



(51) International Patent Classification:

E21B 43/30 (2006.01) *E21B 43/25* (2006.01)
E21B 43/26 (2006.01)

(21) International Application Number:

PCT/US2018/041204

(22) International Filing Date:

09 July 2018 (09.07.2018)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/530,386 10 July 2017 (10.07.2017) US

(71) Applicant: **TEXAS TECH UNIVERSITY SYSTEM**
[US/US]; Box 42007, Lubbock, TX 79409-2007 (US).(72) Inventors: **MOHAMED, Ahmed**; 508 Foster Lane, Marietta, Ohio 45750 (US). **SOLIMAN, Mohamed Yousef**; 16030 Elmwood Manor Drive, Cypress, Texas 77429 (US). **HEINZE, Lloyd**; 4908 75th Street, Lubbock, Texas 79429 (US).(74) Agent: **LOPEZ, Kermit** et al.; Ortiz & Lopez, PLLC, P.O. Box 4484, Albuquerque, NM 87196-4484 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

— with international search report (Art. 21(3))

(54) Title: METHODS AND SYSTEMS FOR BALLOONED HYDRAULIC FRACTURES AND COMPLEX TOE-TO-HEEL FLOODING

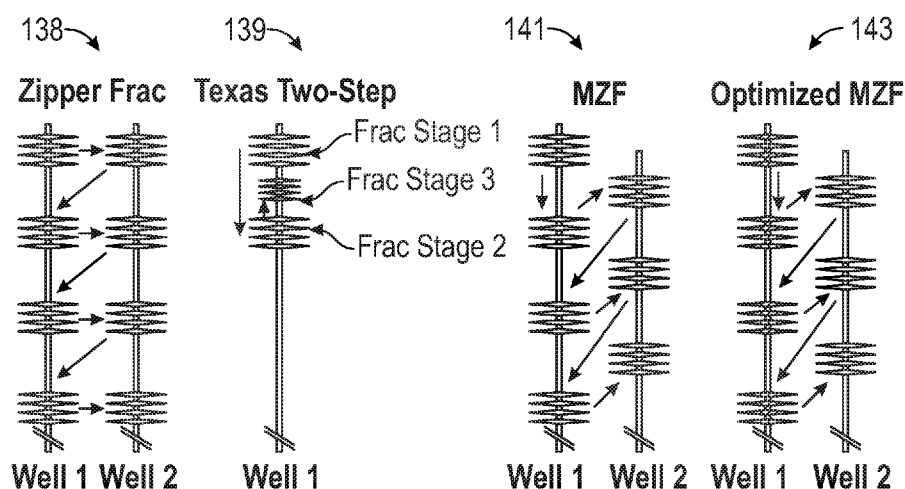


FIG. 7

(57) Abstract: Improved methods and systems for hydrocarbon production, including operations involving ballooned hydraulic fractures and complex toe-to-heel flooding. The recovery of ballooned hydrocarbons via ballooned hydraulic fractures can include the use of an OZF (Optimized Modified Zipper Frac) that recovers hydrocarbons. OZF can be implemented as a fracturing technique with respect to organic shale reservoirs to maximize near-wellbore complexity and overall permeability and hydrocarbon recovery. Additionally, Complex toe-to-heel flooding (CTTHF) can be applied to horizontal wells. CTTHF uses one or more barriers and an injector hydraulic fracture, and facilitates the control of early water production.

(88) Date of publication of the international search report:
26 March 2020 (26.03.2020)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 18/41204

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - E21B 43/30, E21B 43/26, E21B 43/25 (2018.01)

CPC - E21B 43/30, E21B 43/26, E21B 43/25, E21B 43/305, E21B 43/255

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History Document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2016/0003020 A1 (Board of Regents, The University of Texas System) 7 January 2016 (07.01.2016) Entire document especially para [0004]-[0005], [0057], [0061], [0120]-[0126], [0187], [0190] and figs. 2, 11 and Table 5	1-12
Y	US 2008/0142224 A1 (Wilson) 19 June 2008 (19.06.2008) Entire document especially para [0019]-[0020], [0030], [0035] and fig. 2	1-12
Y	US 2003/0054962 A1 (England et al.) 20 March 2003 (20.03.2003) Entire document especially para [0003], [0005], [0012], [0023], [0032], [0041], [0042], [0049]	2, 4, 8, 10
Y	US 2014/0305638 A1 (Schlumberger Technology Corporation) 16 October 2014 (16.10.2014) Entire document especially para [0002], [0030], [0065]-[0066] and fig. 3	3-4, 9-10
A	US 2017/0122086 A1 (Texas Tech University System) 4 May 2017 (04.05.2017) Entire document	1-12
A	US 2014/0048270 A1 (Texas Tech University System) 20 February 2014 (20.02.2014) Entire document	1-12
A	US 2011/0209868 A1 (Dusterhoft et al.) 1 September 2011 (01.09.2011) Entire document	1-12
A	US 2016/0298435 A1 (Diversion Technologies, LLC) 13 October 2016 (13.10.2016) Entire document	1-12

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

1 October 2018

Date of mailing of the international search report

21 DEC 2018

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-8300

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 18/41204

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
---see extra sheet---

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-12

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 18/41204

-*Supplemental Box - Box III - Observations where unity of invention is lacking-*

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-12 drawn to a system for recovering hydrocarbons comprising an OZF (Optimized Zipper Frac) configured with an operation sequence for creating a plurality of staggered stages of fractures in adjacent wells and an associated method.

Group II: Claims 13-20 drawn to a system for recovering hydrocarbons by increasing flood efficiency comprising perforations, a plug and a packer and an associated method.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

SPECIAL TECHNICAL FEATURES

Group I has the special technical features an OZF (Optimized Zipper Frac) that recovers hydrocarbons, wherein said OZF is configured by an operational sequence comprising: initially creating a first stage of hydraulic fractures creating a second stage, wherein said second stage is ballooned on a same well at a designated distance from said first stage; creating a third stage along an adjacent well midway and staggered between said first stage and said second stages, and thereafter repeating said operational sequence, not required by Group II.

Group II has the special technical features of toes placed on a same plane that is perpendicular to said minimum horizontal stress direction; perforations located close to said toes to inject a high viscous batch to form a nonpermeable barrier along said reservoir; a plug set to separate said non-permeable barrier from a remainder of said horizontal section, wherein said remainder of said horizontal section is perforated; and a packer that is set and sealed and located at a designated distance from said plug, not required by Group I.

COMMON TECHNICAL FEATURES

The only technical features shared between Groups I and II is a system for recovering hydrocarbons comprising a toe of a horizontal well, which does not provide any contribution over the prior art as it is anticipated by US 2016/0003020 A1 to Board of Regents, The University of Texas System (hereinafter 'Regents').

Regents teaches a system (See fig. 2; para [0123]) for recovering hydrocarbons (102 - "hydrocarbon formation", fig. 2) comprising a horizontal well (112, 114, 116, 118 - "wellbores", fig. 2; para [0124]) wherein the horizontal well comprises a toe (para [0131]; see fig. 11).

As the common features were known in the art at the time of the invention, they cannot be considered special technical features that would otherwise unify the groups.

Therefore, Groups I and II lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.