US005360066A

United States Patent [19]

Venditto et al.

[11] **Patent Number: 5,360,066**

[45] **Date of Patent: Nov. 1, 1994**

[54] **METHOD FOR CONTROLLING SAND PRODUCTION OF FORMATIONS AND FOR OPTIMIZING HYDRAULIC FRACTURING THROUGH PERFORATION ORIENTATION**

[75] Inventors: **James J. Venditto; Hazim H. Abass; David E. McMechan; Matthew E. Blauch,** all of Duncan, Okla.

[73] Assignee: **Halliburton Company,** Duncan, Okla.

[21] Appl. No.: **992,847**

[22] Filed: **Dec. 16, 1992**

[51] **Int. Cl.**[5] **E21B 43/26**

[52] **U.S. Cl.** **166/250;** 166/308

[58] **Field of Search** 166/250, 308, 271, 297

[56] **References Cited**

U.S. PATENT DOCUMENTS

2,414,997	1/1947	Atkins	285/97.3
4,220,205	9/1980	Coursen et al.	166/308 X
4,523,649	6/1985	Stout	175/4.51
4,529,036	7/1985	Daneshy et al.	166/254
4,542,648	9/1985	Vinegar et al.	73/153
4,637,478	1/1987	George	175/4.51
4,673,890	6/1987	Copland et al.	33/178
4,714,115	12/1987	Uhri	166/308
4,830,120	5/1989	Stout	175/4.51
4,848,468	7/1989	Hazlett et al.	166/300
4,869,322	9/1989	Vogt, Jr. et al.	166/308 X
4,889,186	12/1989	Hanson et al.	166/308 X
4,974,675	12/1990	Austin et al.	166/250
4,977,961	12/1990	Avasthi	166/297
5,025,859	6/1991	Hanson et al.	166/308
5,111,881	5/1992	Soliman et al.	166/308 X

OTHER PUBLICATIONS

Vinegar, H. J., "X-Ray CT and NMR Imaging of Rocks", J. of Petroleum Technology, Mar. 1986, pp. 257–259.

Bergosh, J. L., Marks, T. R., and Mitkus, A. F., "New Core Analysis Techniques for Naturally Fractured Reservoirs", SPE Paper 13653, presented at the 1985 SPE California Regional Meeting, Bakersfield, Mar. 27–29, 1985.

Honarpour, M. M., et al., "Reservoir Rock Descriptions Using Computed Tomography (CT)", SPE Paper 14272 presented at the 60th Annual Technical Conference and Exhibition of the Society of Petroleum Engineers held in Las Vegas, Sep. 22–25, 1985.

Hunt, P. K., et al., "Computer Tomography as a Core Analysis Tool: Applications and Artifact Reduction Techniques", SPE Paper 16952, presented at the 62nd Annual Technical Conference and Exhibition of the Society of Petroleum Engineers held in Dallas, Sep. 27–30, 1987.

Gilliland, R. E., "Use of CT Scanning in the Investigation of Damage to Unconsolidated Cores", SPE Paper 19408, presented at the SPE Formation Damage Control Symposium held in Lafayette, Feb. 22–23, 1990.

Suzuki, F., "X-Ray Computed Tomography for Carbonate Acidizing Studies", Paper No. CIM/SPE 90–45, presented at the CIM/SPE Meeting in Calgary, Jun. 10–13, 1990.

Halliburton Logging Services, Inc. Publication No. EL–1055, Aug. 1989(3 pages).

Seiler, Edmiston, Torres and Goetz, "Field Performance of a New Borehole Televiewer Tool and Associated Image Processing Techniques", Jun. 1990 (19 pages).

(List continued on next page.)

Primary Examiner—William P. Neuder

Attorney, Agent, or Firm—Arnold, White & Durkee

[57] **ABSTRACT**

An improved method for fracturing oil wells is disclosed and claimed herein. In particular, the present invention involves the determination of the direction of fracture propagation, i.e., perpendicular to the minimum stress existing within a given formation and the alignment of perforations produced by a variety of perforating devices with the previously determined direction of fracture propagation. The methods disclosed and claimed herein will eliminate many problems encountered in the prior art, including reducing the pressure required to initiate fractures and reducing the undesirable effects of near wellbore tortuosity.

8 Claims, 9 Drawing Sheets

US005360066A

United States Patent [19]

Venditto et al.

[11] Patent Number: 5,360,066

[45] Date of Patent: Nov. 1, 1994

[54] **METHOD FOR CONTROLLING SAND PRODUCTION OF FORMATIONS AND FOR OPTIMIZING HYDRAULIC FRACTURING THROUGH PERFORATION ORIENTATION**

[75] Inventors: **James J. Venditto; Hazim H. Abass; David E. McMechan; Matthew E. Blauch,** all of Duncan, Okla.

[73] Assignee: **Halliburton Company,** Duncan, Okla.

[21] Appl. No.: **992,847**

[22] Filed: **Dec. 16, 1992**

[51] **Int. Cl.**[5] **E21B 43/26**

[52] **U.S. Cl.** **166/250;** 166/308

[58] **Field of Search** 166/250, 308, 271, 297

[56] **References Cited**

U.S. PATENT DOCUMENTS

2,414,997	1/1947	Atkins	285/97.3
4,220,205	9/1980	Coursen et al.	166/308 X
4,523,649	6/1985	Stout	175/4.51
4,529,036	7/1985	Daneshy et al.	166/254
4,542,648	9/1985	Vinegar et al.	73/153
4,637,478	1/1987	George	175/4.51
4,673,890	6/1987	Copland et al.	33/178
4,714,115	12/1987	Uhri	166/308
4,830,120	5/1989	Stout	175/4.51
4,848,468	7/1989	Hazlett et al.	166/300
4,869,322	9/1989	Vogt, Jr. et al.	166/308 X
4,889,186	12/1989	Hanson et al.	166/308 X
4,974,675	12/1990	Austin et al.	166/250
4,977,961	12/1990	Avasthi	166/297
5,025,859	6/1991	Hanson et al.	166/308
5,111,881	5/1992	Soliman et al.	166/308 X

OTHER PUBLICATIONS

Vinegar, H. J., "X-Ray CT and NMR Imaging of Rocks", J. of Petroleum Technology, Mar. 1986, pp. 257–259.

Bergosh, J. L., Marks, T. R., and Mitkus, A. F., "New Core Analysis Techniques for Naturally Fractured Reservoirs", SPE Paper 13653, presented at the 1985 SPE California Regional Meeting, Bakersfield, Mar. 27–29, 1985.

Honarpour, M. M., et al., "Reservoir Rock Descriptions Using Computed Tomography (CT)", SPE Paper 14272 presented at the 60th Annual Technical Conference and Exhibition of the Society of Petroleum Engineers held in Las Vegas, Sep. 22–25, 1985.

Hunt, P. K., et al., "Computer Tomography as a Core Analysis Tool: Applications and Artifact Reduction Techniques", SPE Paper 16952, presented at the 62nd Annual Technical Conference and Exhibition of the Society of Petroleum Engineers held in Dallas, Sep. 27–30, 1987.

Gilliland, R. E., "Use of CT Scanning in the Investigation of Damage to Unconsolidated Cores", SPE Paper 19408, presented at the SPE Formation Damage Control Symposium held in Lafayette, Feb. 22–23, 1990.

Suzuki, F., "X-Ray Computed Tomography for Carbonate Acidizing Studies", Paper No. CIM/SPE 90–45, presented at the CIM/SPE Meeting in Calgary, Jun. 10–13, 1990.

Halliburton Logging Services, Inc. Publication No. EL–1055, Aug. 1989(3 pages).

Seiler, Edmiston, Torres and Goetz, "Field Performance of a New Borehole Televiewer Tool and Associated Image Processing Techniques", Jun. 1990 (19 pages).

(List continued on next page.)

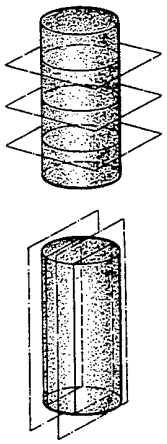
Primary Examiner—William P. Neuder

Attorney, Agent, or Firm—Arnold, White & Durkee

[57] **ABSTRACT**

An improved method for fracturing oil wells is disclosed and claimed herein. In particular, the present invention involves the determination of the direction of fracture propagation, i.e., perpendicular to the minimum stress existing within a given formation and the alignment of perforations produced by a variety of perforating devices with the previously determined direction of fracture propagation. The methods disclosed and claimed herein will eliminate many problems encountered in the prior art, including reducing the pressure required to initiate fractures and reducing the undesirable effects of near wellbore tortuosity.

8 Claims, 9 Drawing Sheets



OTHER PUBLICATIONS

Goetz, Seiler and Edmiston, "Geological and Borehole Features Described by the Circumferential Acoustic Scanning Tool", SPWLA 31st Annual Logging Symposium, Jun. 1990 (21 pages).

Torres, Strickland and Gianzero, "A New Approach to Determining Dip and Strike Using Borehole Images"; SPWLA 31st Annual Logging Symposium, Jun. 1990 (16 pages).

Halliburton Logging Services, Inc. "Telecast"flier; Jan. 1990 (1 page).

Halliburton Logging Services, Inc. publication, "An Introduction to the HLS Borehole Televiewer"; 1990 (15 pages).

Halliburton Logging Services, Inc. publication, "Cast—The Circumferential Acoustic Scanning Tool"; 1990 (3 pages).

Aadnoy, Bernt S., "Modeling of the Stability of Highly Inclined Boreholes in Anisotropic Rock Formations", SPE Drilling Engineering, Sep. 1988, p. 263.

Teufel, L. W., "Strain Relaxation Method for Predicting Hydraulic Fracture Azimuth from Oriented Core", SPE/DOE 9836 (1981).

Teufel, L. W., "Prediction of Hydraulic Fracture Azimuth from Anelastic Strain Recovery Measurements of Oriented Core", Proceeding of 23rd Symposium on Rock Mechanics: Issues in Rock Mechanics, Ed. by R. E. Goodman and F. F. Hughes, p. 239, SME of AIME, New York, 1982.

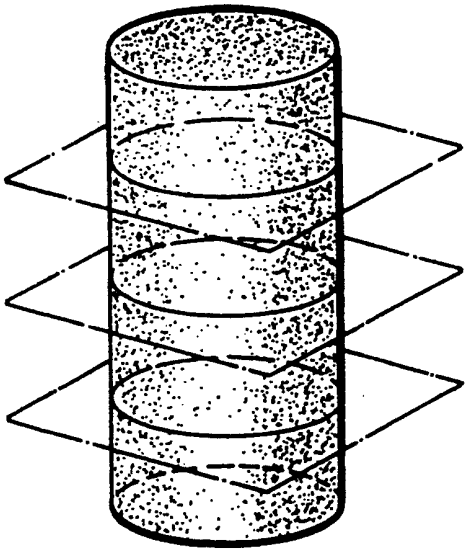
Blanton, T. L., "The Relation Between Recovery Deformation and In–Situ Stress Magnitudes", SPE/DOE 11624 (1983).

El Rabaa, W., and Meadows D. L., "Laboratory and Field Application of the Strain Relaxation Method", SPE 15072 (1986).

El Rabaa, W., "Determination of Stress Field and Fracture Direction in Danian Chalk", 1989.

Halliburton Logging Services, Inc. publication, "Full Wave Sonic Log", Mar. 1986 (11 pages).

Fig. 1a



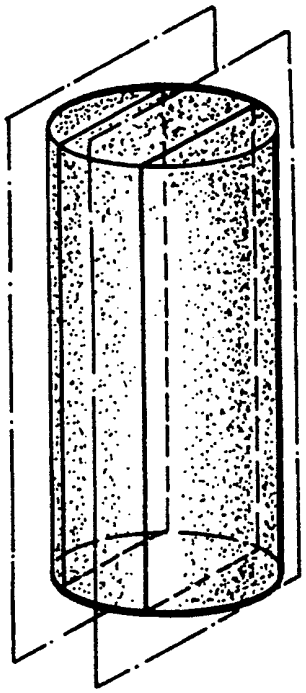
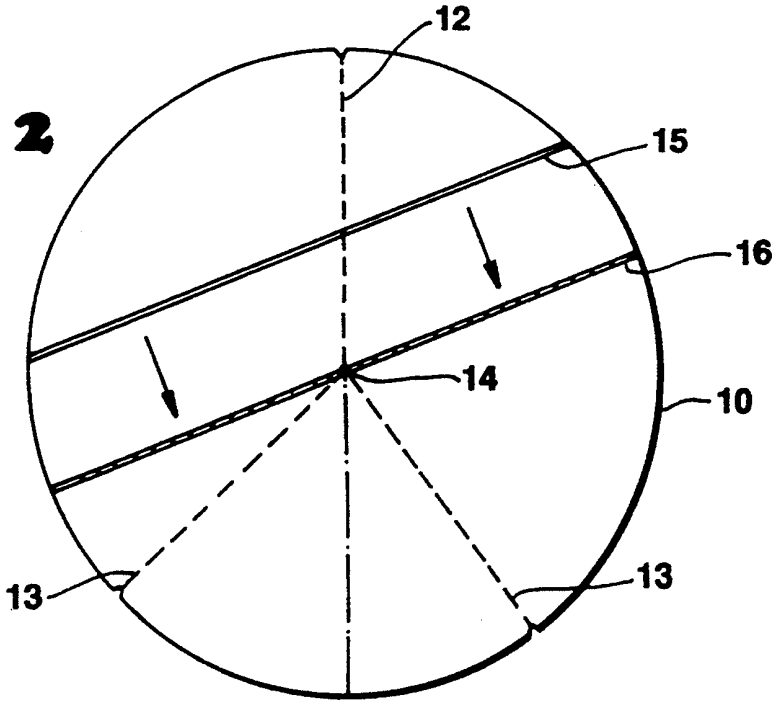


Fig. 1b

Fig. 2



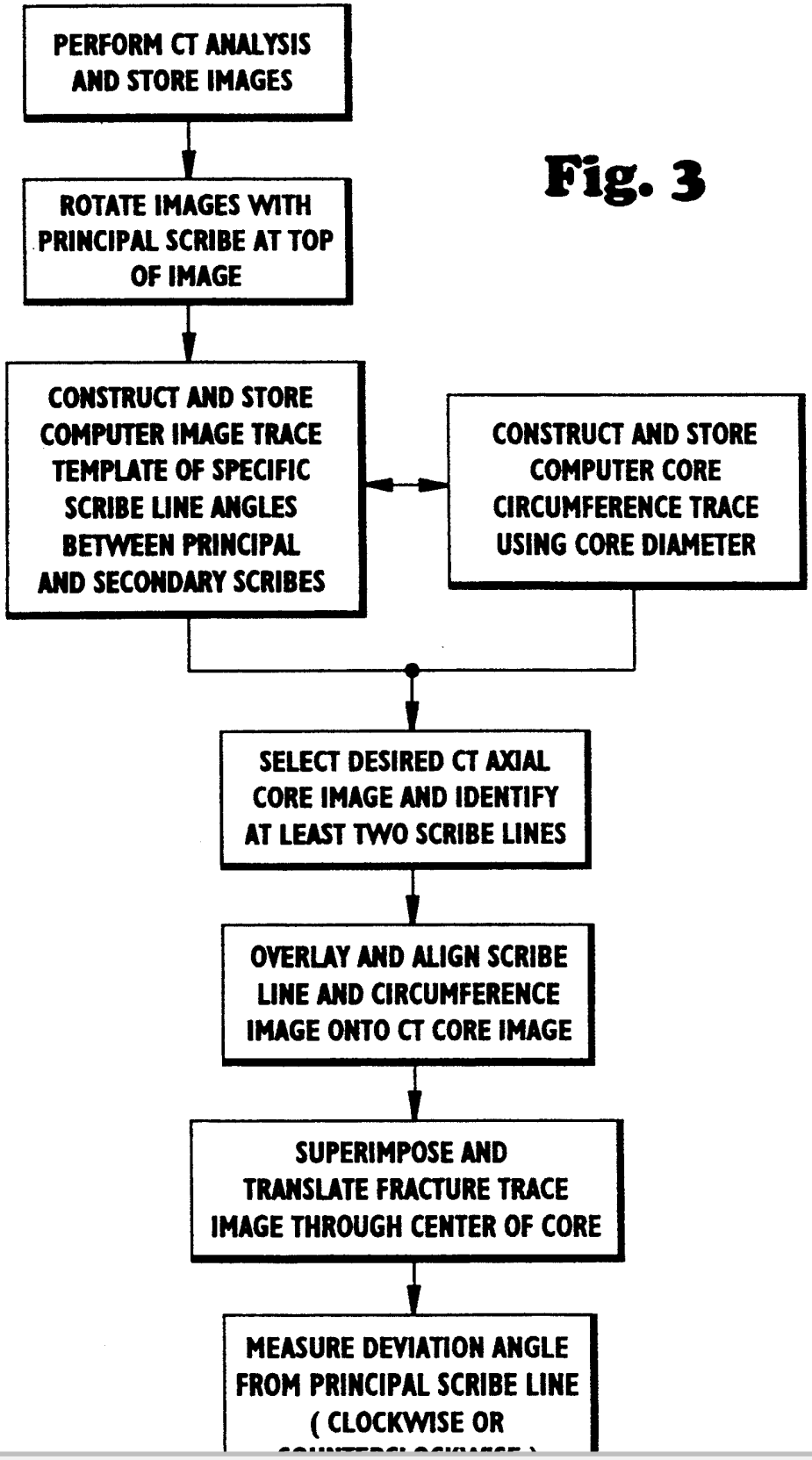


Fig. 3

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.