



(51) International Patent Classification:
G01V 5/10 (2006.01)

(21) International Application Number:
PCT/US2009/048810

(22) International Filing Date:
26 June 2009 (26.06.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/077,524 2 July 2008 (02.07.2008) 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,

[Continued on next page]

(54) Title: DOWNHOLE NEUTRON ACTIVATION MEASUREMENT

(57) Abstract: Systems and methods for measuring neutron-induced activation gamma-rays in a subterranean formation are provided. In one example, a downhole tool for measuring neutron-induced activation gamma-rays may include a neutron source and a gamma-ray detector. The neutron source may emit neutrons according to a pulsing scheme that includes a delay between two pulses. The delay may be sufficient to allow substantially all neutron capture events due to the emitted neutrons to cease. The gamma-ray detector may be configured to detect activation gamma-rays produced when elements activated by the emitted neutrons decay to a non-radioactive state.

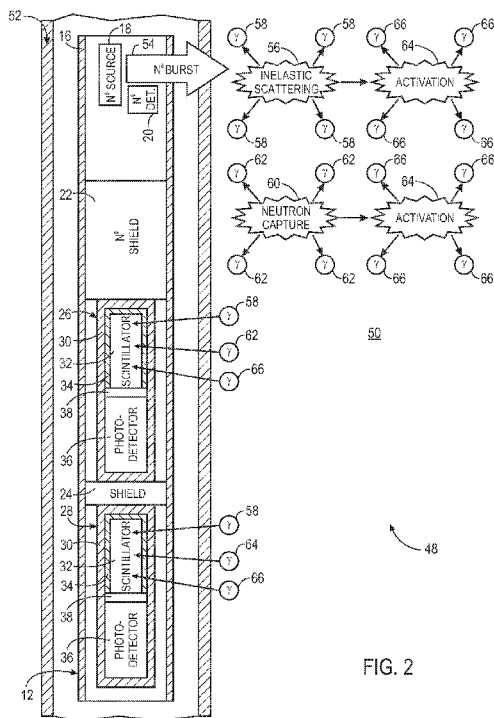


FIG. 2





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, 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:

15 July 2010

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/048810

A. CLASSIFICATION OF SUBJECT MATTER INV. G01V5/10		
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) G01V		
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; WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 943 362 A (PEELMAN HAROLD E) 9 March 1976 (1976-03-09) column 5, line 60 - column 6, line 16; figure 3	1,2
X	US 3 662 173 A (YOUMANS ARTHUR H) 9 May 1972 (1972-05-09) column 3, line 15 - line 21 column 3, line 59 - column 4, line 8	1,2
<input 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 8 April 2010		Date of mailing of the international search report 01/06/2010
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 Anderson, Alex

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/048810

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.:

1-3

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: 1-3

A downhole tool comprising a pulsed neutron source and a gamma-ray detector for detecting activation gamma-rays; the delay between neutron pulses is > 1 second

2. claims: 4, 5

A downhole tool comprising a pulsed neutron source and a gamma-ray detector for detecting activation gamma-rays; the delay between neutron pulses is dependent upon the logging speed of the tool

3. claims: 6-9

A downhole tool comprising a pulsed neutron source and a gamma-ray detector for detecting activation gamma-rays; the delay between neutron pulses is independent of the logging speed of the tool, and the pulse from the neutron source is made up from a plurality of microbursts

4. claims: 10-14, 19-22, 30-33

A downhole tool comprising a pulsed neutron source and a gamma-ray detector for detecting activation gamma-rays, and inelastic gamma-rays and/or neutron capture gamma-rays

5. claims: 15-18

A method for determining fracture heights in a borehole using neutron logging

6. claims: 23-25

A downhole tool comprising a pulsed neutron source, a gamma-ray detector for detecting activation gamma-rays, and a neutron monitor for monitoring the output of neutron source, and whose output is used to normalise the detected gamma-rays

7. claim: 26

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

A downhole tool comprising a pulsed neutron source, a gamma-ray detector for detecting activation gamma-rays, and a data processing unit; the data processing unit is used to determine whether the detected gamma-rays are formed in the formation or in the borehole

8. claims: 27-29

A downhole tool comprising a pulsed neutron source and a gamma-ray detector for detecting activation gamma-rays; the detected activation gamma rays are subdivided into time bins

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2009/048810
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Patent document cited in search report	A	Publication date		Patent family member(s)	Publication date
US 3943362	A	09-03-1976	AU	7720475 A	15-07-1976
			CA	1022691 A1	13-12-1977
			DE	2461743 A1	24-07-1975
			DK	691974 A	08-09-1975
			FR	2258641 A1	18-08-1975
			GB	1450259 A	22-09-1976
			IE	40854 B1	29-08-1979
			NO	750126 A	11-08-1975
			YU	6575 A1	30-06-1982
US 3662173	A	09-05-1972	CA	929680 A1	03-07-1973
			FR	2065929 A5	06-08-1971