

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
10 September 2010 (10.09.2010)

(10) International Publication Number
WO 2010/102016 A4

- (51) International Patent Classification:
G01V 3/32 (2006.01) *G01V 3/18* (2006.01)
G01V 3/175 (2006.01) *G01V 3/15* (2006.01)
- (21) International Application Number:
PCT/US2010/026068
- (22) International Filing Date:
3 March 2010 (03.03.2010)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/156,966 3 March 2009 (03.03.2009) 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, 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, 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,

[Continued on next page]

(54) Title: ATOMIC MAGNETOMETERS FOR USE IN THE OIL SERVICE INDUSTRY

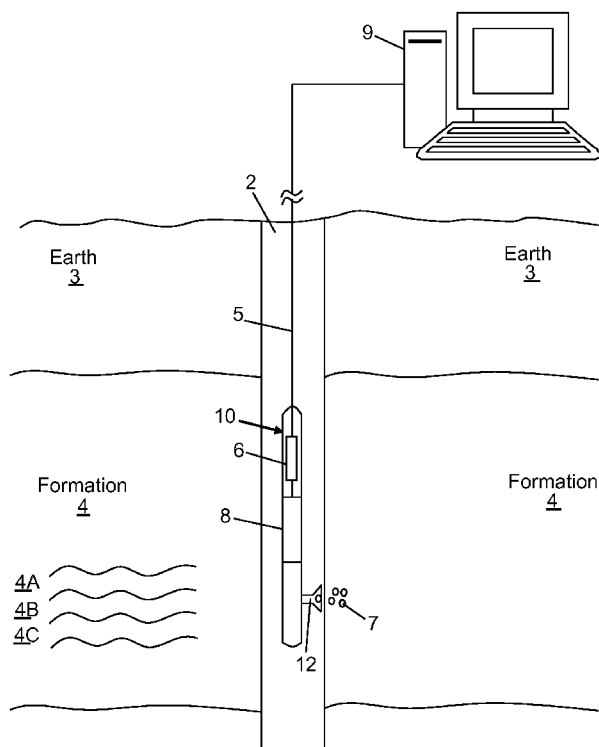


FIG. 1

(57) Abstract: An apparatus for obtaining information from a subterranean environment, the apparatus includes: an atomic magnetometer configured to measure a magnetic field related to the information. An associated method for obtaining the information is also disclosed.

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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))
- with amended claims (Art. 19(1))

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

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

13 January 2011

Date of publication of the amended claims:

3 March 2011

AMENDED CLAIMS

received by the International Bureau on 17 December 2010 (17.12.2010)

1. An apparatus for obtaining information from a subterranean environment penetrated by a borehole, the apparatus comprising:

- (a) a carrier configured to be conveyed through the borehole;
- (b) an atomic magnetometer disposed at the carrier and configured to measure a magnetic field related to the information; and
- (c) a device configured to be disposed in the borehole and to transmit energy comprising the information to the surface of the Earth, a measurement of the magnetic field being related to the transmitted energy.

2. The apparatus of claim 1, wherein the information comprises a property of an earth formation in the subterranean environment and the apparatus further comprises:

- (a) an instrument coupled to the atomic magnetometer, the instrument being configured to estimate the property using a magnetic field measurement performed by the atomic magnetometer.

3. The apparatus of claim 2, wherein the carrier comprises at least one selection from a group consisting of a logging tool, a wireline, a slickline, a drillstring and coiled tubing.

4. The apparatus of claim 1, wherein the atomic magnetometer is configured to measure precession of spins of electrons in the magnetic field to measure the magnetic field.

5. The apparatus of claim 4, wherein the electrons are part of an alkali-metal vapor disposed in a cell.

6. The apparatus of claim 5, further comprising an optical pumping laser configured to spin-polarize atoms of the vapor.

7. The apparatus of claim 6, further comprising a probe laser disposed substantially orthogonal to the optical pumping laser and configured to measure the precession of spins.

8. The apparatus of claim 7, further comprising a photodetector configured to receive light from the probe laser traversing the cell wherein a magnitude of the received light relates to a magnitude of the magnetic field being measured.

9. The apparatus of claim 8, further comprising a shield surrounding at least a portion of the cell and configured to shield the vapor from an external magnetic field.

10. The apparatus of claim 1, wherein the atomic magnetometer is fabricated as a micro-electro-mechanical system (MEMS) device.

11. An apparatus for obtaining information from a subterranean environment, the apparatus comprising:

an atomic magnetometer configured to measure a magnetic field related to the information;

wherein the information comprises navigational information for navigating the subterranean environment and the apparatus further comprises a carrier configured to convey the atomic magnetometer in a borehole penetrating the subterranean environment, the magnetic field being related to a position in the borehole.

12. The apparatus of claim 11, wherein the magnetic field is the Earth's magnetic field.

13. The apparatus of claim 11, further comprising a magnetic field source configured to consecutively apply a first bias magnetic field to the vapor, a second bias magnetic field orthogonal to the vapor orthogonal to the first magnetic field, and a third bias magnetic field to the vapor orthogonal to the first magnetic field and the second magnetic field to construct a three dimensional magnetic field vector measurement wherein the magnetic field vector is used to provide the navigation information.

14. (Canceled)

15. The apparatus of claim 1, further comprising another atomic magnetometer configured to be disposed in the borehole and to measure another magnetic field related to energy comprising other information transmitted from the surface of the Earth to the another atomic magnetometer.

16. A method for obtaining information from a subterranean environment penetrated by a borehole, the method comprising:

(a) conveying an atomic magnetometer to a location in the borehole to obtain the information;

(b) measuring a magnetic field using the atomic magnetometer wherein the magnetic field is related to the information; and

(c) transmitting energy comprising the information from a device disposed in the borehole to a surface of the Earth wherein a measurement of the magnetic field is related to the transmitted energy.

17. The method of claim 16, wherein the atomic magnetometer is conveyed by a carrier configured to be conveyed through the borehole.

18. The method of claim 17, wherein the information comprises a property of an earth formation in the subterranean environment.

19. (Canceled)

20. (Canceled)

21. The method of claim 18, wherein the property is obtained using an instrument coupled to the atomic magnetometer, the instrument being configured to estimate the property using a magnetic field measurement performed by the atomic magnetometer.

22. The method of claim 16, wherein the information comprises navigational information for navigating the subterranean environment, the magnetic field being related to a position in the borehole.