

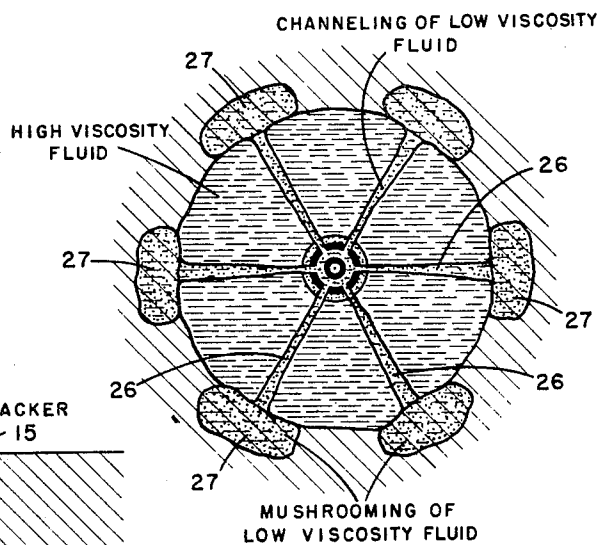
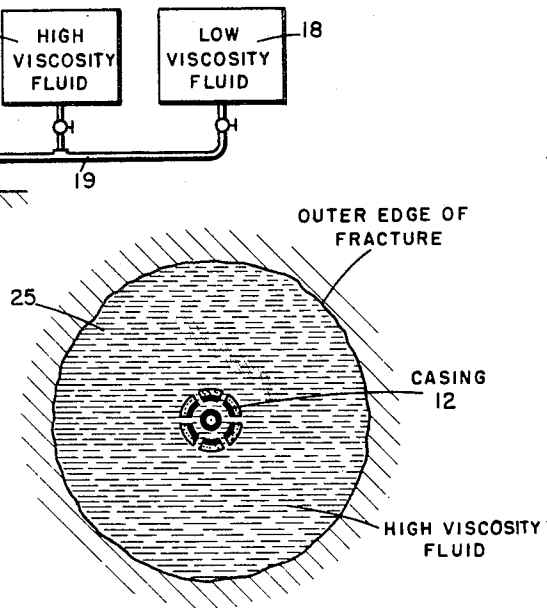
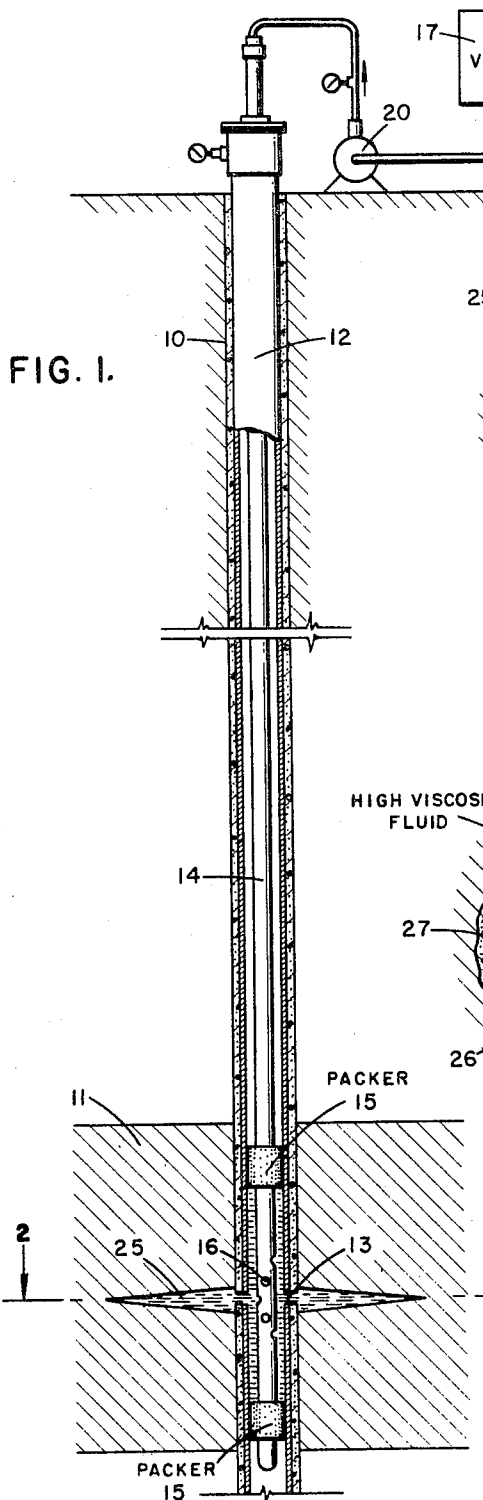
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HYDRAULIC FRACTURING TECHNIQUE

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HYDRAULIC FRACTURING TECHNIQUE

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The present invention concerns an improved hydraulic fracturing method for use in stimulating hydrocarbon-containing subsurface formations penetrated by a borehole.

The method of the invention is designed to create fractures of extremely high conductivity in subsurface formations, and it essentially comprises injecting into previously formed fractures filled with a very viscous fluid a relatively nonviscous fluid containing sand or other propping agent material. This fracturing procedure results in sand packed fractures formed in a generally radial pattern and providing highly conductive fluid paths for production fluids. The higher viscosity fluid may be used to create the initial fractures in the formation sands.

Thus, a primary object of the present invention is to provide an improved method of hydraulic fracturing which improves the fluid conductivity of fractures formed in subsurface formations when the well is placed on production.

The above object and other objects and advantages of the invention will be apparent from a more detailed description thereof when taken with the drawings wherein:

FIG. 1 is a diagrammatic view of a borehole penetrating the earth's subsurface formations including a productive zone and showing the equipment for performing the method of the invention;

FIG. 2 is a view taken along lines 2—2 of FIG. 1 following the first step of the method of the invention; that is, showing fractures containing the higher viscosity fluid; and

FIG. 3 is a view similar to that shown in FIG. 2 but illustrating the appearance of the formation following injection of the lower viscosity fluid.

For a more complete description of the invention, reference is made to the drawings in greater detail.

In FIG. 1 is shown a borehole 10 penetrating a subsurface hydrocarbon-containing productive formation 11. A casing pipe 12 is cemented in borehole 10, and casing pipe 12 and formation 11 are gun perforated as indicated at 13. A tubing 14 provided with straddle packers 15 is arranged in casing pipe 12. Packers 15 are arranged to straddle the perforated interval 13, and perforations 16 are provided in tubing 14 between packers 15. On the earth's surface a source of high viscosity fluid 17 and a source of low viscosity fluid 18 containing a propping agent such as sand connect to a conduit 19 which in turn is connected to tubing 14 through a pump 20.

The highly viscous fluid should be in the range of 100 to 100,000 cps. and it may be suitably a crude oil or refinery cuts and blends used alone or a bodying agent may be added thereto as, for example, colloid materials, metal soaps of organic acids, high molecular weight oil soluble polyolefins or blown asphalt, pitch and the like. Also usable as the high viscosity fluid are water and dilute hydrochloric acid with bodying agents added. The low viscosity fluid should be in the range of 1 to 10 cps. and may be composed of the same material as the high viscosity fluid with no bodying agent added. The propping agent

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used is preferably sand, although other conventional propping agents such as gravel may be used instead.

In operation, perforations 13 are first formed adjacent formation 11 and then tubing 14 carrying straddle packers 15 is run in casing pipe 12 until packers 15 straddle perforations 13. Then the high viscosity fluid from source 17 is pumped into tubing 14 through conduit 19 by means of pump 20 under high pressure to form fractures 25 which, as seen in FIG. 2, would be uniformly circular around well bore 10 but with irregular boundaries. If fractures 25 were previously formed in accordance with conventional hydraulic fracture techniques, then highly viscous fluid from source 17 would be pumped into these fractures. That is, the highly viscous fluid may be used to create the fractures, however, if the fractures had been previously formed, then highly viscous fluid would be injected into the fractures to displace the original hydraulic fracture fluid. Following placement of the highly viscous fluid, the low viscosity fluid from source 18 containing sand or other propping agent, is pumped through conduit 19 into tubing 14 by means of pump 20, and into fractures 25. As illustrated in FIG. 3, the low viscosity fluid fingers through the high viscosity fluid as represented by radial channels 26, and when fingers 26 containing the propping agent reach the extremity of the highly viscous fluid, they mushroom out, as indicated at 27, to form more extensive areas of propping sand.

When the viscosity of the highly viscous fluid has broken or otherwise dissipated and the well is placed on production, the conductivity of fractures 25 and therefore the productivity of the well is considerably greater than would have resulted from a conventional hydraulic fracture job.

Although the hydraulic fracturing and injection of fluid has been illustrated and described, employing the straddle packer technique, a single packer placed at the end of tubing or drill pipe to isolate the interval to be treated may be used instead.

Having fully described the objects, elements and method of the invention, I claim:

1. A hydraulic fracture method for use in stimulating hydrocarbon-containing subsurface formations penetrated by a borehole comprising injecting into fractures, previously formed in a subsurface formation which contain a highly viscous fluid capable of being produced with production of formation fluids, a substantially lower viscosity fluid containing a propping agent so as to form highly conductive, radial fluid paths extending from the borehole completely through said higher viscosity fluid located in said fractures and then producing said formation fluids.

2. A method as recited in claim 1 in which said highly viscous fluid has a viscosity in the range between about 100 and about 100,000 cps. and said substantially lower viscosity fluid has a viscosity in the range between about 1 and about 10 cps.

3. A hydraulic fracture method for use in stimulating hydrocarbon-containing subsurface formations penetrated by a borehole comprising:

injecting a highly viscous fluid into a subsurface formation in a manner so as to fracture said formation and place said viscous fluid in the fractures formed, said viscous fluid being capable of being produced with production of formation fluids;

then injecting into said fractures a substantially lower viscosity fluid containing a propping agent so as to

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form highly conductive, radial fluid paths extending from the borehole completely through said viscous fluid located in said fractures; and then producing said formation fluids.

4. A method as recited in claim 3 in which said highly viscous fluid has a viscosity in the range between about 100 and about 100,000 cps. and said substantially lower viscosity fluid has a viscosity in the range between about 1 and about 10 cps.

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