166-308

CROSS REFERENCE SEARCH ROOM

Jan. 11, 1955 N. B. DISMUKES 2,699,212

METHOD OF FORMING PASSAGEWAYS EXTENDING FROM WELL BORES

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FIG. 1

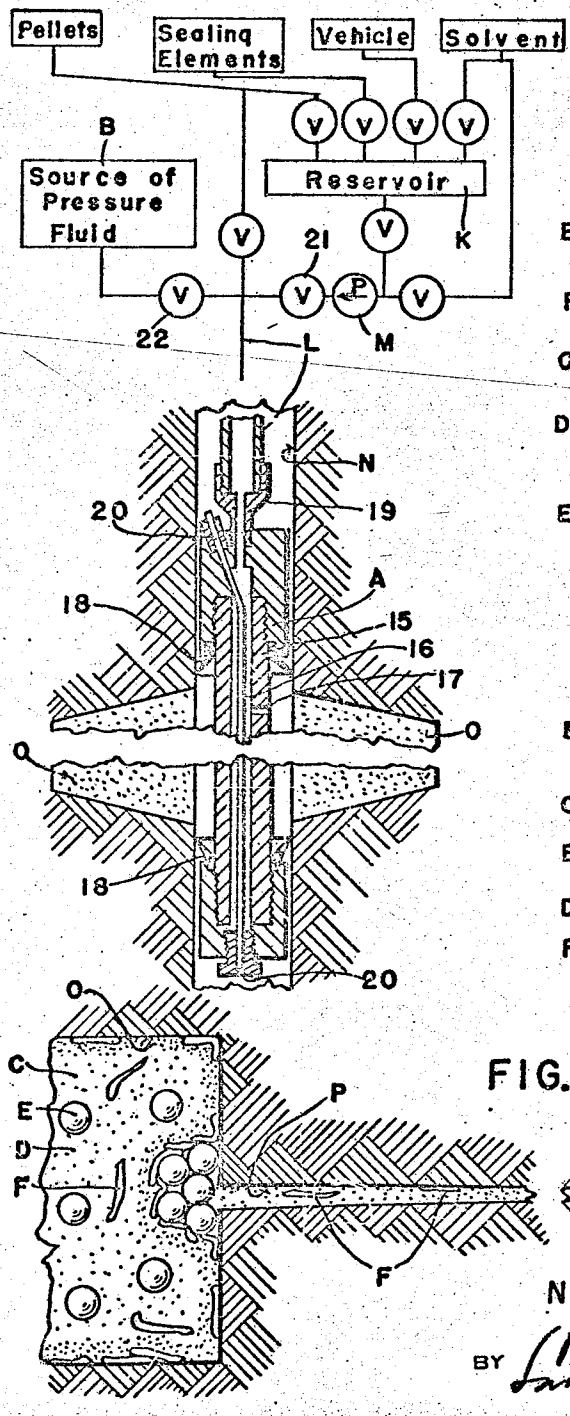


FIG. 2

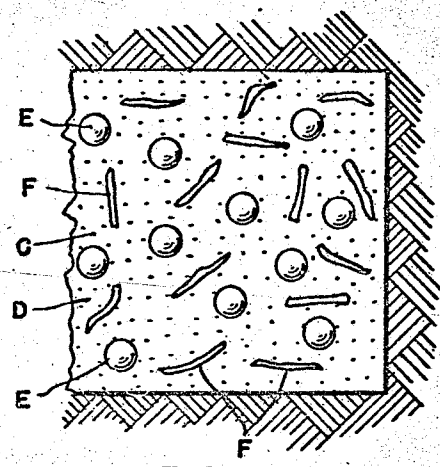


FIG. 3

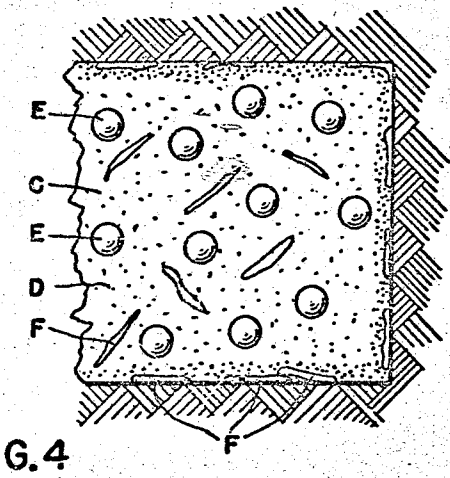


FIG. 4

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METHOD OF FORMING PASSAGEWAYS EXTENDING FROM WELL BORES

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FIG. 5

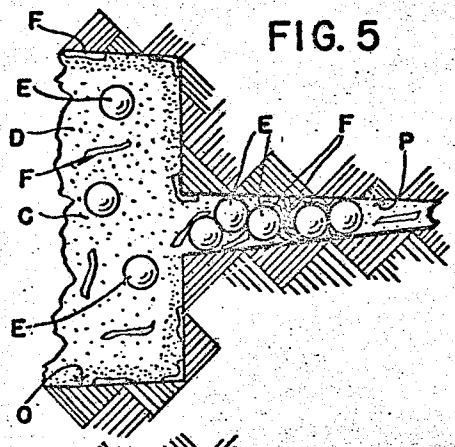
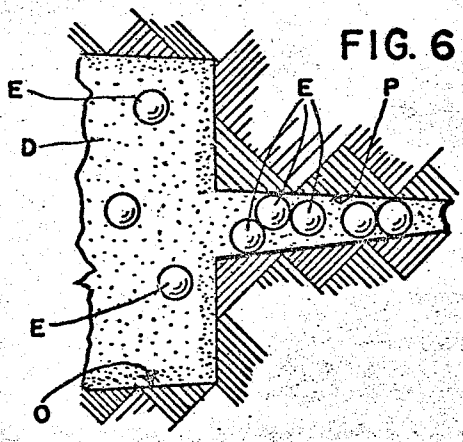


FIG. 6



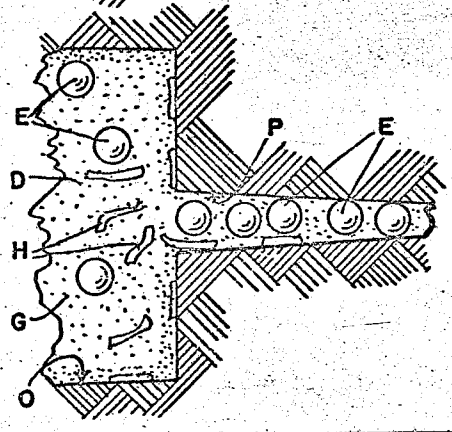


FIG. 7

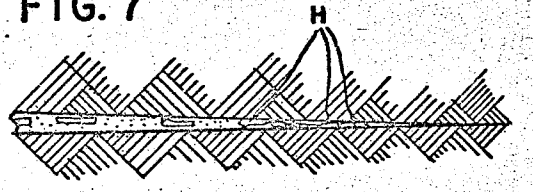
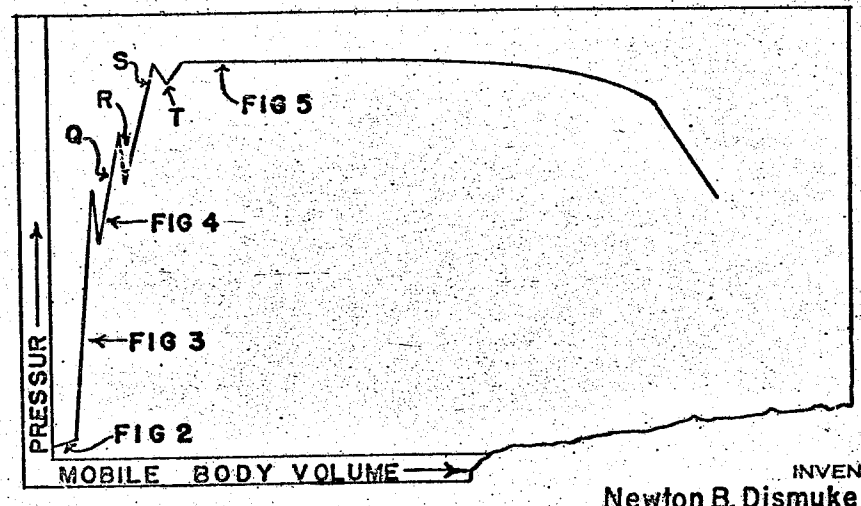


FIG. 8



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United States Patent Office 2,699,212 Patented Jan. 11, 1955

2,699,212

METHOD OF FORMING PASSAGEWAYS EXTENDING FROM WELL BORES

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Application September 1, 1948, Serial No. 47,168

18 Claims. (Cl. 166—22)

This invention relates to methods of increasing the flow of fluids to wells and more specifically to methods of forming fluid passageways in the stratum surrounding well bores by the use of mobile means, which means also prevents the passageways, thus formed, from closing.

It has been proposed to inject abrasive particles of polygonal shape into well bores for the purpose of scouring away portions of the walls of passageways and then to permit the larger particles to remain in the enlarged passageways for the support of the walls thereof. However, a major object of my invention is to provide a method whereby pellets, having curved surfaces and no appreciable abrading characteristics but, instead, having anti-frictional characteristics, are injected, together with a suitable liquid under pressure, into the initially formed passageways and enlarge or extend the passageways by creating continuations or extensions thereof, by pressure splitting rather than by abrading, whereupon the pellets are permitted to remain in the enlarged passageways to prevent the latter from closing. Since the pellet surfaces are curved and there is no accumulation of abraded debris, the pellets will not form a tightly-packed mass with the debris but, instead, a loose mass with a large number of interconnected passageways for the flow of the oil or other fluid into the bore.

Neither are the pellets employed in my method in any sense missiles adapted to be discharged forcibly against the stratum in attempting to shatter it. Instead it is not proposed to propel the pellets with any stratum-shattering velocity and, in fact, it would be substantially impossible to do so, since there are employed no high-capacity pumps to provide a jetting action of the mobile bodies forming the compositions of matter I employ. In addition, it is not essential in applicant's method that the pellets be of solid metal, hard enough to form a projectile, nor hollow metal strong enough to form an exploding projectile.

Another important object is to provide a method whereby particularly mobile pellets are employed, which are, preferably, spherical, and the specific gravity of which permits them to float in the liquid even tho they may include pellets of large diameters, whereby they will be substantially evenly dispersed throughout the fluid and in positions to function as hereinafter set out in detail.

Still another important object is to provide a method employing such non-abrasive pellets, dispersed (floating) in a suitable vehicle, which vehicle also supports a plurality of sealing elements, dispersed therein, which are adapted to seal the pores, at the openings, in the stratum as well as seal or block, in conjunction with the pellets, the mouths of the passageways, formed as continuations of the initial passageways, to prevent the dissipation of pressures and pressure liquid. However, upon subsequent widening of these mouths, the pellets are able to pass thru the mouths and the seals or blocks are broken to permit the flow of fluid in and out of the mouths, while the pellets remain in the passageways and prevent the reclosing thereof.

A further important object is to provide a method as described which, in one aspect thereof, includes a step of dissolving the sealing elements subsequent to the breaking of the seals or blocks.

In another aspect of the invention, the sealing elements are caused, after breaking of the seals or blocks, to migrate to the outer extremities of the enlarged passageways, where the sealing elements have no appreciable adverse effects upon the fluid flow into the well bore.

Other objects and advantages of the invention will be apparent during the course of the following detailed description of the invention, taken in connection with the accompanying drawing, forming a portion of this disclosure, and in which drawing:

Figure 1 is a vertical section of a suitable packer which may be employed to carry out the method, and disposed within a well bore provided with a pair of initial passageways.

Figure 2 is a fragmentary horizontal section of one of the initial passageways prior to its enlargement but illustrating conditions at the time of the injection of a volume of a vehicle-pellets-sealing elements-containing-composition of matter into the initial passageway. This composition may or may not contain a slowly-acting solvent for the sealing elements.

Figure 3 is a section somewhat like that of Figure 2, but illustrating a subsequent step in which pressure has been applied to the composition of matter but the passageway has not yet widened.

Figure 4 is also a section somewhat like those of Figures 2 and 3 but showing the widening of the initial passageway and formation of a narrow extension thereof and the mouth of the latter blocked or sealed.

Figure 5 is a like section but illustrating a widening of the mouth, and the migration of the pellets and additional sealing elements into the extension.

Figure 6 is a section somewhat like Figure 5 but showing conditions after the sealing elements have been dissolved.

Figure 7 is a section somewhat like Figure 6 but showing conditions when the sealing elements are not dissolved.

Figure 8 is a graph illustrating certain conditions taking place within the passageways during practice of the methods.

In the drawings, wherein similar reference characters designate corresponding parts thruout the several views, the packer which may be used to carry out the methods is designated as A, a source B of pressure fluid; C a composition of matter employed in one form of the novel method, including a vehicle D, pellets E and sealing elements F; G a composition of matter employed in another form of the novel method and including a vehicle D, pellets E and sealing elements H; K a source or reservoir of the composition C or G; L a conduit system between B, K and A; in which may be interposed a pump or impeller M; N a well bore from which extend lateral passageways O which are lengthened by the novel method by continuations or additional passageways P.

The initial passageways O may be provided by the means illustrated and described in my co-pending application Serial Number 47,364, filed September 2, 1948, for Machines for Increasing the Subterranean Flow of Fluid Into and From Wells, where vertical passageways are illustrated in Figs. 13 and 15, considerably longer vertically then wide horizontally, as may be appreciated by comparing Fig. 14 with Fig. 13 of said application Serial No. 47,364, whereupon a packer, having the general characteristics of the apparatus A, may be run into the well bore N and into a position substantially like that shown in Figure 1. This device A preferably includes a body portion 15 having a longitudinal passageway 16 and a lateral passageway 17 opening into the passageway 16 and exteriorly of the body portion 15. The body portion 15 carries a plurality of spaced-apart packing means, as the cups 18, a coupling 19 carried by the body portion 15 to connect the passageway 16 with the source B of pressure fluid and source C of additional fluid, and means to substantially equalize the pressure beyond each end of the packing device A. This last means may comprise a conduit 20 opening at its lower end 21 below the body portion 15, extending upwardly thru the body portion and opening exteriorly of the body portion above the uppermost packing means.

The composition of matter C consists of a vehicle (which also functions as a preliminary sealing means) D, pellets E, sealing elements F and a solvent for the sealing elements but not for the pellets. This solvent may be mixed with the vehicle D when the vehicle D is introduced

into the passageways O or subsequent to the introduction of the vehicle D.

The vehicle D is, preferably, a drilling fluid having a filter loss of less than 2 c. c. by the American Petroleum Institute Standard Test for Filter Ratio of Drilling Fluid.

The vehicle may be, for example, one, or combinations of, the drilling fluids described in U. S. Patents 2,356,776, dated August 29, 1944, 2,316,967 dated April 20, 1943, and 2,316,968 dated April 20, 1943, all granted to George Miller. Or it may be the oil-base drilling fluid described by H. W. Hindry in "Petroleum Development and Technology," American Institute of Mining and Metallurgical Engineers, 1941, under "Characteristics and Application of Oil Base Mud," pages 70–75. Or the vehicle may be an oil-emulsion drilling fluid as described in U. S. Patent 2,430,039 granted to Francis M. Anderson on November 11, 1947.

The vehicle may be weighed to a desired specific gravity by addition of a commonly-used weighing material, such as ground barytes.

The pellets E are bodies having substantially no scouring nor abrasive surface area. Preferably, they are bodies having curved surfaces, such as spheres, ovoids and elliposids. Their diameters may vary. A preferred size of pellet has a diameter or greatest diameter of substantially 0.1". They are substantially insoluble in the vehicle D, common well fluids, and the solvents to be hereinafter named. The pellets may be, for example, of glass, plastics or well-rounded pebbles, having no appreciable abrasive surfaces, and have a specific gravity which will permit them to float in the vehicle D and be substantially evenly dispersed therein.

The sealing elements F may be strips, sheets, flakes, shavings, strands, fibres or somewhat analogous forms as have been employed as additions to drilling muds, and my sealing elements are, preferably somewhat pliable, and may be, for example, of (1) polyvinyl acetate; (2) polymethyl methacrylate; (3) cellulose acetate; (4) cellulose nitrate or (5) polystyrene. Their essential characteristics are that they are relatively slowly soluble in suitable solvents but not quickly soluble in the vehicle D nor in common well fluids.

The selection of the solvent or solvents G depends, of course, upon the composition of the sealing element or elements F employed. Preferably, the solvent is an aromatic hydrocarbon, suitable esters or ketones. For example, for sealing elements of 1, 2 or 5 above, I may employ solvents of benzene, toluene, xylene, acetone, diacetone alcohol, ethyl acetate, or n-butyl acetate; for 3 above, I may use acetone, diacetone alcohol, ethyl acetate or methyl aceto acetate, and for 1, 2 or 4 above I may employ acetone, methyl ethyl ketone, diacetone alcohol, ethyl acetate, n-butyl acetate or n-amyl acetate. Obviously, if desired, I may employ sealing elements of two or more of the above, for example, having common solvent.

In the event I employ the modified composition G, which contains a vehicle D, pellets E and sealing elements H, but no appreciable volume of solvent, I may substitute a wider range of materials for the sealing elements since the characteristics of the sealing elements H do not require solubility. In fact, the common fluids found within wells and in drilling are generally such that they do not act chemically toward them. Such sealing elements H therefore may be of the same compositions as the sealing elements F and, in addition, may be, for example, of mica, regenerated cellulose or cotton seed hulls.

In carrying out the steps of one form of the invention, preferred volumes or weights of vehicle D, substantially like-sized pellets E, sealing elements F and solvent for the sealing elements F are combined as in the reservoir K and form the composition of matter C, which flows thru a portion of the conduit system L to the packer A and are discharged into the initial passageways O with the elements of the composition of matter C being dispersed somewhat after the showing in Figure 2, whereupon the valve 21 may be closed and the valve 22 opened, permitting the flow of a suitable pressure fluid as water, oil, air, carbon dioxide or nitrogen thru a portion of the conduit system L to the packer A, where it pressures the composition C. Obviously, if the pump M can build up the required pressure, the step of introducing the pressure fluid B may be omitted.

The introduced composition C, under sufficient pressure, will be affected as follows: colloids of the vehicle will migrate to the surfaces of the initial passageways and close most of the smaller pores therein while some of the sealing elements F will also tend to migrate to these surfaces and seal most of the remaining pores, thus decreasing pressure loss. Conditions, at this point, are substantially as shown in Figure 3. Building up of the pressure will finally cause the formation of a narrow continuation P of the passageway O (as in Figure 4) since the pressure will force the opposite walls (or one of them) of the initial passageway O apart (or one away from the other). The inrush of the vehicle D (and some of the sealing elements F) into the continuation P will carry some of the pellets E to the mouth of the continuation P but, because the mouth is then narrower than the diameters of the pellets E, the latter cannot enter the continuation but pile up at the mouth, forming a bridge, for example as shown in Figure 4. However, the vehicle may still flow thru the passageways between the pellets (their curved surfaces, in contact, forming point contacts and not surface contacts) and this tends to draw the sealing elements F to the bridge, where they are caught by the pellets of the bridge and quickly form a seal across the mouth of the continuation P. As a result dissipation of pressure and the vehicle into the stratum surrounding the continuation P is stopped and the pressure utilized, instead, in widening the passageway O. (In some cases this pressure is augmented by further building up the pressure by again employing more pressure fluid.)

Finally, the mouth of the continuation P is widened, by continued pressure upon the walls of the initial passageway O, to permit the pellets forming the bridge to enter the continuation and lodge therealong and this breakage of the bridge will rupture the seal formed by the sealing elements. Pressure upon the vehicle may now be released. Obviously, by introducing into the vehicle, in the passageway O, a number of pellets of a larger diameter than those initially introduced, permitting them to disperse throughout this passageway O and again building up pressure to cause some of them to migrate to the mouth of the continuation P, the bridge and seal may be formed again, a still wider and longer continuation provided, and the bridge and seal broken as before, since they have then served their purposes. Some of the larger pellets will, of course, enter the enlarged continuation and lodge therein in part supporting its walls, while the smaller (or initially-introduced pellets) will migrate further along the continuation and lodge therein, also supporting the walls thereof.

The solvent will, in time, dissolve the sealing elements.

The sub-modification of the method just disclosed contemplates the introduction of the solvent subsequent to the introduction of a vehicle-pellets-sealing elements mixture. That is, the solvent may be introduced during any subsequent step or even after the last step described. This sub-modification permits the use of a rapidly-acting solvent.

A further modification contemplates the use of a vehicle-pellets-sealing elements mixture or composition following the steps as described but omitting entirely a solvent for the sealing elements. This is the composition G wherein, too, the sealing elements may be of the classes of materials mentioned, including regenerated cellulose and cotton seed hulls, and other suitable materials substantially insoluble in conventional solvents which could be employed. Practicing the method, employing this composition is desirable, in some instances, because solvents for plastics, particularly such solvents as aromatic hydrocarbons, may also exert a solvent action on some of the asphaltic materials in the oil-base muds, tending to impair the pore-sealing properties mentioned.

In the modified method, a portion of the sealing elements are driven by pressure to the outer extremity of the passageway continuation (where their presence has no appreciable undesirable effects) and the others removed with the vehicle and loose pellets, as by bailing.

It will be noted that, in the practicing of any of the several methods described, there is substantially no change in the integral mass of the stratum surrounding the bore during the steps of the method, in that there is substantially no debris, since the stratum is cloven or split to form the passageway continuation. In addition, it will be noted that the pellets not only provide a partial means to close the mouth of the continuation but, without subsequent mechanical manipulation of the pellets, they are caused

to provide an additional function when migrated to the continuation.

The practicing of the methods herein disclosed result in (1) economy in the use of the compositions of matter and volume of pressure fluid employed; (2) being able to build up sufficient pressure to cause splitting of the stratum to form fissures of appreciable width; (3) in maintaining the fissures in open conditions. These are illustrated by the graph in Figure 8 where the solid line represents the pressures required to inject the mobile body in the initial passageway and continuation thereof, and the magnitude of the pressures at various steps of the methods is indicated by reference to Figures 3, 4 and 5 of the drawings. Successive failing and reforming of the bridge and seal at the mouth of the continuation may occur but, finally the mouth is sealed, and the successive fluctuations of pressure are indicated at Q and R on the graph. Thereupon the pressure builds up, as at S, so that the mouth widens and the bridge and seal is broken, whereupon the pressure may fall slightly, as at T. In order to propel the pellets into wall-sustaining contact with the walls of the continuation the pressure, of course, may be increased.

It will be noted in Figure 5 that a seal of the sealing elements F has formed within the continuation P, resulting in blocking the flow of composition of mattar or mobile body toward the right. This, upon the application of sufficient pressure against the walls of the initial passageway O and continuation P to the left of this seal, will cause additional widening of the continuation as is now apparent, and the consequent breaking of the seal and further movement of some of the pellets into the additionally widened continuation.

By the use of the term "pellets" I mean bodies whose greatest diameters may be 0.02 inch or greater.

From the foregoing it will now be apparent that the methods herein disclosed may be employed in forming a completed passageway extending from a well bore and keeping the passageway open, without employing a step of initially forming a passageway and then enlarging the passageway. However, the completed passageway may be subsequently enlarged by also employing the step of closing the mouth thereof by bridging and sealing the mouth thereof, spreading the walls, breaking the closure and causing the pellets to enter the widened passageway in order to prevent its walls from closing.

What is claimed is:

1. A method of treating an earth formation for the purpose of increasing the production of a fluid therefrom which includes the steps of drilling a borehole into the formation, under-reaming a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to lifting forces when hydrostatic pressure is applied and then pumping a liquid into the borehole and applying a hydraulic pressure on the liquid and on the selected portion of the formation sufficient to fracture the formation.

2. A method of treating an earth formation for the purpose of increasing the production of a fluid therefrom which consists in drilling a borehole into the formation, under-reaming a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to lifting forces when hydrostatic pressure is applied, then pumping into the under-reamed portion of the borehole and into the formation a liquid having substantially constant viscosity, applying hydrostatic pressure to the liquid of such a value as to lift the formation and fracture the same and then removing the liquid from the formation.

3. A method of treating a formation in the earth for the purpose of increasing the production of a fluid therefrom which includes the steps of drilling a bore hole into the formation, under-reaming a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to lifting forces when hydraulic pressure is applied, forming a filter cake on the wall of the under-reamed portion and pumping a liquid into the borehole, applying a hydrostatic pressure on the liquid and the selected portion of the formation to fracture the formation, the filter cake being used to assist in confining the fracturing liquid while it is being pumped.

4. A method of treating a formation in the earth for the purpose of increasing the production of a fluid therefrom which includes the steps of drilling a borehole into the formation, under-reaming a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to lifting forces when hydraulic pressure is applied, mixing with a fracturing liquid a material capable of forming a filter cake on the wall of the under-reamed portion and pumping said liquid into the borehole under pressure to cause a filter cake to form, applying hydrostatic pressure on the liquid and on the selected portion of the formation to fracture the formation, the filter cake being used to assist in confining the fracturing liquid while it is being pumped.

5. A method of treating a formation in the earth for the purpose of increasing the production of a fluid therefrom which includes the steps of drilling a borehole into the formation, under-reaming a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to lifting forces when hydrostatic pressure is applied, then pumping a liquid into the under-reamed portion of the borehole and into the formation and applying hydrostatic pressure on the liquid and on the selected portion of the formation to fracture the formation.

6. A method of treating a formation in the earth for the purpose of increasing the production of a connate fluid therefrom which includes the steps of drilling a borehole into the formation, under-reaming a selected portion of the borehole in the formation to weaken the same and increase the area subjected to lifting forces when hydrostatic pressure is applied, forming a filter cake on the wall of the under-reamed portion, pumping a fracturing liquid into the borehole, applying pressure on the liquid to place a hydrostatic pressure on the selected portion of the formation to fracture the same, the filter cake being used to assist in confining the fracturing liquid while it is being pumped and then removing some of the fracturing liquid from the borehole to cause the connate fluid in the formation to flush the fracturing liquid from the fractured formation.

7. A method of treating a formation in the earth for the purpose of increasing the production of a connate fluid therefrom which consists in drilling a borehole into the formation, under-reaming at least a portion of the formation, then forcing into the under-reamed portion of the formation, a fracturing liquid of substantially constant viscosity under such a pressure as to lift at least a portion of the formation as well as the overburden and cause the portion of the formation to fracture, and then removing some of the fracturing liquid from the borehole to cause the connate fluid in the formation to flush the fractured portion of the formation and force fracturing liquid back into the borehole.

8. A method of treating an earth formation for the purpose of increasing the production of a fluid therefrom which includes the steps of drilling a borehole into the formation, undercutting a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to parting forces when hydrostatic pressure is applied and then pumping a liquid into the borehole and applying a hydraulic pressure on the liquid and on the selected portion of the formation sufficient to fracture the formation.

9. A method of treating an earth formation for the purpose of increasing the production of a fluid therefrom which consists in drilling a bore hole into the formation, under-cutting a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to parting forces when hydrostatic pressure is applied, then pumping into the undercut portion of the borehole and into the formation a liquid having substantially constant viscosity, applying hydrostatic pressure to the liquid of such a value as to part the formation and fracture the same and then removing the liquid from the formation.

10. A method of treating a formation in the earth for the purpose of increasing the production of a fluid therefrom which includes the steps of drilling a borehole into the formation, undercutting a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to parting forces when hydraulic pressure is applied, forming a filter cake on the wall of the undercut portion and pumping a liquid into the borehole, applying a hydrostatic pressure on the liquid and the selected portion of the formation to fracture the formation, the filter cake being used to assist in confining the fracturing liquid while it is being pumped.

11. A method of treating a formation in the earth for the purpose of increasing the production of a fluid there-

from which includes the steps of drilling a borehole into the formation, undercutting a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to parting forces when hydraulic pressure is applied, mixing with a fracturing liquid a material capable of forming a filter cake on the wall of the undercut portion and pumping said liquid into the borehole under pressure to cause a filter cake to form, applying hydrostatic pressure on the liquid and on the selected portion of the formation to fracture the formation, the filter cake being used to assist in confining the fracturing liquid while it is being pumped.

12. A method of treating a formation in the earth for the purpose of increasing the production of a fluid therefrom which includes the steps of drilling a borehole into the formation, undercutting a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to parting forces when hydrostatic pressure is applied, then pumping a liquid into the undercut portion of the borehole and into the formation and applying hydrostatic pressure on the liquid and on the selected portion of the formation to fracture the formation.

13. A method of treating a formation in the earth for the purpose of increasing the production of a connate fluid therefrom which includes the steps of drilling a borehole into the formation, undercutting a selected portion of the borehole in the formation to weaken the same and increase the area subjected to parting forces when hydrostatic pressure is applied, forming a filter cake on the wall of the undercut portion, pumping a fracturing liquid into the borehole, applying pressure on the liquid to place a hydrostatic pressure on the selected portion of the formation to fracture the same, the filter cake being used to assist in confining the fracturing liquid while it is being pumped, and then removing some of the fracturing liquid from the borehole to cause the connate fluid in the formation to flush the fracturing liquid from the fractured formation.

14. A method of treating a formation in the earth for the purpose of increasing the production of a connate fluid therefrom which consists in drilling a borehole into the formation, undercutting at least a portion of the formation, then forcing, into the undercut portion of the formation, a fracturing liquid of substantially constant viscosity under such a pressure as to part at least a portion of the formation as well as the overburden and cause the portion of the formation to fracture, and then removing some of the fracturing liquid from the borehole to cause the connate fluid in the formation to flush the fractured portion of the formation and force fracturing liquid back into the borehole.

15. A method of treating a formation in the earth for the purpose of increasing the production of a fluid therefrom which consists of the steps of drilling a borehole into the formation, undercutting a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to parting forces when hydrostatic pressure is applied, pumping a mobile body containing a vehicle, and rigid pellets and pliable sealing elements floating in the vehicle, into the undercut portion of the borehole, applying a hydrostatic pressure on the mobile body and on the selected portion of the formation sufficient to fracture the formation and provide a mouth, for the fracture thus produced, opening into the undercut portion, the mouth being narrower than the diameters of some of the pellets, applying hydrostatic pressure on the mobile body until some of the pellets within the undercut portion migrate to and pile up across the mouth to form a bridge, continuing the hydrostatic pressure on the mobile body until some of the sealing elements migrate to the piled-up pellets at the mouth and are stopped by the piled-up pellets and form a seal across the piled-up pellets against flow of the vehicle into the fracture, and increasing the hydrostatic pressure on the mobile body and on the selected portion of the formation until the fracture and mouth are widened thereby to a width sufficient for the piled-up pellets to migrate into the widened mouth and widened fracture.

16. A method of treating a formation in the earth for the purpose of increasing the production of a fluid therefrom which consists of the steps of drilling a borehole into the formation, undercutting a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to parting forces when hydrostatic pressure is applied, pumping a mobile body containing a vehicle, and rigid pellets and pliable sealing elements floating in the vehicle, into the undercut portion of the borehole, applying a hydrostatic pressure on the mobile body and on the selected portion of the formation sufficient to fracture the formation and provide a substantially V-shaped fracture and a mouth, for the fracture thus provided, opening into the undercut portion, the mouth being narrower than the diameters of some of the pellets, applying hydrostatic pressure on the mobile body until some of the pellets within the undercut portion migrate to and pile up across the mouth to form a bridge, continuing the hydrostatic pressure on the mobile body until some of the sealing elements migrate to the piled-up pellets at the mouth and are stopped by the piled-up pellets and form a seal across the piled-up pelletes against flow of the vehicle into the fracture, increasing the hydrostatic pressure on the mobile body and on the selected portion of the formation until the fracture and mouth are widened thereby to a width sufficient for the piled-up pellets and sealing elements to migrate into the widened mouth and widened fracture until the migrating pellets are wedged into the narrower portions of the V-shaped fracture, continuing the hydrostatic pressure on the mobile body until some of the pellets in the widened V-shaped fracture are stopped by contacting the opposite walls thereof and form a bridge within the widened V-shaped fracture and some of the sealing elements in the widened V-shaped fracture are stopped by the bridge and form a seal across the bridge against the flow of the vehicle toward the apex of the widened V-shaped fracture, and increasing the hydrostatic pressure on the mobile body and on the selected portion of the formation, and also on that portion of the widened V-shaped fracture between the mouth of the widened V-shaped fracture and the bridge within the V-shaped fracture, and also on the bridge and seal within the V-shaped fracture, until the V-shaped fracture is further widened, and the bridge and seal broken.

17. A method of treating a formation in the earth for the purpose of increasing the production of a fluid therefrom which consists of the steps of drilling a borehole into the formation, undercutting a selected portion of the borehole in the formation to weaken the same and to increase the area subjected to parting forces when hydrostatic pressure is applied, pumping a mobile body containing a vehicle, and rounded rigid pellets and pliable sealing elements each sealing element having a greater size than those of the interstices between the pellets when the pellets are piled-up, said pellets and elements floating in the vehicle, into the undercut portion of the borehole, applying a hydrostatic pressure on the mobile body and on the selected portion of the formation sufficient to fracture the formation and provide a mouth, for the fracture thus produced, opening into the undercut portion, the mouth being narrower than the diameters of some of the pellets, applying hydrostatic pressure on the mobile body until some of the pellets within the undercut portion migrate to and pile up across the mouth to form a bridge with interstices between adjacent pellets of the bridge, continuing the hydrostatic pressure on the mobile body until some of the sealing elements migrate to the piled-up pellets at the mouth and are stopped by the piled-up pellets and form a seal across the piled-up pellets and interstices between adjacent pellets of the bridge against flow of vehicle into the fracture, and increasing the hydrostatic pressure on the mobile body and on the selected portion of the formation until the fracture and mouth are widened thereby to a width sufficient for the piled-up pellets to migrate into the widened mouth and widened fracture.

18. A method of enlarging a mechanically-formed initial fluid passageway extending from a well-bore into the formation surrounding the well-bore, to form a second passageway extending from the initial passageway with a mouth at the initial passageway and thus increase fluid flow into the well-bore, comprising introducing a mobile body, containing a vehicle and rigid pellets and pliable sealing elements floating in the vehicle, into the well-bore and initial passageway, the pellets being each of a diameter greater than the width of the mouth of the second passageway as initially formed, and the sealing elements being of greater size than the interstices between adjoining pellets when the pellets are in piles, pressuring the mobile body against opposite walls of the initial passageway until at least one of the walls moves bodily away

from the other wall and the formation beyond the initial passageway is fractured to provide a second passageway extending from the initial passageway and having a mouth opening to the initial passageway, continuing pressuring of the mobile body against the opposite walls of the initial passageway until some of the pellets and sealing elements float in the vehicle to the mouth and the pellets are blocked against entry into the second passageway by the walls of the initial passageway at the mouth and pile up at the mouth, and some of the sealing elements are blocked against entry into the second passageway by the piled-up pellets and accumulate over the surface of the pile of pellets to form a seal against entry of the vehicle into the second passageway, and increasing the pressure upon the mobile body within the initial passageway until the second passageway is widened and at least some of the piled-up pellets and at least some of the sealing elements, which accumulated over the surface of the pile, float into the second passageway and the pellets therein lodge against the walls of he second passageway to prop the walls thereof.

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