

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
5 February 2009 (05.02.2009)

PCT

(10) International Publication Number  
**WO 2009/018019 A3**

(51) International Patent Classification:  
**E21B 43/24** (2006.01)

(21) International Application Number:  
PCT/US2008/070776

(22) International Filing Date: 22 July 2008 (22.07.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
11/832,620 1 August 2007 (01.08.2007) US

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(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, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, 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, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

(88) Date of publication of the international search report:  
19 March 2009

(54) Title: DRAINAGE OF HEAVY OIL RESERVOIR VIA HORIZONTAL WELLBORE

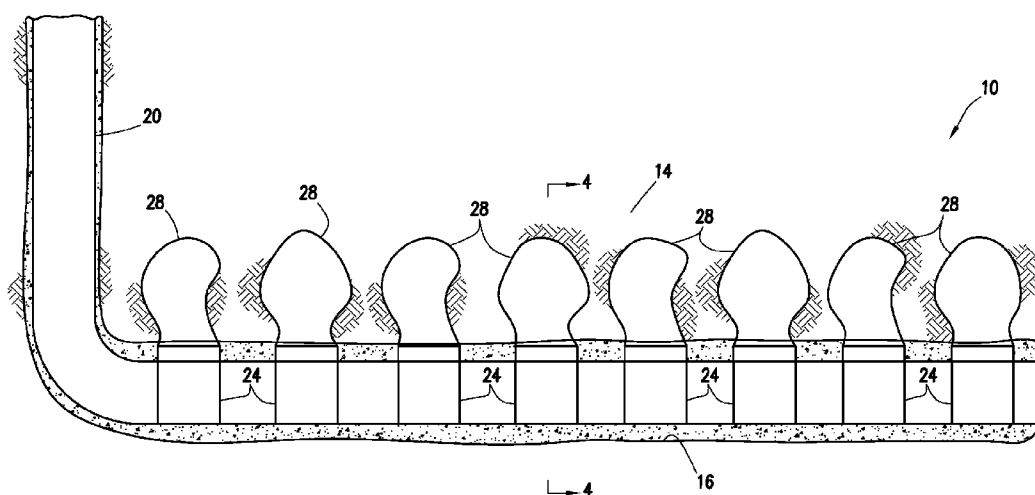


FIG. 3

(57) Abstract: Systems and methods for drainage of a heavy oil reservoir via a horizontal wellbore. A method of improving production of fluid from a subterranean formation includes the step of propagating a generally vertical inclusion into the formation from a generally horizontal wellbore intersecting the formation. The inclusion is propagated into a portion of the formation having a bulk modulus of less than approximately 750,000 psi. A well system includes a generally vertical inclusion propagated into a subterranean formation from a generally horizontal wellbore which intersects the formation. The formation comprises weakly cemented sediment.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2008/070776

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - E21B 43/24 (2008.04)

USPC - 166/303

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)

IPC(8) - E21B 43/24 (2008.04)

USPC - 166/50, 263, 271, 303

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

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

PatBase

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------|-----------------------|
| X         | US 5,148,869 A (SANCHEZ) 22 September 1992 (22.09.1992) entire document            | 1, 2, 10, 11, 13-18   |
| Y         |                                                                                    | 3-9, 12               |
| Y         | US 5,215,146 A (SANCHEZ) 01 June 1993 (01.06.1993) entire document                 | 3-9                   |
| Y         | US 6,991,037 B2 (HOCKING) 31 January 2006 (31.01.2006) entire document             | 12                    |
| A         | US 2006/0131074 A1 (CALHOUN et al) 22 June 2006 (22.06.2006) entire document       | 1-18                  |

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

## \* 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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

03 December 2008

Date of mailing of the international search report

02 JAN 2009

Name and mailing address of the ISA/US

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Facsimile No. 571-273-3201

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PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2008/070776

## 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.:  
1-18

### 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/US2008/070776

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 1-18, drawn to a method of improving production from a subterranean formation

Group II, claims 19-30, drawn to a well system

Group III, claims 31-48, drawn to a method of improving production from a subterranean formation

Group IV, claims 49-66, drawn to a method of improving production from a subterranean formation

The inventions listed as Groups I-III 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: the special technical feature of Group I, propagating a generally vertical first inclusion into the formation from a generally horizontal first wellbore intersecting the formation, the first inclusion being propagated into a portion of the formation having a Skempton B parameter greater than  $0.95\exp(-0.04 p') + 0.008 p'$ , where  $p'$  is a mean effective stress at a depth of the first inclusion, is not present in Groups II, III and/or IV; the special technical feature of Group II, a wherein the formation comprises weakly cemented sediment, is not present in Groups I, III and/or IV; the special technical feature of Group III, a propagating a generally vertical first inclusion into the formation from a generally horizontal first wellbore intersecting the formation, the first inclusion being propagated into a portion of the formation having a cohesive strength of less than a sum of 400 pounds per square inch and 0.4 times a mean effective stress in the formation at the depth of the first inclusion, is not present in Groups I, II and/or IV; the special technical feature of Group IV, a propagating a generally vertical first inclusion into the formation from a generally horizontal first wellbore intersecting the formation, the first inclusion being propagated into a portion of the formation having a bulk modulus of less than approximately 750,000 psi., is not present in Groups I, II and/or III.

Since none of the special technical features of the Group I, Group II, Group III or Group IV inventions is found in more than one of the inventions, unity of invention is lacking.