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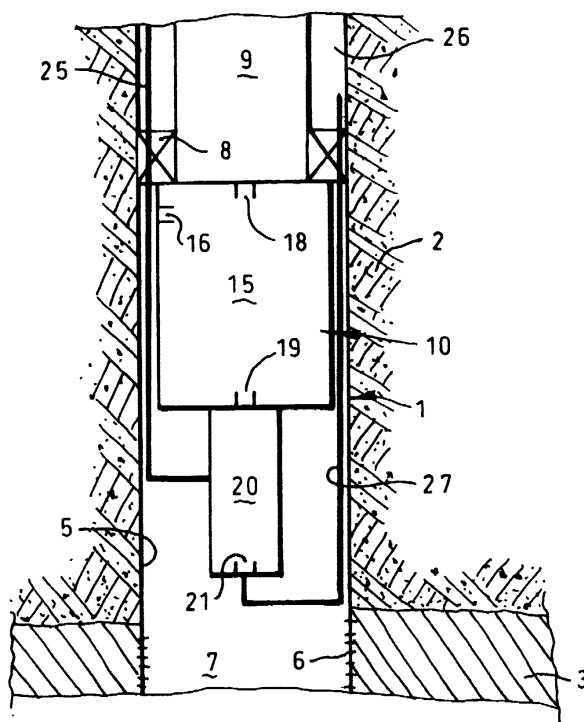
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(54) **Downhole gas/liquid separation system**

(57) A downhole gas/liquid separation system (10) arranged in a production well (1), comprising a gas/liquid separator (15) having an inlet (16) in fluid communication with a production reservoir (3), which separator

(15) has an outlet (18) for gas and an outlet (19) for liquid, and a pump (20) that has an inlet in fluid communication with the outlet (19) for liquid of the separator and an outlet (21) that is in fluid communication with a receptacle (25) for liquid.

Fig.1.



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Description

[0001] The present invention relates to a downhole gas/liquid separation system arranged in a production well.

[0002] In general a hydrocarbon-bearing formation contains hydrocarbon oil, gas and water. Till now much attention has been paid to downhole oil/water separation, whereas gas/liquid separation is done in a separation unit at surface. In the specification and in the claims the word 'liquid' will be used to refer to oil, water or mixtures of oil and water.

[0003] It is an object of the present invention to provide a downhole gas/liquid separation system.

[0004] To this end the downhole gas/liquid separation system arranged in a production well according to the present invention comprises a gas/liquid separator having an inlet in fluid communication with a production reservoir, which separator has an outlet for liquid and an outlet for gas, and a pump that has an inlet in fluid communication with either to outlet for liquid or the outlet for gas of the separator and an outlet that is in fluid communication with a receptacle for fluid, wherein the other outlet of the separator is in fluid communication with a receptacle at surface.

[0005] Suitably the outlet for liquid of the separator is in fluid communication with the inlet of the pump, and the outlet for gas is in fluid communication with a receptacle for gas at surface. In this embodiment the gas is produced and the liquid can be disposed.

[0006] The invention will now be described in more detail with reference to the accompanying drawings, wherein

Figure 1 shows schematically a first embodiment of the present invention;

Figure 2 shows schematically a second embodiment of the present invention; and

Figure 3 shows schematically two further embodiments of the present invention.

[0007] Reference is first made to Figure 1, showing a partial longitudinal section of a production well 1 in an underground formation 2 that contains a production reservoir 3.

[0008] The production well 1 comprises a borehole lined with a casing or a liner 5. At the location of the production reservoir 3, the wall of the casing 5 is provided with perforations 6, allowing during normal operation the reservoir fluids to enter into a separation chamber 7 defined in the production well 1 and sealed off at its upper end by means of a packer 8, into which the lower end of a production tubing 9 is secured. The upper end of the tubing 9 is connected to a receptacle at surface (not shown).

[0009] The downhole gas/liquid separation system 10 according to the present invention is arranged in the separation chamber 7. It comprises a gas/liquid separator 15 having an inlet 16. The inlet 16 of the gas/liquid separator is in fluid communication with the production reservoir 3 via the separation chamber 7. The gas/liquid separator has an outlet 18 for gas and an outlet 19 for liquid. The outlet 18 for gas is in fluid communication with the lower end of the production tubing 9.

[0010] The downhole gas/liquid separation system 10 further comprises a pump 20 for pumping liquids. The inlet (not shown) of the pump 20 is in fluid communication with the outlet 19 for liquid of the separator 15. The pump 20 has an outlet 21, which outlet 21 is suitably provided with a backflow valve, which valve prevents fluids from flowing backwards into the pump 20. The outlet 21 of the pump 20 is in fluid communication with a receptacle for liquid.

[0011] The pump 20 is driven by means of a motor, for example an electric motor powered through an electric cable 25 that extends through the packer 8 to surface.

[0012] In the embodiment of Figure 1 this receptacle for liquid is the annulus 26 between the casing 5 and the production tubing 9, to which the outlet 21 of the pump 20 is connected by means of conduit 26 extending through the packer 8. At surface (not shown) the upper end of the annulus 25 is in fluid communication with a means for storing the liquid (not shown). In this embodiment gas and liquid are separately produced to surface.

[0013] An alternative embodiment of the invention is shown in Figure 2, wherein the elements discussed with reference to Figure 1 have got the same reference numerals as in Figure 1.

[0014] In the embodiment of Figure 2 the receptacle for liquid is a disposal reservoir 30 other than the production reservoir 3. The lower end of the well 1 comprises a separation chamber 7 as well as a disposal chamber 33, separated from the separation chamber by an additional packer 35.

[0015] The lower end of the pump 20 extends through the additional packer 35 so that the outlet 21 provided with a backflow valve (not shown) debouches into the disposal chamber 33. At the level of the reservoir 30, the wall of the casing 5 is perforated with perforations 37, to allow liquid to enter into the disposal reservoir 30.

[0016] Reference is now made to Figure 3. In this case the disposal reservoir 30 is above the production reservoir 3. Therefore, above the packer 8 a disposal chamber 43 is defined by an additional packer 45, which additional packer 45 is provided with a passage so that the electric cable 25 can extend through the additional packer 45. The disposal chamber 43 is in fluid communication with the disposal reservoir 30 by means of perforations 47 in the wall of the casing 5.

[0017] In a further embodiment of the present invention the receptacle is the production reservoir 3, and in order to bring the separated liquid to the production reservoir 3, and additional well is provided (schematically shown by dashed line 50) which forms a fluid communication between the disposal chamber 43 and the pro-

duction reservoir 3. The liquid injection enables maintaining the gas production of the production reservoir 3 at a substantial constant level.

[0018] The separator 15 can be a cyclonic separator. The pump 20 can be any suitable pump. The motor driving the compressor can be an electric motor or a hydraulic motor or turbine, in which case the electric cable is replaced by a suitable conduit providing the fluid for driving the hydraulic motor or turbine. 5

[0019] The hole below the lowermost packing (8 in Figures 1 and 3 and 35 in Figure 2) can be cased as shown, wherein the casing is perforated, or it can be an open hole. 10

[0020] Thus the present invention provides a simple downhole gas/liquid separation system, which has the advantage that no separation units at surface are required. A further advantage is that the liquid is disposed downhole, and that if a surface handling system is available, the disposed liquid can be retrieved. Moreover, the disposed liquid can be used in driving the gas out of the production reservoir. 15 20

[0021] The invention has been described with reference to a system wherein gas is separated from liquid, and wherein the liquid is separately produced or disposed. The invention also relates to a downhole gas/liquid separation system in which the gas is separately produced or disposed. In that case, the outlet for gas is connected to a pump (which is then a compressor) and the outlet for liquid is connected to a receptacle at surface. 25 30

Claims

1. A downhole gas/liquid separation system arranged in a production well, comprising a gas/liquid separator having an inlet in fluid communication with a production reservoir, which separator has an outlet for liquid and an outlet for gas, and a pump that has an inlet in fluid communication with either to outlet for liquid or the outlet for gas of the separator and an outlet that is in fluid communication with a receptacle for fluid, wherein the other outlet of the separator is in fluid communication with a receptacle at surface. 35 40 45
2. Downhole gas/liquid separation system according to claim 1, wherein the outlet for liquid of the separator is in fluid communication with the inlet of the pump, and wherein the outlet for gas is in fluid communication with a receptacle for gas at surface. 50
3. Downhole gas/liquid separation system according to claim 2, wherein the outlet for gas is connected to a tubing extending to surface, and wherein the receptacle for liquid is an annulus extending to surface. 55

4. Downhole gas/liquid separation system according to claim 2 or 3, wherein the receptacle for liquid is a part of the well that communicates with an underground reservoir that can receive the liquid.

Fig.1.

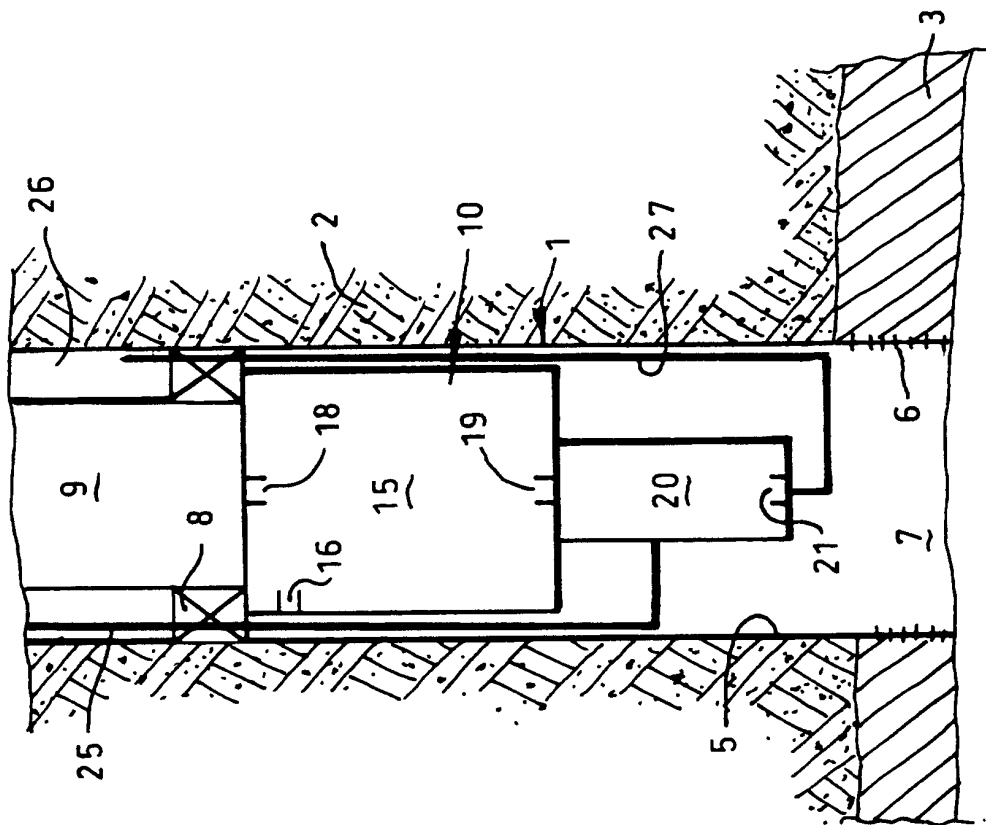


Fig.2.

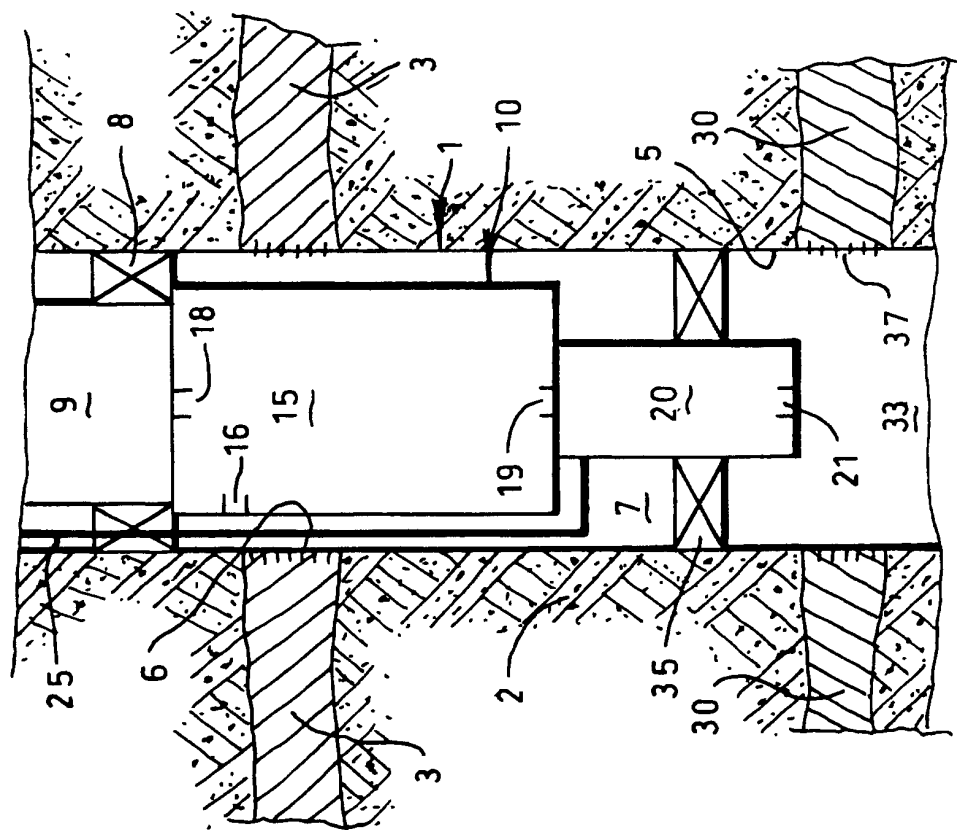
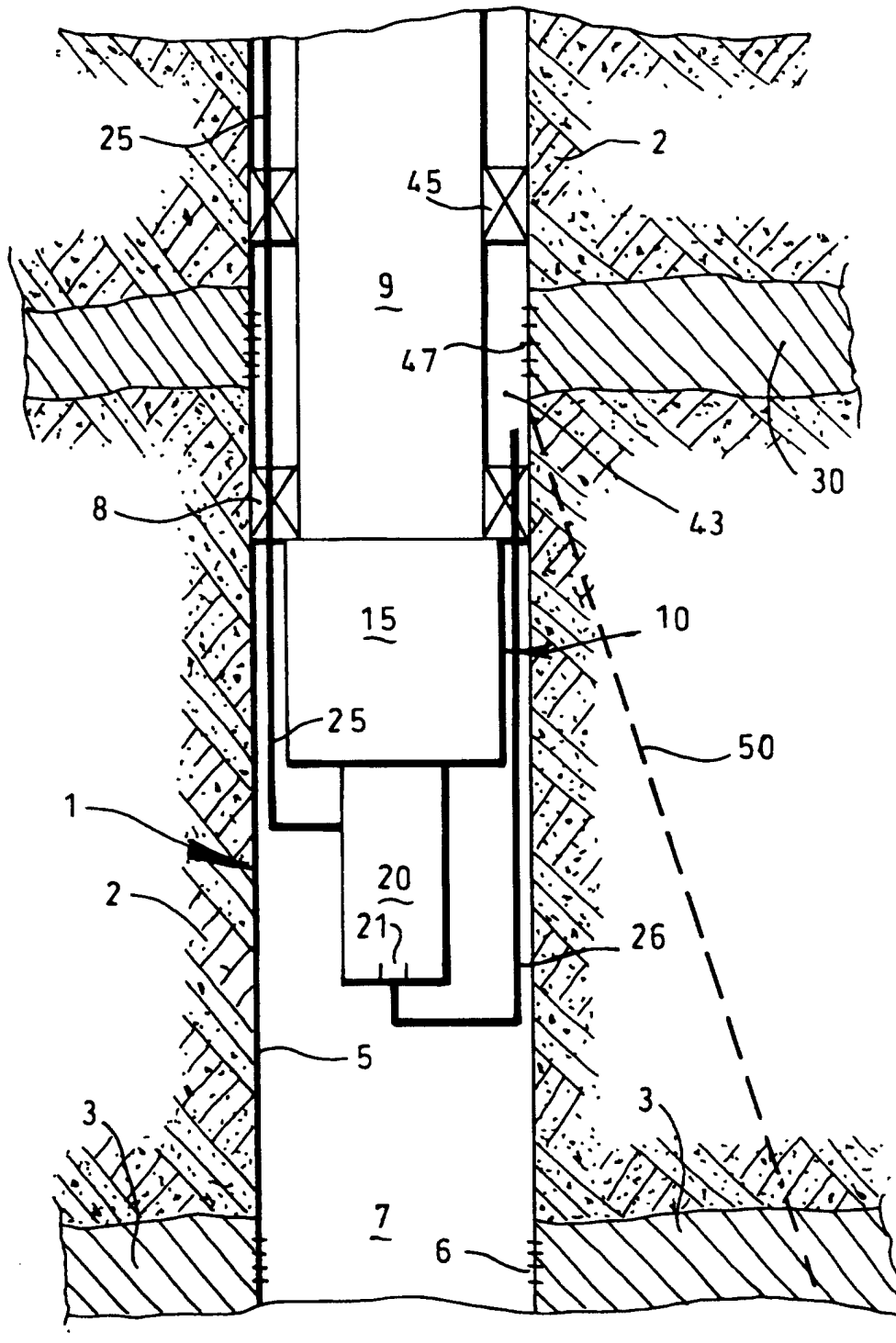


Fig.3.





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EUROPEAN SEARCH REPORT

Application Number
EP 99 30 9533

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The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 29 February 2000	Examiner Tompouloglou, C
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82