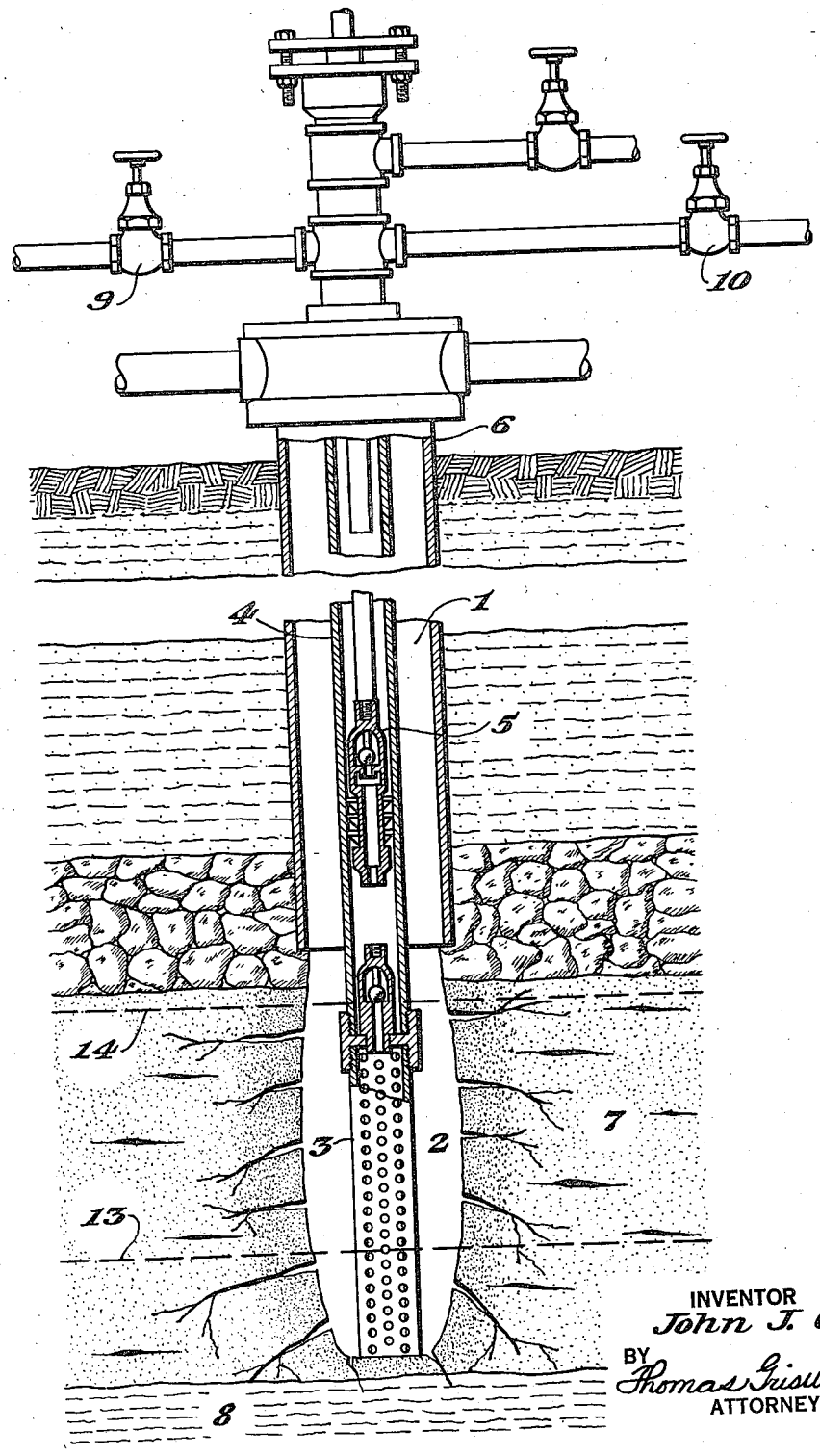
June 27, 1933. J. J. GREBE 1,916,122

METHOD OF TREATING WELLS WITH ACIDS

Filed Jan. 18, 1933



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Patented June 27, 1933

1,916,122

UNITED STATES PATENT OFFICE

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METHOD OF TREATING WELLS WITH ACIDS

Application filed January 18, 1933. Serial No. 652,288.

The invention relates to an improvement in the use of acids for the treatment of deep wells yielding oil or gas, to increase the production therefrom.

In prior methods of employing acids in deep wells the procedure has been to introduce the acid directly into the well cavity in any convenient manner, where it is then allowed to act upon the rock. As an illustration of such methods, United States Patent No. 556,669 describes the treatment of oil wells to increase the production by introducing a quantity of hydrochloric acid directly into the well cavity. The acid is allowed to follow its own course of attack upon the rock or earth in which attack it may be assisted by applying hydrostatic or other pressure upon it from above.

In actual practice of this method, heretofore, no provision has been made for controlling the direction of action of the acid. The acid naturally follows the line of least resistance through the pores and passages in the rock and may flow downwardly as well as more or less horizontally. Due to the lack of control possessed by the operator over the activity of acid conventionally introduced into a well, it has been well recognized in the past that there is always danger of the acid forming channels leading to water bearing regions which would allow the well to be flooded with water. Besides such drawback, there is the problem of making the process economically feasible inasmuch as the ramified course that the acid may follow necessitates the use of prohibitive volumes of acid in some instances. In some wells I have found that the production of oil may be decreased by the conventional use of acids, presumably due to the tendency for the acid to work in a generally downward course, largely directly below the point of introduction. Thus instead of the acid mainly acting upon the oil bearing stratum it may be spent ineffectively, or even to the detriment of the well.

One of the objects of my invention is to provide means whereby the action of the acid introduced into a well drilled into an oil bearing stratum may be confined substantially to such stratum. Another object is to reduce the consumption of acid. Further objects and advantages will appear as the description proceeds.

I have discovered that acids may be employed to increase the productivity of an oil or gas well with greatly reduced danger of forming leakage channels into a stratum underlying an oil bearing stratum into which such well is drilled, with increased effectiveness of use of acid, if, before introducing the acid into the well cavity, I first introduce a quantity of relatively heavy liquid or solution that is substantially inactive toward the earth or rock formation. The heavy liquid fills the voids, cavities and the like underlying the oil bearing stratum, or the lower levels of the oil bearing stratum may be filled as well, so as to provide a substantially horizontal fluid support for the acid. Acid solution subsequently introduced is thereby made to spread out largely in a horizontal direction above the level of the heavier liquid in the well, so as to confine its attack upon the rock or earth in the oil productive level above the heavy liquid.

The invention, then, consists of the method hereinafter fully described and particularly pointed out in the claims, the accompanying drawing and the following description setting forth in detail a mode of carrying out the invention, such mode illustrating, however, but one of various ways in which the principle of the invention may be used.

The accompanying drawing is a diagrammatic view in vertical section of an oil well drilled into an oil bearing stratum, provided with a casing, pump tube and well screen and also with equipment for treating the well according to my invention.

As shown, the upper portion 1 of the well is cased and passes through non-productive earth and rock while its lower portion ends in the well cavity 2 located in a producing stratum 7 into which extends the well screen 3 attached to the pump tube 4 through which oil or other fluids may be introduced or withdrawn from the well. Pumping mechanism 5 is shown within the pump tube which extends above the well casing 6 at the top of the well. The producing stratum 7 is shown

located above a non-productive stratum 8. Valves 9 and 10 provide means for regulating the admission of heavy liquid and of acid respectively via the pump tube, although these fluids may be run into the well through the casing if desired.

In carrying out the acid treatment of wells according to my invention, I bail or pump the well as clean as practicable and then introduce into the well a liquid having a higher specific gravity than that of the acid solution to be used subsequently, so as to fill the voids in the stratum below the point at which it is desired to treat with acid. The heavy liquid will naturally flow into the voids in the surrounding earth or rock formation to form therein a liquid layer. As indicated in the drawing, the heavy liquid layer may be at a level 13 within the oil bearing stratum just above the non-productive stratum, or at any other desired level. An acid or acid solution capable of attacking the earth or rock formation in the oil bearing stratum is then introduced. The level of the acid in the productive stratum is shown at 14, although this may be varied if desired by introducing more or less of either liquid. By virtue of the lower specific gravity of the acid solution it does not mix readily with the heavier supporting solution and therefore spreads horizontally upon the latter. The action of the acid is thus confined to the earth or rock formation above the heavy liquid.

Although I have described the introduction of the heavy liquid prior to the acid solution, in some instances I have found it advantageous first to introduce a relatively smaller quantity of acid into the well so as to cut through the oil bearing stratum to the underlying non-productive stratum and then run in the heavy liquid so as to fill the voids in the underlying stratum, following which the main body of the acid solution may be spread upon the heavy liquid layer to treat the oil bearing stratum. This procedure may be followed where the well bore is drilled only into, and not through or deeply into, the oil stratum inasmuch as it usually is not desirable to flood any considerable depth of such stratum with the heavy liquid, but important to prevent acid which is to be used to treat the oil bearing stratum to increase production from cutting through it and thereby being lost, as already indicated.

It is advantageous to use liquids which are not dissolved by the acid although other liquids may be used. These may be either aqueous or non-aqueous. As illustrative of liquids of the non-aqueous type may be mentioned chlorinated hydrocarbons such as carbon tetrachloride, propylene dichloride and the corresponding brominated compounds and the various chlor- and brom-ethanes, ethylenes and the like. Among the various aqueous liquids that I have found suitable are the aqueous solutions of the chlorides and the soluble sulphates of the alkali and alkaline earth metals, although other water-soluble salts may be used. Calcium chloride solutions for example containing from 1.3 to 4.6 pounds per gallon possess specific gravities ranging from 1.12 for the lower concentration to 1.4 for the higher concentration. Aqueous solutions containing 20 per cent or more of sodium sulphate, magnesium sulphate, magnesium chloride, or sodium chloride, possess specific gravities that are greater than approximately 1.18. The strength and consequently the specific gravity of the solution to employ in any case depends upon the specific gravity of the acid.

The amount of difference in specific gravity between that of the heavy liquid and that of the acid which is sufficient to maintain the two liquids in substantially separate layers within the earth or rock formation without an excessively rapid diffusion or mixing occurring between each layer varies somewhat with the chemical behavior of the acid, the composition of the heavy liquid employed, as well as the size of the voids to be filled with the same. I have found, however, that the difference in specific gravity need not be more than about 1 or 2 per cent when the stratum to be filled largely consists of sandy material. Where the voids to be filled are more spacious, such as a shot well cavity, preferably a greater difference in specific gravity is maintained between the two solutions.

The aqueous solutions that I have mentioned by way of illustration are suitable upon which to spread aqueous hydrochloric acid solutions of strengths up to about 35 per cent, nitric acid up to about 29 per cent, phosphoric acid up to about 29 per cent, and sulphuric acid up to about 25 per cent, since the specific gravity of the strongest of these acid solutions is about 1.17, or lower than that of the aforementioned solutions. Substances such as aluminum chloride, ferric chloride, or the like which on being dissolved in water yield an acid solution may be used in water solution in place of or with the usual acids.

After the treating fluids have been introduced into the well their action may be extended, if desired, by applying pressure to these fluids. This may be accomplished by filling the well bore with oil, water, or other suitable fluid so as to produce a hydrostatic head or by applying gas or air pressure.

After the introduction of the acid I allow a sufficient time for it to act upon the earth or rock formation and then I bail or pump out the spent solution which carries with it the acid soluble constituents of the earth or rock formation.

Other modes of applying the principle of my invention may be employed instead of those explained, change being made as re-

gards the method herein disclosed, provided the step or steps stated by any of the following claims or the equivalent of such stated step or steps be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. In a method of treating a deep well with an acid, the step which consists in introducing into the well ahead of the acid a liquid having a higher specific gravity than that of the acid.

2. In a method of treating a deep well with an acid, the step which consists in introducing into the well ahead of the acid a non-aqueous liquid having a higher specific gravity than that of the acid.

3. In a method of treating a deep well with an acid, the step which consists in introducing into the well ahead of the acid an aqueous solution having a higher specific gravity than that of the acid.

4. In a method of treating a deep well with an acid, the step which consists in introducing into the well ahead of the acid an aqueous solution of a salt selected from the group consisting of the chlorides and soluble sulphates of the alkali and alkaline earth metals, having a higher specific gravity than that of the acid.

5. In a method of treating a deep well with an acid, the step which consists in introducing into the well ahead of the acid an aqueous solution of a salt selected from the group consisting of calcium chloride, magnesium chloride, sodium chloride, magnesium sulphate, sodium sulphate, having a higher specific gravity than that of the acid.

6. In a method of treating a deep well to increase the production thereof, the steps which consist in introducing into the well a liquid that is substantially inactive toward the earth or rock formation and then introducing an acid capable of attacking the earth or rock formation, such acid having a lower specific gravity than that of said liquid.

7. In a method of treating a deep well to increase the production thereof, the steps which consist in introducing into the well a non-aqueous liquid that is substantially inactive toward the earth or rock formation and then introducing an acid capable of attacking the earth or rock formation, such acid having a lower specific gravity than that of said non-aqueous liquid.

8. In a method of treating a deep well to increase the production thereof, the steps which consist in introducing into the well an aqueous solution that is substantially inactive toward the earth or rock formation and then introducing an acid capable of attacking the earth or rock formation, such acid having a lower specific gravity than that of said aqueous solution.

9. In a method of treating a deep well to increase the production thereof, the steps which consist in introducing into the well an aqueous solution of a salt selected from the group consisting of the chlorides and soluble sulphates of the alkali and alkaline earth metals and then introducing an acid capable of attacking the earth or rock formation, such acid having a lower specific gravity than that of said aqueous solution.

10. In a method of treating a deep well to increase the production thereof, the steps which consist in introducing into the well an aqueous solution of a salt selected from the group consisting of calcium chloride, magnesium chloride, sodium chloride, magnesium sulphate, sodium sulphate, and then introducing an acid capable of attacking the earth or rock formation, such acid having a lower specific gravity than that of said aqueous solution.

11. In a method of treating a deep well to increase the production thereof, the steps which consist in introducing into the well a liquid that is substantially inactive toward the earth or rock formation and then introducing hydrochloric acid solution having a lower specific gravity than that of said liquid.

12. In a method of treating a deep well to increase the production thereof, the steps which consist in introducing into the well an aqueous solution of a salt selected from the group consisting of the chlorides and soluble sulphates of the alkali and alkaline earth metals and then introducing hydrochloric acid solution having a lower specific gravity than that of said solution.

13. In a method of treating a deep well to increase the production thereof, the steps which consist in introducing into the well an aqueous solution of a salt selected from the group consisting of calcium chloride, magnesium chloride, sodium chloride, magnesium sulphate, sodium sulphate, and then introducing hydrochloric acid solution having a lower specific gravity than that of said solution.

Signed by me this 7th day of January, 1933.

JOHN J. GREBE.