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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, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, 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, RW, SA, SC,

(54) Title: RECEIVE OPERATION OF AN ULTRASONIC SENSOR

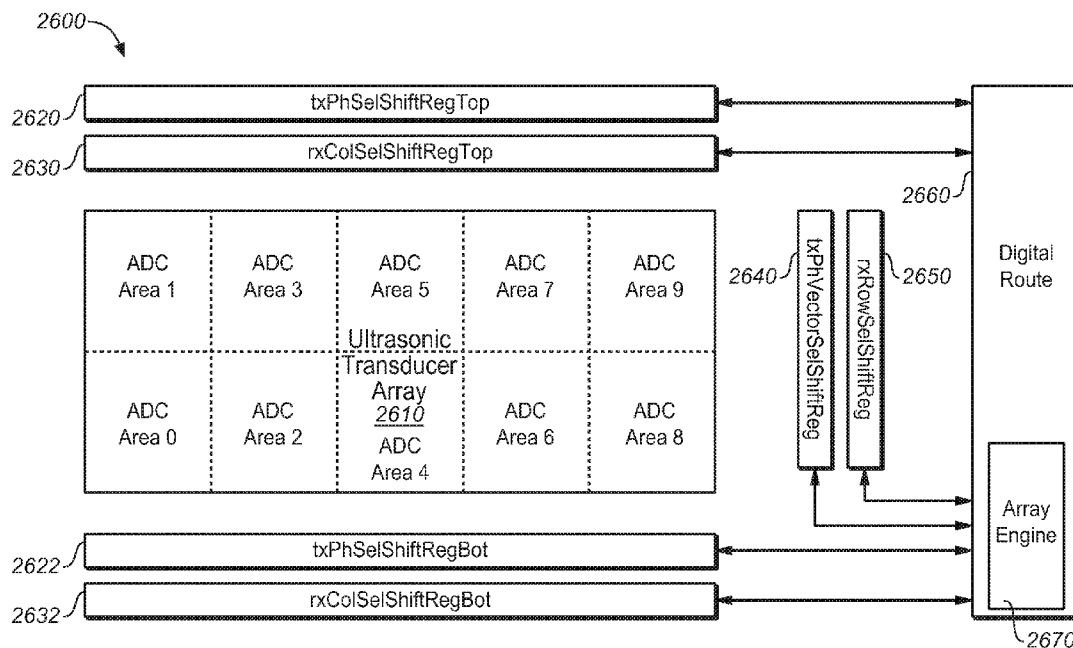


FIG. 26A

(57) Abstract: An ultrasonic sensor includes a two-dimensional array of ultrasonic transducers including a plurality of sub-arrays of ultrasonic transducers, wherein a sub-array of ultrasonic transducers of the plurality of sub-arrays of ultrasonic transducers is independently controllable, and wherein a sub-array of ultrasonic transducers has an associated receive channel. A plurality of shift registers is configured to select a receive pattern of ultrasonic transducers of the two-dimensional array of ultrasonic transducers to activate during a receive operation. An array controller is configured to control selection of the ultrasonic transducers during the receive operation according to the receive pattern and configured to shift a position of the receive pattern within the plurality of shift registers such that the ultrasonic transducers activated during the receive operation moves relative to and within the two-dimensional array of ultrasonic transducers.



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, ST, 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, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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:

05 April 2018 (05.04.2018)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/031826

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, 10-13, 18-20

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.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/031826

A. CLASSIFICATION OF SUBJECT MATTER
INV. G10K11/34 B06B1/06
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)
B06B G10K

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 2015/087991 A1 (CHEN KAILIANG [US] ET AL) 26 March 2015 (2015-03-26) | 1,2,4,5, 12,13, 18-20 |
| Y | abstract; claims 1-4; figures paragraphs [0002], [0003], [0061] - [0077], [0093] - [0098], [0112] - [0113] | 3 |
| X | US 2005/057284 A1 (WODNICKI ROBERT GIDEON [US]) 17 March 2005 (2005-03-17) | 1,2,4,5, 10,11, 13,19,20 |
| Y | abstract; figures paragraphs [0015], [0018], [0055] - [0118] | 3 |
| | ----- -/-- | |

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

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| Date of the actual completion of the international search 24 November 2017 | Date of mailing of the international search report 28/02/2018 |
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| 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 Scappazzoni, E |
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/031826

| C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | |
|--|--|-----------------------|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| Y | <p>US 2016/107194 A1 (PANCHAWAGH HRISHIKESH VIJAYKUMAR [US] ET AL) 21 April 2016 (2016-04-21) abstract; figures paragraphs [0003] - [0005], [0062] - [0074]</p> <p style="text-align: center;">-----</p> | 3 |
| Y | <p>US 2014/117812 A1 (HAJATI ARMAN [US]) 1 May 2014 (2014-05-01) abstract; figures paragraph [0046]</p> <p style="text-align: center;">-----</p> | 3 |

INTERNATIONAL SEARCH REPORT

Information on patent family members

| |
|---|
| International application No PCT/US2017/031826 |
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| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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| ----- | | | |

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, 10-13, 18-20

2D ultrasonic array with independently controllable sub-arrays having each an associated receive channel, shift registers to select active receiver transducers and a controller to decide on the selection and to shift a receiving aperture

1.1. claims: 2, 3

2D pmut ultrasonic array with independently controllable sub-arrays having each an associated receive channel, shift registers to select active receiver transducers and a controller to decide on the selection and to shift a receiving aperture

1.2. claims: 4, 5, 13, 19, 20

Details on the selection of the active receiver transducers by the shift registers

2. claims: 6-9, 14-17, 21-24

2D ultrasonic array with independently controllable sub-arrays having each an associated receive channel, shift registers to select active receiver transducers and a controller to decide on the selection and to shift a receiving aperture and to decide to which receive channel a specific received signal will go
