytic reaction that heats and expands the cooled CO₂ causing the fracturing of shale and other geo-

logical formations in the well.

9. The method according to Claim 8 including the triggering of a sensor valve when a sufficient amount of cooled CO₂ has been released into the well bore to close off the insertion of cooled CO₂ and opening a second valve to allow pressurized steam to be injected into the well to rapidly expand the cooled CO₂. 5

10. A system for producing fracturing in a well bore utilizing only carbonated water, sand as needed, and pressurized steam, comprising: 10
 - a well bore having a vertical and horizontal region; 15
 - a pipe extending downward in the vertical region and horizontally in the horizontal region;
 - a storage unit for holding carbonated water for injection into the well;
 - a steam generator for injecting pressurized steam into the carbonated water for producing fracturing in the well; and 20
 - means for removing at least one of gas and oil released during the fracturing process. 25

11. The system according to Claim 10, including a unit for refrigerating the carbonated water prior to being injecting into the well bore.

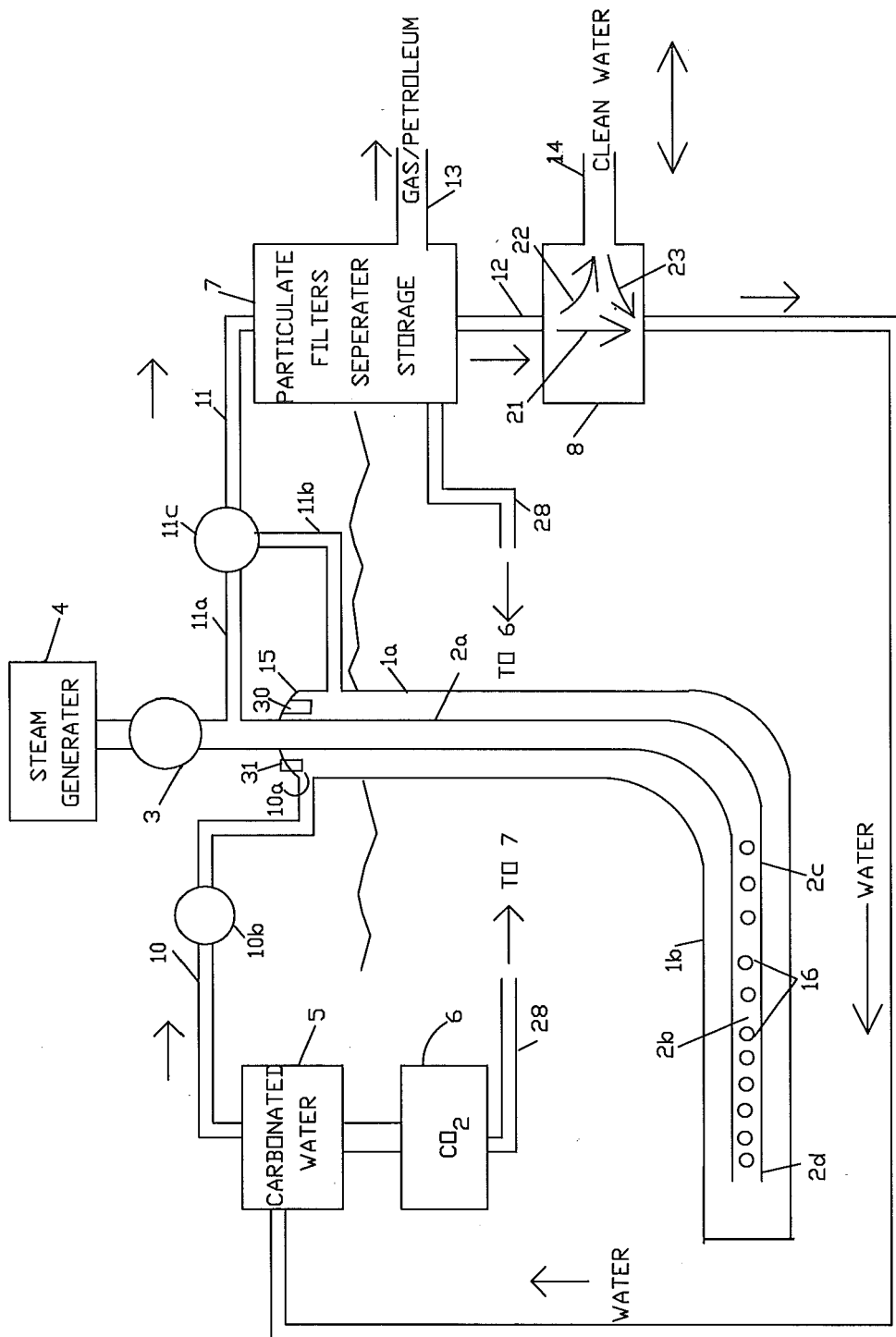
12. The system according to Claim 10, wherein the pipe extending into the well bore has perforated openings spaced apart along the horizontal portion of the pipe to evenly distribute the pressurized steam equally along the length of the horizontal portion of the pipe. 30
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13. The system according to Claim 10, including an isolation plug to prevent the pressurized steam, contaminants and carbonated water from moving up the vertical portion of the well, increasing the pressure in any portion of the well bore to produce greater fracturing in the well. 40

14. The system according to Claim 10, including a seal at the top of the well to prevent any gases and other materials from leaving the well and entering the atmosphere, and a system for freezing CO₂ for injecting into the well bore. 45

15. The method according to claim 1, where in CO₂ is injected into the well bore instead of carbonated water, and the CO₂ is expanded by the pressurized steam to cause fracturing. 50

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9/ **FIGURE 1**

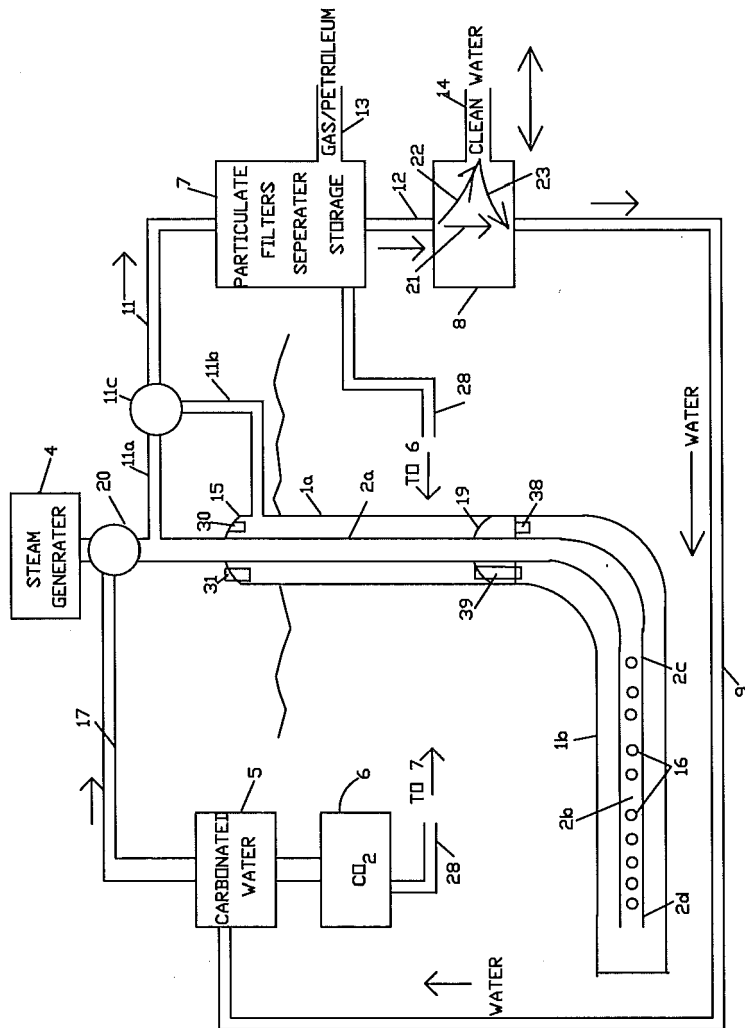


FIGURE 2

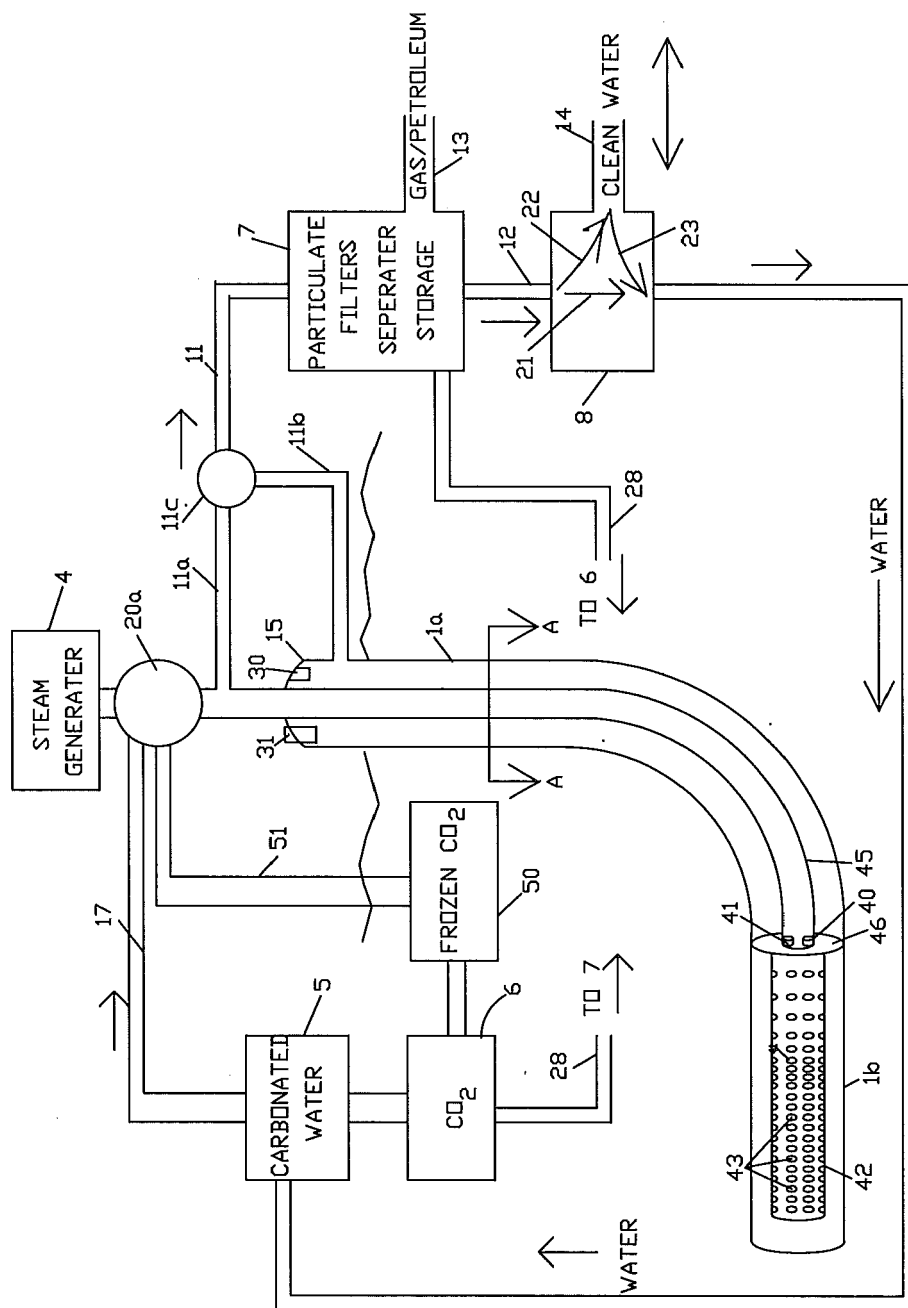
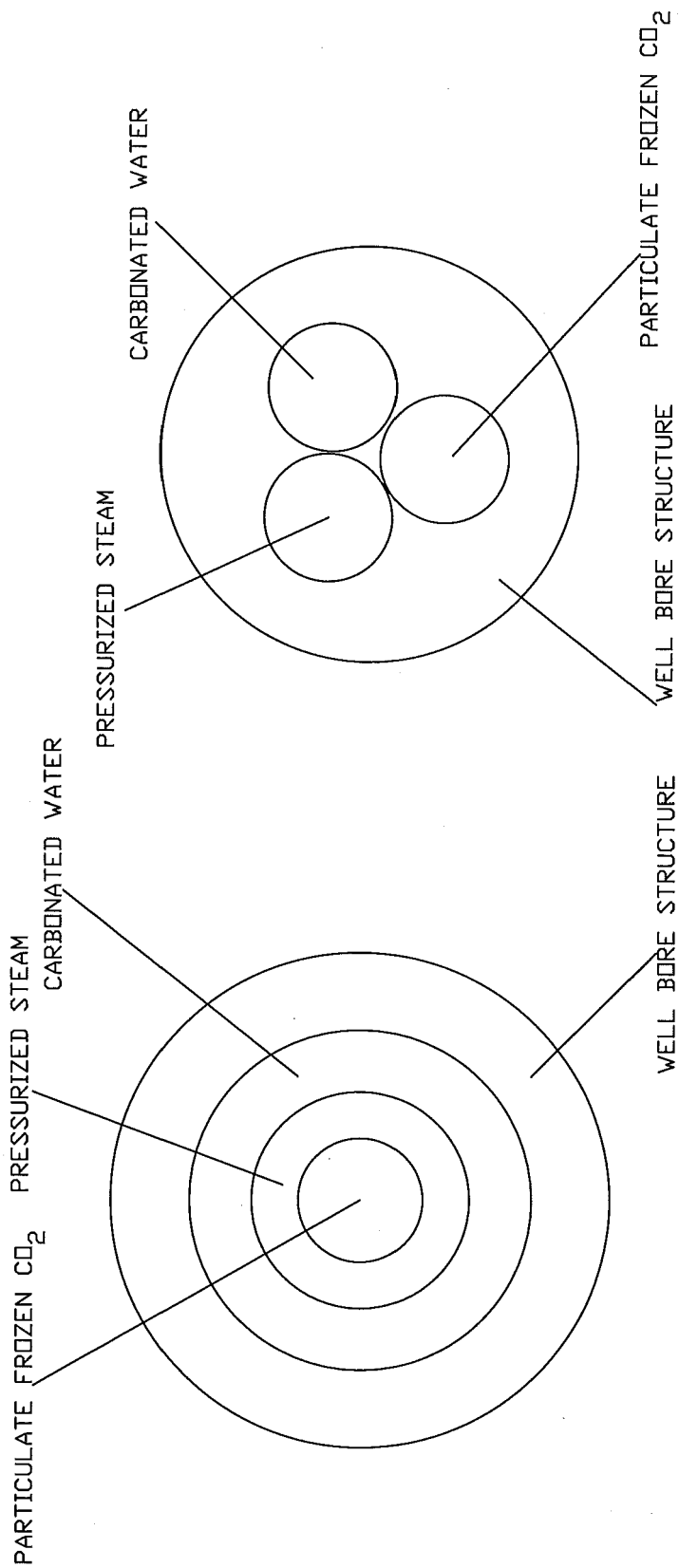


FIGURE 3



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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