



(51) International Patent Classification:

G01 V3/08 (2006.01)

(21) International Application Number:

PCT/US20 12/065 126

(22) International Filing Date:

14 November 2012 (14.11.2012)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/559,696	14 November 2011 (14.11.2011)	US
61/561,809	18 November 2011 (18.11.2011)	US
61/614,829	23 March 2012 (23.03.2012)	US
13/676,989	14 November 2012 (14.11.2012)	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, BN, 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, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU,

[Continued on nextpage]

(54) Title: MULTI-FREQUENCY LOCATING SYSTEMS AND METHODS

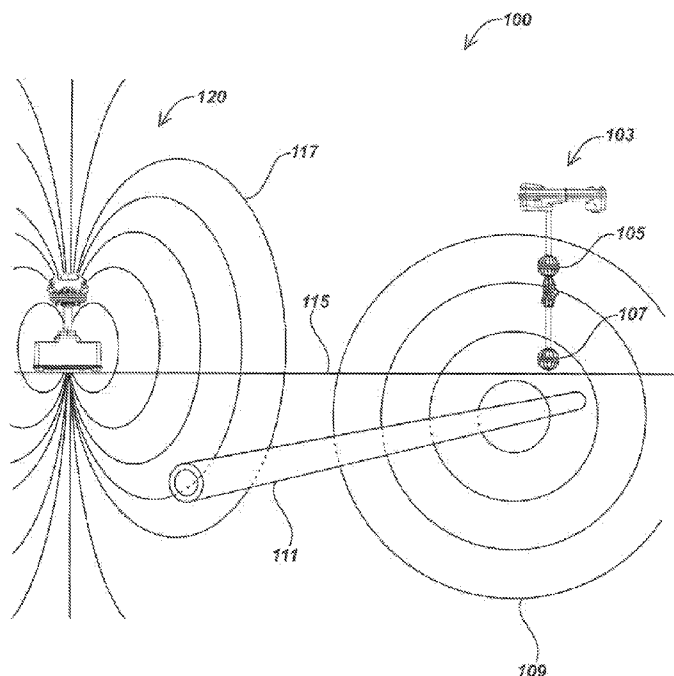


FIG. 1

(57) Abstract: Multi-frequency buried object location system transmitters and locators are disclosed. A transmitter may generate and provide output signals to a buried object at a plurality of frequencies, which may be selected based on a connection type. Corresponding locators may simultaneously receive a plurality of magnetic field signals emitted from the buried object and generate visual and/or audible output information based at least in part on the plurality of received magnetic field signals. The visual and/or audible output may be further based on signals received from a quad-gradient antenna array.

RW, 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 even-kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, **MW**, MZ, NA, RW, SD, SL, 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, 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:**

27 February 2014

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/065126

A. CLASSIFICATION OF SUBJECT MATTER INV. G01V3/08 ADD..		
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 practicable, 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 2006/284610 A1 (THOMPSON JEFF [GB] ET AL) 21 December 2006 (2006-12-21)	1
Y	paragraphs [0001], [0015], [0016], [0025], [0041], [0042], [0061]; figure 1	2-5, 10-15
Y	----- US 2008/136631 A1 (FLUCK FREDERICK DEAN [US]) 12 June 2008 (2008-06-12) abstract paragraphs [0002], [0006] - [0010] -----	2-5, 10-15
<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="display: flex; align-items: center;"> <input type="checkbox"/> Further documents are listed in the continuation of Box C. </div> <div style="display: flex; align-items: center;"> <input checked="" type="checkbox"/> See patent family annex. </div> </div>		
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"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</p> <p>"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</p> <p>"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</p> <p>"&" document member of the same patent family</p> </div> </div>		
Date of the actual completion of the international search <div style="text-align: center;">16 October 2013</div>	Date of mailing of the international search report <div style="text-align: center;">10/01/2014</div>	
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 <div style="text-align: center;">Vollmer, Thorsten</div>	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/065126

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. :
1-5 , 10-15

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: 1-5, 10-15

how to display information

2. claims: 6-9

processing of signals with a unique frequency

3. claims: 16-20

generating simultaneously signals with different frequencies
and retrieving magnetic signals

4. claims: 21-35, 100-106

timing of buried transmitters

5. claims: 36-41

processing signals based on timing information

6. claims: 42-46

transmitting of information through the underground

7. claims: 47-51, 76, 77

coupling of output signals to a buried object

8. claims: 52-59

generating of a buried object current

9. claims: 60-65

coupling of a buried object transmitter to the ground

10. claims: 66-75

estimating the depth of a buried object

11. claims: 78-95

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

generati ng output si gnal s wi th di fferent frequenci es

12. cl aims: 96-99

retri evi ng i nformati on based on the phases of si gnal s

13. cl aim: 107

buri ed object l ocator system wi th buri ed transmi tter and a
buri ed recei ver

14. cl aim: 108

buri ed object l ocator system wi th means for generati ng
output si gnal s

15. cl aims: 109, 111, 112, 115, 116

a buri ed object transmi tter

16. cl aims: 110, 113, 114, 117, 118

a buri ed object recei ver

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2012/065126

Patent document cited in search report			Publication date		Patent family member(s)			Publication date	
US	2006284610	AI	21-12-2006	CA	2613304	AI		28-12-2006	
				CN	101248372	A		20-08-2008	
				EP	1899749	AI		19-03-2008	
				GB	2427474	A		27-12-2006	
				JP	2008544273	A		04-12-2008	
				US	2006284610	AI		21-12-2006	
				Wo	2006136779	AI		28-12-2006	

US	2008136631	AI	12-06-2008	US	2008136631	AI		12-06-2008	
				US	2008284425	AI		20-11-2008	
