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| [72] | Inventor | Renic P. Vincent, deceased
late of Tulsa, Okla. (by Meta Luella
Vincent, administratrix), Tulsa, Okla. |
| [21] | Appl. No. | 853,221 |
| [22] | Filed | Aug. 26, 1969 |
| [45] | Patented | Aug. 31, 1971 |
| [73] | Assignee | Amoco Production Company
Tulsa, Okla. |

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Primary Examiner—Ian A. Calvert

Attorneys—Paul F. Hawley and John D. Gassett

- [54] HYDRAULICALLY FRACTURING AN ISOLATED ZONE OF AN UNCONSOLIDATED FORMATION**
5 Claims, 2 Drawing Figs.

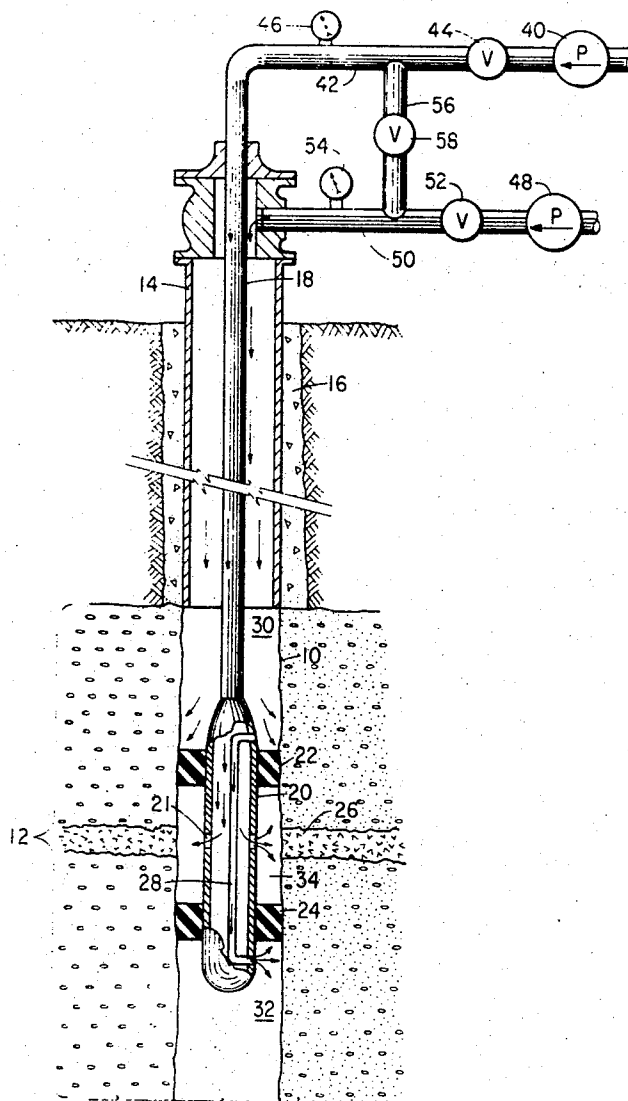
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| [52] | U.S. Cl. | 166/281,
166/308 |
| [51] | Int. Cl. | E21b 43/26 |
| [50] | Field of Search | 166/281,
283, 294, 307, 308 |

[56] **References Cited**

UNITED STATES PATENTS

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ABSTRACT: This invention concerns selectively locating fractures in an underground formation and especially in "soft sections" like the tar sands in Canada. A zone is isolated in the well bore at the elevation at which it is desired to initiate a fracture. A fracturing fluid is conducted down this channel to the elevation to be fractured. A low penetrating fluid is introduced through a second channel to that portion of the formation not so isolated. The pressure in the pump fracture fluid is raised sufficiently so that a fracture is initiated by the fracture fluid at the selected elevation.



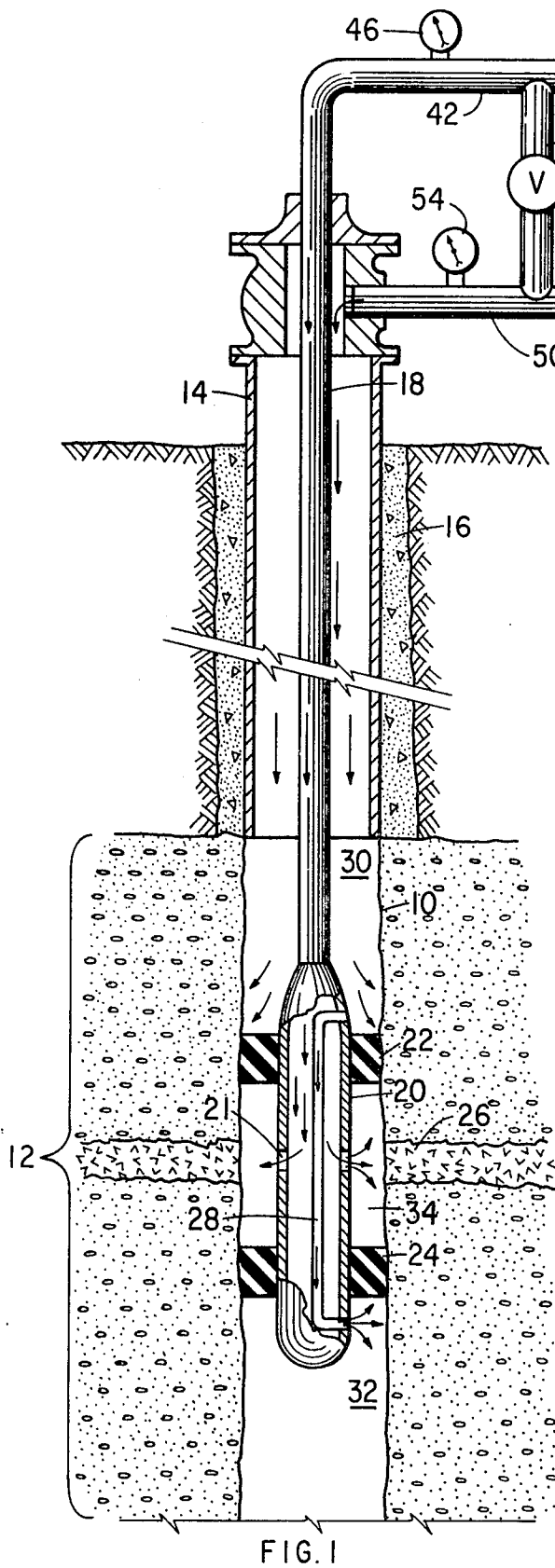
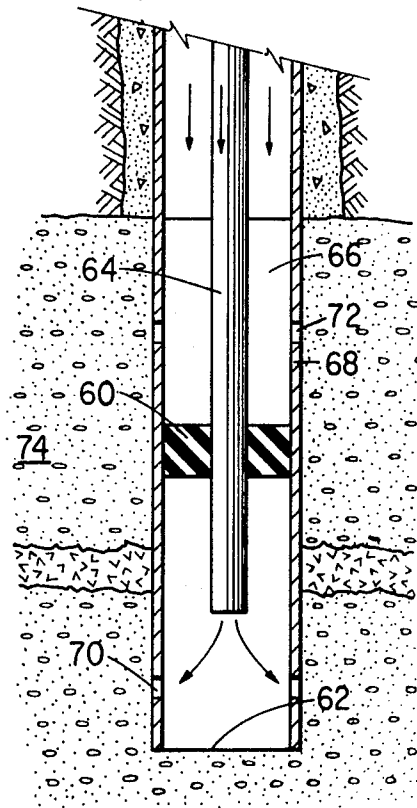


FIG. 2

INVENTOR.

RENIC P. VINCENT

BY

John D. Gassett
ATTORNEY

HYDRAULICALLY FRACTURING AN ISOLATED ZONE OF AN UNCONSOLIDATED FORMATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to creating fractures at a selected elevation in an underground formation penetrated by a well bore. It relates especially to the forming of fractures in an uncased hole or in soft formations like the Athabasca tar sands in Canada.

2. Setting of the Invention

Many oil and gas wells are drilled into formations that are considered "tight," i.e., the formation has low permeability. It is hard to produce oil and gas from such formations or inject fluids into them. The development of the hydraulic fracturing technique is considered to be the outstanding development toward obtaining more oil and gas from such low permeability, tight reservoirs or injecting fluids into them. The hydraulic fracturing technique broadly includes injecting a special type fracturing liquid into the formation at a rate and under sufficient pressure so as to cause the formation to crack. Propping agents are left in these cracks so that the cracks will not close when the pressure is relieved. Although the hydraulic fracturing technique is developed to a high degree, there still remain some problem areas. One of these is the fracturing of soft or unconsolidated formations. The outstanding example of such soft formations is the Athabasca tar sands in Canada. This present invention provides a process whereby such formation can be fractured and at a selected elevation.

SUMMARY OF THE INVENTION

This is a method of fracturing a soft or unconsolidated formation. In the preferred embodiment, a zone in the well bore is isolated adjacent to the elevation at which the fracture is to be initiated. A fracturing fluid is injected into this isolated zone. Simultaneously, a low penetrating fluid is injected into that part of the well bore outside the isolated zone adjacent to the formation. The fracturing fluid is pumped at a rate and pressure sufficient to open a fracture in the formation at the exposed elevation in the isolated zone.

This fracturing fluid contains sufficient propping materials so that as the pressure is released and the soft formation tends to settle back on the created fractures, there is formed a permeable path extending out where the fracture was formed.

Various objects and a better understanding of the invention will become apparent from the description which follows when taken in conjunction with the drawings.

DRAWINGS

FIG. 1 illustrates a cross section of a well drilled in the earth with apparatus set for practicing the process of this invention.

FIG. 2 is a modification of the system of FIG. 1.

Referring to the drawing, well 10 penetrates a formation 12. A casing 14 lines hole 10 from above the surface to the top of formation 12. Casing 14 is conventionally set with cement 16 between it and the borehole wall.

A tubing string 18 is suspended in the well bore and has an enlarged mandrel 20 located at the lower end thereof. The lower end of mandrel 20 is closed. An upper packer 22 and a lower packer 24 are set around mandrel 20. These packers 22 and 24 are above and below an elevation 26 at which it is desired to initiate a fracture. Mandrel 20 has perforations 21 between packers 22 and 24. A conduit 28 permits fluid communication from the annulus 30 above packer 22 with the annulus 32 below packer 24. Thus it is seen that a first channel is formed within tubing 18 from the surface to isolated zone 34 between packers 22 and 24.

At the surface a first pump 40 supplies a fracturing fluid from a source (not shown) through conduit 42 to tubing 18. Conduit 42 has a valve 44 and a pressure gauge 46 therein. A second pump 48 provides a low penetrating fluid from a

source (not shown) through conduit 50 to the annulus between tubing 18 and casing 14. Conduit 50 contains a valve 52 and a pressure gauge 54. A crossover conduit 56 having valve 58 connects conduit 42 and conduit 50 when the valve is open.

Fracturing liquids are well known. For example, the fracturing liquid may be prepared in accordance with U.S. Pat. Re 23,733. A low penetrating fluid the other or second fluid used in this invention, has a high apparent viscosity and a low API fluid loss. A low penetrating liquid can be a gel and essentially seals the flow channels above packer 22 and below packer 24 and may be water base or oily or hydrocarbon gels, depending upon the characteristics of the formation. The base liquid or solvent may be, for example, a higher alcohol, crude oil, or a refined oil such as gasoline, kerosene, naphtha, fuel oil, diesel oil, or the like. This base liquid is gelled with an oil-soluble gelling agent, such as grease-making soaps produced by or from ammonia or any material of the alkali-metal and alkaline-earth-metals groups and some polyvalent metal groups including sodium, potassium, magnesium, calcium strontium, cadmium, mercury, lithium, cobalt, lead, nickel, combined with a fatty acid. A desirable gelling agent is made from aluminum soaps or a combination of aluminum soaps, particularly a 2:1:1 mixture of aluminum soaps of coconut oil acid, aluminum naphthenate, and aluminum oleate. A water base fracturing liquid may be prepared by gelling fresh or salt water with a thickening agent such as guar gum, CMC, karaya gum, polyacrylamide, or similar materials.

A particularly preferred low penetrating fluid is water with guar gum added thereto in the range of from about 8 to about 12 pounds per barrel of water.

In one embodiment of the operation of the system of FIG. 1, the low penetrating fluid is injected into the annular portions 30 and 32 at about the same pressure as is the fracturing fluid.

FIG. 2 shows a modification of FIG. 1 with the difference being that there is only one packer 60 set in the well bore and the casing is set through the pay formation. The portion of the formation to be fractured is below packer 60. In other words, it is desired that the fracture be located between packer 60 and the bottom 62 of the well bore. In this case the fracturing fluid is conducted through tubing 64 to below the packer and the low penetrating fluid is conducted down through the annulus 66. In this case, casing 68 is set to the bottom of the hole. The interior of the casing below packer 60 is in fluid communication through perforations 70 with the formation. Casing 68 has perforations 72 above packer 60. Both perforations 70 and 72 may open into a common soft formation 74 such as the Athabasca tar sands or may be in adjacent formations.

The configuration of FIG. 2 was utilized to fracture a tar sand in which perforations 72 were at 1101 feet and the perforations 70 were from 1111 to 1112 feet. Packer 60 was set at 1106 feet. A low penetrating fluid which was 48 barrels of fresh water containing 400 pounds of guar gum was pumped into the annulus. The fracturing fluid was water with a considerably lesser amount of gelling agent. The particular fracturing fluid was in the proportion of 250 barrels of fresh water with 200 pounds of guar gum, 200 pounds of ground silica, 0.5 pounds enzyme gel breaker, one pound fluorescent dye. The water temperature was between 75° and 80° F. Thus there was not over about 1 pound guar gum per barrel of water. The surface annulus pressure was built up to 175 p.s.i. and the maximum pressure in the tubing 64 at the surface was between about 600-750 p.s.i. Thus the pressure of the fluid in the annulus was about one-fourth the pressure in tubing 64. During the fracturing treatment a small amount of low penetrating fluid had to be added to maintain the annulus pressure. This indicated that there was communication between perforations 70 and 72, and that fracturing fluid displaced down tubing 64 was prevented from moving up towards perforations 72 by the injection of the low penetrating fluid down the annulus 66. Sufficient fracturing fluid containing adequate sand propping agent was pumped therein so that a permeable streak was formed in that portion of the sand which was fractured.

While the above embodiments of the invention have been described with considerable detail, it is to be understood that various modifications of the device can be made without departing from the scope or spirit of the invention.

I claim:

1. A method of causing a fracture at a selected elevation in a permeable unconsolidated underground formation penetrated by a well which comprises:

forming an isolated zone in said well bore adjacent said elevation at which the fracture is to be initiated;

forming a first channel from said isolated zone to the surface;

forming a second channel to the surface from that portion of said unconsolidated formation encompassing elevations other than that of the isolated zone;

injecting a low penetrating liquid through said second channel;

injecting a fracturing fluid into said first channel, said fracturing fluid having a higher penetrating rate than said low

penetrating liquid, increasing the pressure and rate of injection of the fluid in said first channel until sufficiently high pressure and rate are reached so that said unconsolidated formation is fractured.

2. A method as defined in claim 1 in which the pressure of the fluid in said first channel is approximately equal to the pressure of the fluid in said second channel.

3. A method as defined in claim 1 in which the pressure of fluid in said second channel is at least about one-fourth the pressure of the fluid in said first channel.

4. A method as defined in claim 1 in which said low penetrating liquid in said second channel is water with guar gum added thereto in an amount of about 8 to 12 pounds of guar gum per barrel of water.

5. A method as defined in claim 4 in which the fracturing fluid contains guar gum in an amount of not over about 1 pound per barrel of water such that the fracturing fluid is much less viscous than said low penetrating fluid.

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