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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, PE, PG, PH, PL, PT, QA, RO, RS, RU, 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 every 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).

Declarations under Rule 4.17:

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

Published:

- with international search report (Art. 21(3))

[Continued on nextpage]

(54) **Title:** MAGNETIC FIELD SENSING ELEMENT COMBINING A CIRCULAR VERTICAL HALL MAGNETIC FIELD SENSING ELEMENT WITH A PLANAR HALL ELEMENT

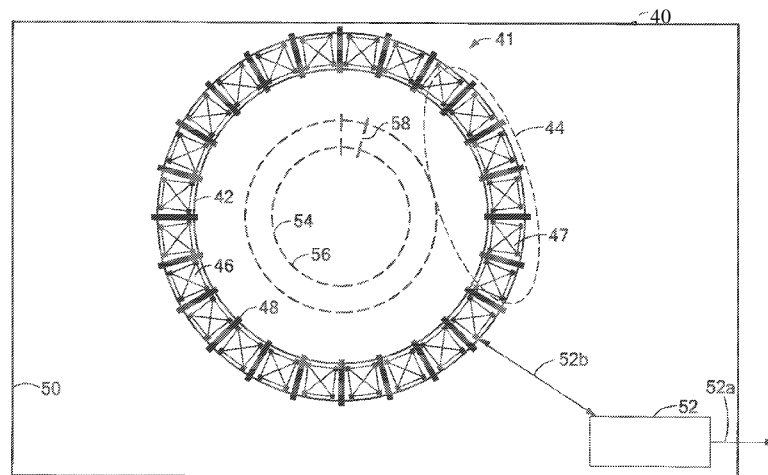


FIG. 2B

(57) **Abstract:** A magnetic field sensor (10;40) includes a circular vertical Hall (CVH) sensing element (12; 48) and at least one planar Hall element (18; 47). The CVH sensing element has contacts (14a,14b,14c,14d,14e) arranged over a common implant region (16;42) in a substrate (22;50). In some embodiments, the at least one planar Hall element is formed as a circular planar Hall (CPH) sensing element (46) also having contacts disposed over the common implant region (42). A CPH sensing element (46) and a method of fabricating the CPH sensing element are separately described



— 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))

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/050074

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01R33/02 G01R33/07
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)
G01R

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	EP 2 000 813 AI (ECOLE POLYTECH [CH]) 10 December 2008 (2008-12-10)	1
Y	figures 2,3,4,5	1-20
A	paragraph [0008] - paragraph [0024]	27,28, 30,31

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	paragraph [0010] - paragraph [0016] figures 1,4,9 , 11, 12	

	-/- .	

Further documents are listed in the continuation of Box C.

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 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

"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/050074

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PAVEL KEJI K ET AL: "Ultra low-power angular position sensor for high-speed portable applications", SENSORS, 2009 IEEE, IEEE, PISCATAWAY, NJ, USA, 25 October 2009 (2009-10-25), pages 173-176, XP031618610, ISBN: 978-1-4244-4548-6 the whole document	1-20
A	CHAVDAR ROUMENIN ET AL: "Vertical Hall Effect Devices in the Basis of Smart Silicon Sensors", THE THIRD WORKSHOP 2005 IEEE INTELLIGENT DATA ACQUISITION AND ADVANCED COMPUTING SYSTEMS: TECHNOLOGY AND APPLICATIONS, PROCEEDINGS OF, IEEE, PI, 1 September 2005 (2005-09-01), pages 55-58, XP031009280, ISBN: 978-0-7803-9445-2 the whole document	1-20
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A	KEJI K P ET AL: "Purely CMOS angular position sensor based on a new hall microchip", INDUSTRIAL ELECTRONICS, 2008. IECON 2008. 34TH ANNUAL CONFERENCE OF IEEE, IEEE, PISCATAWAY, NJ, USA, 10 November 2008 (2008-11-10), pages 1777-1781, XP031825685, ISBN: 978-1-4244-1767-4 the whole document	1-20
Y	EP 0 947 846 A2 (SENTRON AG [CH])	1-20
A	6 October 1999 (1999-10-06) paragraph [0008] - paragraph [0018] figures 1,2,3	27,28, 30,31
X	wo 01/18556 AI (FRAUNHOFER GES FORSCHUNG [DE]; HOHE HANS PETER [DE]; WEBER NORBERT [DE]) 15 March 2001 (2001-03-15) figure 3b page 6, line 7 - line 10 page 8, line 11 - page 10, line 13 page 11, line 13 - line 17 page 11, line 30 - page 12, last line	21-31
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/050074

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>wo 2009/030361 AI (FRAUNHOFER GES FORSCHUNG [DE] ; HOHE HANS-PETER [DE] ; HACKNER MICHAEL [] 12 March 2009 (2009-03-12) figures 5,6 page 2, line 13 - page 5, last line page 26, line 15 - page 27, line 13 -----</p>	21,28,29
A	<p>BURGER F ET AL: "New fully integrated 3-D silicon Hall sensor for precise angular-position measurements" , SENSORS AND ACTUATORS A, ELSEVIER SEQUOIA S.A. , LAUSANNE, CH, vol . 67, no. 1-3 , 15 May 1998 (1998-05-15) , pages 72-76, XP022713608, ISSN: 0924-4247 , DOI : 10.1016/50924-4247 (97)01750-0 [retrieved on 1998-05-15] abstract; figure 2 -----</p>	21-31

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2012/050074

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/05Q074

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.:

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: 1-20

magnetic field sensor for 3D measurements comprising vertical Hall elements arranged as circular vertical Hall structure and one planar Hall element generating a z output signal

2. claims: 3-31

magnetic field sensing arrangement comprising a plurality of planar Hall elements arranged as a circular planar Hall structure generating a plurality of z output signals
