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[54] **FRACTURE INITIATION BY DISSOLVING A SOLUBLE FORMATION**
4 Claims, 1 Drawing Fig.

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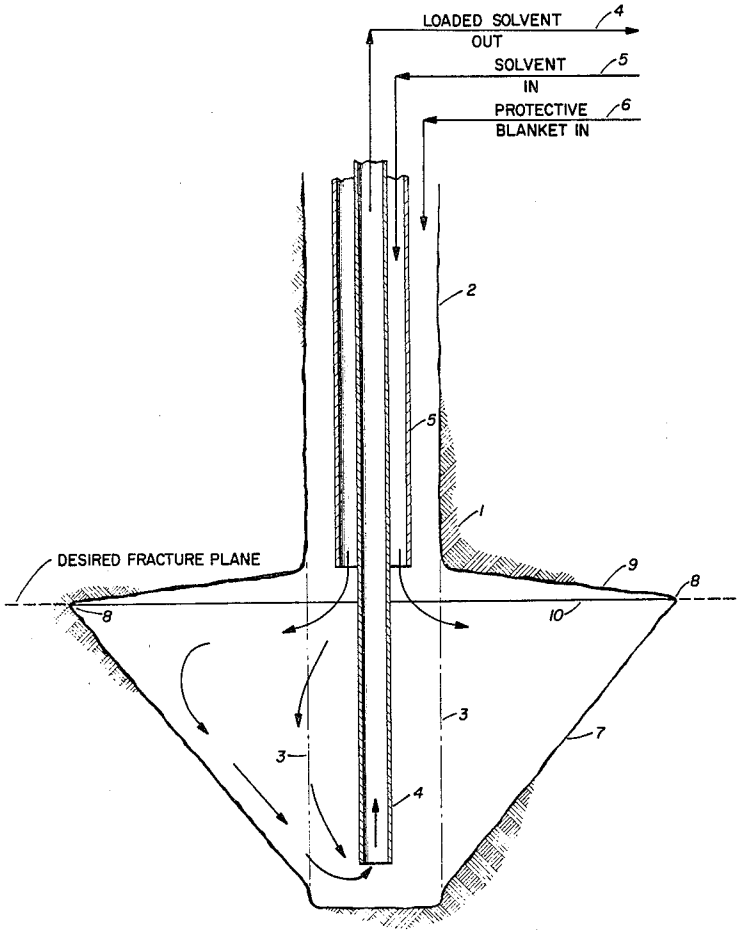
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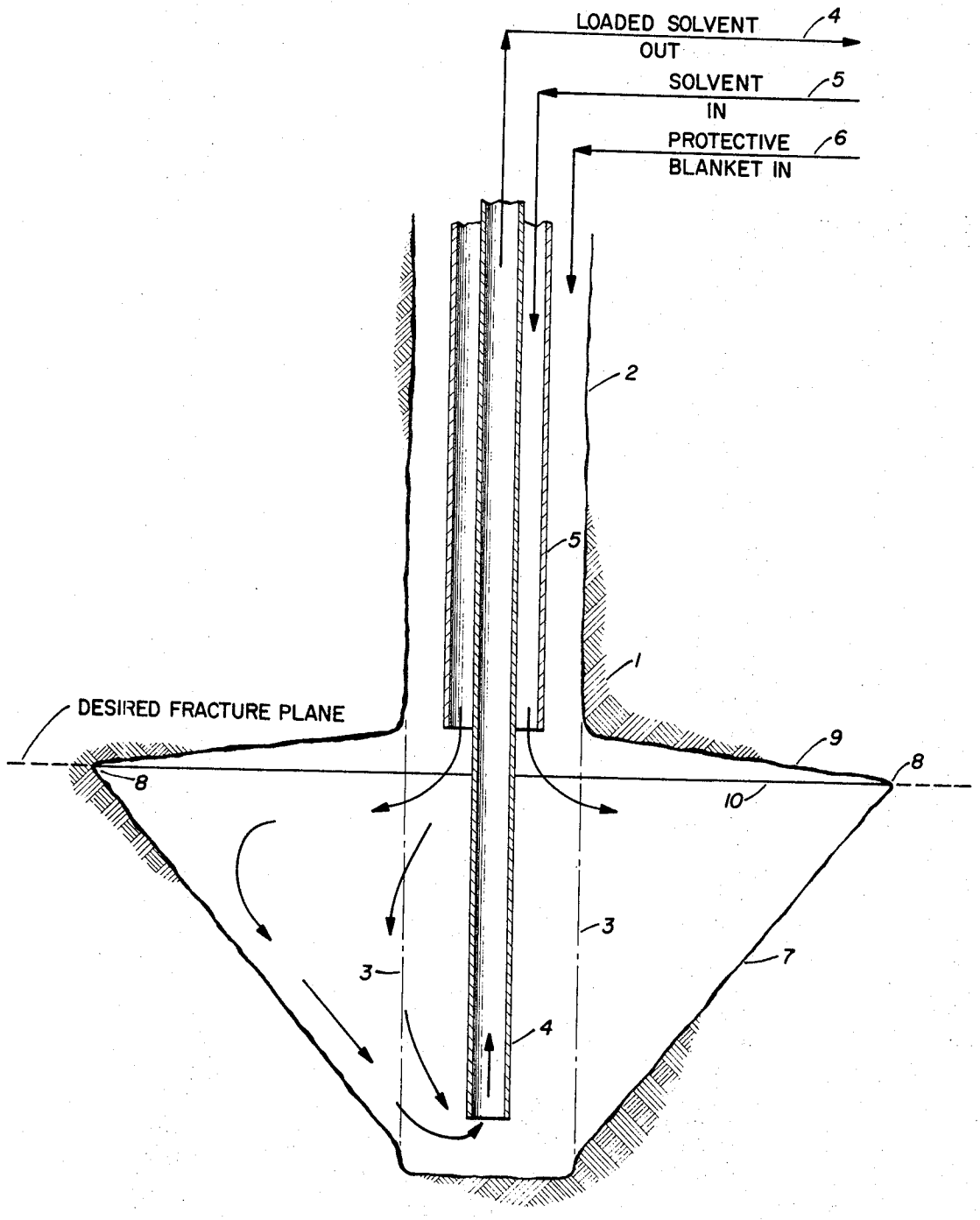
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ABSTRACT: The point of fracture initiation in a soluble formation is controlled by dissolving from the formation a conical volume having the base plane of the cone corresponding to the desired fracture plane. The conical volume is formed during the dissolving step by use of an immiscible blanket fluid above the solvent.



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FRACTURE INITIATION BY DISSOLVING A SOLUBLE FORMATION

This invention relates to a method for initiating a fracture in soluble formation. In one aspect, it relates to controlling the point at which such a fracture is initiated. In another aspect, it relates to a novel method for notching a soluble formation in order to effect a fracture therein.

The technique of applying fluid pressure down a well bore in order to propagate a fracture of a subterranean formation is known in the art. Fracturing is useful to establish communication between two wells in a pay zone, or to increase the surface area available to a single well. A major problem in fracturing is in initiating the fracture at the desired point in the well bore, i.e. at the appropriate depth. Various mechanical cutters and explosive devices have been used to notch the formation at a predetermined depth, but these tools are not totally reliable in that the amount of newly exposed formation area on which the fracturing fluid works is often insignificantly small, with the result that the fracture does not initiate at the desired level even after notching.

Accordingly, it is an object of this invention to provide a method for producing a horizontal enlargement in a subterranean formation. It is another object of this invention to provide a reliable method for selecting the depth at which a fracture is initiated.

Other aspects, objects, and the several advantages of this invention will become apparent upon study of this disclosure, the appended claims, and the drawing, in which:

The sole FIGURE represents a cross section of a notch produced according to the invention.

We have now discovered that a subterranean formation can be effectively notched by a controlled dissolution, the resulting notch comprising an approximately conical volume with the plane of the cone base corresponding to the plane of the desired fracture, and the apex of the cone being below its base. The controlled dissolution comprises, in general, passing down the well bore a solvent effective to disintegrate the formation being notched, recovering from the well bore solvent plus a disintegrated portion of the formation, and maintaining a protective blanket on the roof of the notch being formed.

The invention will now be further explained by reference to the drawing. The formation being notched is indicated generally as **1**. Formation **1** is penetrated by a well bore **2** in conventional manner to a depth below that of the desired notch, the amount of depth below the desired notch level being determined in a manner to be explained herein. The lower end of the well bore prior to notching is shown by broken lines **3**. The well bore is typically protected by a cemented casing, not shown. A plurality of fluid conduits, at least two, are then positioned down the well bore. A first conduit **4** is positioned so as to have its lower end close to the bottom of the well bore, and is connected at its upper end to a suitable recovery pump (not shown) if desired, and thence to a disposal or holding pit or tank. A second conduit **5** is positioned so as to have its lower end open at about the level of the desired fracture plane, and is connected at its upper end to a solvent supply and pump, not shown. Conduit **5** is preferably coaxial with and surrounding conduit **4**, although the two conduits can be side by side. A source of protective blanketing fluid is also provided above ground, and is passed by way of a suitable pump, not shown, and conduit **6** to the well bore and thence to the notch situs. The protective blanketing fluid is shown as being passed down the well bore in the annular space surrounding conduits **4** and **5**, although it is obvious that a third conduit can be provided for its passage.

Operation of the method of the invention will now be described. Conduits **4** and **5** having been positioned as described, an amount of solvent is passed down conduit **5** sufficient to fill the well bore up to about the level of the desired fracture plane. At this time, an amount of protective blanket fluid is passed down the well bore by way of conduit **6** sufficient to fill the remainder of the annular well bore space.

A continuous flow of solvent is now established, into the well bore by way of conduit **5**, down the annular space surrounding the lower end of conduit **4**, and thence up conduit **4** and back to the surface of the earth. As fresh solvent issues from the lower end of conduit **5** and contacts the walls of the well bore there below, it continually dissolves the wall area; as this occurs, the solvent containing dissolved solids becomes more dense, and this factor, added to the circulation established from the lower end of conduit **5** to the lower end of conduit **4**, causes the loaded solvent to pass downward toward the very bottom of the well bore. Of course, the loaded solvent in the lower portion of the bore has a much lower dissolving power than does freshly introduced solvent. The net result of all these factors is that the well bore immediately adjacent the lower end of conduit **5** is enlarged at a much greater rate than is the well bore immediately adjacent the lower end of conduit **4**. As the passing of the solvent is continued, it has been discovered that the cavern which results actually takes on the shape of a cone **7** which, when done according to this invention, forms a sharp acute angle **8** with respect to the base **9** of the cone. The base **9** of the cone, i.e. the roof of the cavern, must be protected from dissolution during the dissolving of the walls in order to form a sharp angle **8**; this is effected by gradually metering into the well bore sufficient blanket fluid by way of conduit **6** to cover the ever-increasing roof area.

Injection of solvent is periodically ceased in order to increase the volume of blanket material. This is effected by injecting additional blanket fluid downwardly through passage **6** until blanket fluid is discharged above ground from conduit **5**, thus assuring that the blanket level is adjusted to the lower end of conduit **5**. The lower end of conduit **5** thus determines the eventual fracture plane.

Laboratory and field data indicate that the diameter of roof **9** will range, depending upon the amount of solvent used, from three to six times the height of the cavity, i.e. approximately the distance between the lower ends of conduits **4** and **5**. A desirable cone diameter is in the range of about 6 to 18 feet, and more preferably about 12 to 18 feet, and thus typical cone heights will range between about 1 and about 6 feet, although of course both heights and diameters greater or smaller than this range are within the scope of the invention.

The protective blanket fluid introduced by way of conduit **6** must be of lower specific gravity than the solvent and should be substantially immiscible therewith in order to maintain a proper protective action; the interface between blanket fluid and solvent is shown in the FIGURE as **10**. The blanket fluid should also have limited or no solvent action on the material forming the roof of the cavern. The blanket fluid can be gaseous or liquid at the conditions prevailing in the cavern. Examples of suitable blanket fluid, depending on the solvent being used and the constitution of the formation, include air, CO_2, natural gases, LPG, ammonia, hydrocarbon oils, water, and various organic materials such as alcohols and ethers.

The solvent material should be heavier than the blanketing fluid and substantially immiscible therewith, and should exhibit a solvent or disintegrating action on the formation to be fractured. Suitable solvents include water and mineral acids. Although the word "solvent" has been used herein, this term is meant to include other methods of attacking or disintegrating a subterranean formation. For example, hot water will not dissolve a sulfur deposit, but will melt it, and the method of this invention can be used to initiate a fracture in a sulfur deposit accordingly. Similarly, dilute mineral acid can be used to attack or "crumble" certain phosphate rock deposits, as set forth in U.S. Pat. No. 3,359,037 to Every et al., issued Dec. 19, 1967. Other formations which can be subjected to the treatment of this invention include halite, potash, phosphate, trona, and tar sands. Once the loaded solvent has been brought to the surface of the earth, it can of course be treated in an appropriate manner to remove therefrom the contained solute, and the solvent then recycled down the well bore.

In the event that it is desired to fracture at the upper face of a formation subject to the solvent action of this invention, the soluble formation being bounded above by a stratum not soluble in the solvent chosen, then use of the protective blanket fluid can be dispensed with. An example of such situation would be a deposit of potash, sodium chloride, or other soluble salt immediately overlain by an anhydrite stratum. In such instance, the use of water circulated between conduits **5** and **4** in the manner described will result in the desired conical cavern without the need of a protective blanket fluid.

After a conical cavern of the desired volume or roof area has been formed, the cavern is subjected to hydraulic pressure in known manner to effect fracture of the formation. The large roof area and the sharp angle formed by practice of this invention combine to result in highly successful fracturing operations. The fracture can subsequently be treated with a propping agent or in other known manner, if desired.

The invention will now be further explained by reference to the following example, which is illustrative and not limiting.

EXAMPLE

A well is drilled into a halite stratum of about 30 feet thickness lying at about 1,450 feet depth. After the well is cased to within about 10 feet of the bottom, two concentric strings of tubing are set, the outer tubing terminating at about 5 feet above the bottom of the borehole and the inner at about one-half foot above the bottom. Water is passed down the annulus between the tubings in amount sufficient to fill the bottom of the borehole, and then butane is passed down the annulus outside the outer tubing until it appears at the surface through the annulus between tubings. Water is now circulated down conduit **5**, and brine is recovered at the surface from conduit **4**. Additional butane blanketing fluid is periodically added in the stated manner. A survey indicates formation of a cone having a roof diameter of about 16 feet and a height of about 6 feet, which cone is subsequently used to initiate a fracture in the halite at the roof periphery by application of fluid pressure.

Although this invention has been described with respect to particular embodiments thereof, it is not to be so limited, as changes and modifications may be made therein which are within the spirit and scope of the invention as defined by the appended claims.

We claim:

1. The method of initiating a fracture in a disintegrable subterranean stratum which comprises:

a. establishing a well bore from the surface of the earth to a depth within said stratum below that of the desired fracture;

b. providing two fluid passageways within said bore from the surface of the earth to within said stratum, the first of said passageways terminating at its lower end at about the level of said desired fracture and the second terminating at its lower end a predetermined distance below that of said first;

c. selecting a first fluid effective to disintegrate said stratum and a second fluid of lower specific gravity than and substantially immiscible with said first fluid and substantially inert to said stratum;

d. passing said first fluid down said first passageway to effect disintegration of said stratum in the region adjacent said lower ends of said first and second passageways and recovering by way of said second passageway first fluid plus disintegrated stratum, while simultaneously maintaining an upper protective blanket layer of said second fluid in said region by injecting said second fluid through a third passageway from the surface of the earth to said region in amount sufficient to maintain the lower surface of said second fluid at a relatively constant level;

e. terminating said passing upon the formation in said stratum of an approximately conical cavern of desired dimension having its base at about the level of said desired fracture and its apex therebelow; and

f. subsequently subjecting the thus formed cavern to hydraulic pressure to initiate fracture of said stratum at about said base of said conical cavern.

2. The method of claim **1** wherein said disintegration comprises dissolving and wherein said first fluid is a solvent for said stratum.

3. The method of claim **1** wherein said maintaining comprises periodic injection of additional volumes of said second fluid.

4. The method of claim **3** wherein said cavern has a terminal base diameter between about 6 and about 18 feet.