

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
15 April 2010 (15.04.2010)

PCT

(10) International Publication Number
WO 2010/042720 A3

(51) International Patent Classification:

E21B 7/14 (2006.01) E21B 43/114 (2006.01)
E21B 7/18 (2006.01)

(21) International Application Number:

PCT/US2009/060003

(22) International Filing Date:

8 October 2009 (08.10.2009)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/103,859	8 October 2008 (08.10.2008)	US
61/140,477	23 December 2008 (23.12.2008)	US
61/140,512	23 December 2008 (23.12.2008)	US
61/140,489	23 December 2008 (23.12.2008)	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, CL, 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, PE, 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, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

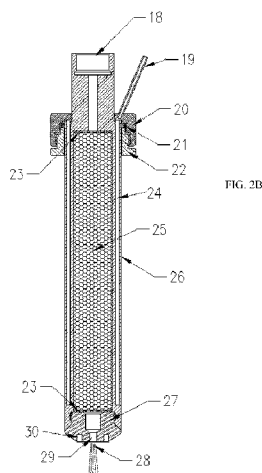
Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(88) Date of publication of the international search report:

12 August 2010

(54) Title: METHODS AND APPARATUS FOR THERMAL DRILLING



(57) Abstract: Methods and apparatus for spalling a geological formation, for example to thermally drill a wellhole, are provided. Such methods may include providing a housing comprising a reaction chamber and a catalyst element (25) held within the reaction chamber, providing at least one jet nozzle (27, 29), contacting one or more unreacted fluids or solids with the catalyst element, wherein the unreacted fluid or solid is adapted to react over the catalyst element, thus generating a reacted fluid, and emitting the reacted fluid through the at least one nozzle, wherein the at least one nozzle is directed to an excavation site within or on the geological rock formation, thereby creating spalls and/or a reacted rock region.

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INTERNATIONAL SEARCH REPORT

International application No PCT/US2009/060003
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A. CLASSIFICATION OF SUBJECT MATTER		
INV. E21B7/14	E21B7/18	E21B43/114
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) E21B		
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 practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2 680 487 A (CARPENTER PAUL G) 8 June 1954 (1954-06-08)	1-3,5-7, 15,16, 20-23, 25,26, 29, 36-38, 43-47, 50-57, 60-65, 67-71,74
Y	column 1, lines 11, 24-31, 35-37; figures 1, 2, 4 column 2, lines 40-48, 5 - column 3, lines 3, 6, 10-14, 25-31, 71-75 column 4, lines 15-18, 33 column 5, lines 13-14, 17, 24-27, 53-55, 60-61 ----- -/--	8-10,17, 18,73
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> 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 document 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	Date of mailing of the international search report	
9 March 2010	18/06/2010	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Georgescu, Mihnea	

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/060003

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3 112 800 A (BOBO ROY A). 3 December 1963 (1963-12-03) column 1, lines 50-53, 58-67; figures 2, 3, 5 -----	8-10
Y	US 4 250 962 A (MADGAVKAR AJAY M ET AL) 17 February 1981 (1981-02-17) column 5, lines 21-22, 34-37 -----	17,18
Y	GB 2 082 650 A (FLOW IND INC) 10 March 1982 (1982-03-10) page 1, lines 19-20, 90-95; figure 3 -----	73
A	US 4 453 597 A (BROWN RICHARD A [US] ET AL) 12 June 1984 (1984-06-12) column 4, lines 19-21 -----	3

INTERNATIONAL SEARCH REPORT

International application No.
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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 additional 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 an 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.:

"see additional sheet(s)"

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-10, 15-18, 20-23, 25, 26, 29, 36-38, 43-47, 50-57, 60-65, 67-74

Group of claims searched together and having in common the features of claim 1.

- 1.1. claims: 1-7, 15, 16, 20-23, 25, 26, 29, 36-38, 43-47, 50-57, 60-65, 67-71, 74

wherein, (potential special technical feature of claim 4) the reacted fluid is 800°C.

Technical problem: to provide a reacted fluid with an increased spalling efficiency.

- 1.2. claims: 8-10

wherein, (potential special technical feature of claim 8) a flow of water or drilling mud is introduced in the excavation.

Technical problem: to enhance the removal of the spalled material from the interior of the bore.

- 1.3. claims: 17, 18

wherein, (potential special technical feature of claim 17) the support of the catalyst comprises alumina.

Technical problem: to provide an appropriate support for the catalyst.

- 1.4. claim: 72

wherein, (potential special technical feature of claim 72) a nozzle is directed at an acute angle to an elongate axis of the apparatus.

Technical problem: to meet a specific need of drilling.

- 1.5. claim: 73

wherein, (potential special technical feature of claim 73) the jet nozzle has a diameter ranging from approximately 0.01 inches to approximately two inches.

Technical problem: to optimise the effect of the jet conveyed through the nozzle to the formation to be drilled.

2. claims: 11, 12, 66

Features of claim 1, wherein (potential special technical feature of claim 11) further comprising heating the unreacted fluid or solid.

Technical problem: to speed up the catalytic reaction.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

3. claims: 13, 14

Features of claim 1, wherein (potential special technical feature of claim 13) said method is capable of producing an about 1 inch diameter borehole in said geological formation at about 0.5 inch per minute of reacted fluid flow.
Technical problem: to provide a specific drilling hole dimension and rate of penetration.

4. claim: 19

Features of claim 1, wherein (potential special technical feature of claim 19) the catalyst element has at least about 10 m²/g surface area of catalyst.
Technical problem: to provide a catalytic reaction surface above a specific minimum.

5. claim: 24

Features of claim 1, wherein (potential special technical feature of claim 24) the unreacted solid comprises encapsulated oxidant.
Technical problem: to prevent any accidental contamination of the oxidant before the contact with the catalyst.

6. claims: 27, 28, 30-35, 39-42, 48, 49, 58, 59

Features of claim 1, wherein (potential special technical features of any of claims 27 to 30, 32, 39-42) various fuel types are used.
Technical problem: to provide a suitable unreacted fluid.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2009/060003
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Patent document cited in search report	A	Publication date	Patent family member(s)	Publication date
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