

# PATENT COOPERATION TREATY

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# PCT

WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY  
(PCT Rule 43*bis*.1)

To:

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Date of mailing  
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference  
see form PCT/ISA/220

**FOR FURTHER ACTION**  
See paragraph 2 below

International application No.  
PCT/EP2016/065440

International filing date (day/month/year)  
30.06.2016

Priority date (day/month/year)  
30.06.2015

International Patent Classification (IPC) or both national classification and IPC  
INV. B06B1/02 A61B8/00 G01N29/24

Applicant  
KONINKLIJKE PHILIPS N.V.

1. This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the international application
- Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:



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this opinion

see form  
PCT/ISA/210

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**Box No. I Basis of the opinion**

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1. With regard to the **language**, this opinion has been established on the basis of:
  - the international application in the language in which it was filed.
  - a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).
2.  This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))
3.  With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
  - a.  forming part of the international application as filed:
    - in the form of an Annex C/ST.25 text file.
    - on paper or in the form of an image file.
  - b.  furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
  - c.  furnished subsequent to the international filing date for the purposes of international search only:
    - in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
    - on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
4.  In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

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**Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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1. Statement

Novelty (N)	Yes: Claims	<u>1-15</u>
	No: Claims	

Inventive step (IS)	Yes: Claims	
	No: Claims	<u>1-15</u>

Industrial applicability (IA)	Yes: Claims	<u>1-15</u>
	No: Claims	

2. Citations and explanations

see separate sheet

**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1       References

Reference is made to the following documents:

- D1       US 2014/247698 A1 (DIRKSEN PETER [NL] ET AL) 4  
          September 2014 (2014-09-04)
- D2       WO 2015/086413 A1 (KONINKL PHILIPS NV [NL]) 18 June  
          2015 (2015-06-18)
- D3       US 2007/215964 A1 (KHURI-YAKUB BUTRUS [US] ET AL) 20  
          September 2007 (2007-09-20)
- D4       US 2010/207484 A1 (CHANG CHIENLIU [JP]) 19 August 2010  
          (2010-08-19)
- D5       WO 2015/044827 A1 (KONINKL PHILIPS NV [NL]) 2 April  
          2015 (2015-04-02)
- D6       US 2011/123043 A1 (FELBERER FRANZ [AT] ET AL) 26 May  
          2011 (2011-05-26)
- D7       YONGLI HUANG ET AL: "Capacitive micromachined ultrasonic  
          transducers with piston-shaped membranes: fabrication and  
          experimental characterization",  
          IEEE TRANSACTIONS ON ULTRASONICS,  
          FERROELECTRICS AND FREQUENCY CONTROL, IEEE,  
          US,  
          vol. 56, no. 1, 31 January 2009 (2009-01-31), pages 136-145,  
          XP011267411,  
          ISSN: 0885-3010, DOI: 10.1109/TUFFFC.2009.1013

D8 Rasim O. Guldiken: "DUAL-ELECTRODE CAPACITIVE MICROMACHINED ULTRASONIC TRANSDUCERS FOR MEDICAL ULTRASOUND APPLICATIONS",  
, 31 December 2008 (2008-12-31), XP055232285,  
Retrieved from the Internet:  
URL:[https://smartech.gatech.edu/bitstream/handle/1853/31806/guldiken\\_rasim\\_o\\_200812\\_phd.pdf](https://smartech.gatech.edu/bitstream/handle/1853/31806/guldiken_rasim_o_200812_phd.pdf)  
[retrieved on 2015-11-30]

2 Lack of novelty

2.1 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of **claim 1** does not involve an inventive step in the sense of Article 33(3) PCT.

Document D1 is regarded as being the prior art closest to the subject-matter of claim 1, and discloses an ultrasound system comprising:

a probe (par. 37) including an array of CMUT cells (par. 61), each cell comprising a substrate (12) carrying a first electrode (16) of an electrode arrangement, the substrate being spatially separated from a flexible membrane (14) including a second electrode (18) of said electrode arrangement by a gap (20), the flexible membrane comprising a mass element in a central region (30); and

a voltage supply coupled to said probe and adapted to, in a transmission mode of the ultrasound system (par. 41), provide the respective electrode arrangements of at least some of the CMUT cells with a voltage including:

a bias voltage component (par. 74);

a stimulus component (par. 41) having a set frequency for resonating the respective flexible membranes of the at least some of the CMUT cells in said collapsed state (par. 50),

wherein at least some of the CMUT cells are driven into a collapsed state in which a central part of the flexible membrane contacts the substrate, said central part including the central region (par. 40); and

the mass element of each of the at least some CMUT cells forces at least the central region of the flexible membrane of said cell to remain in contact with the substrate during said resonating (par. 55; the mass (30) forces the flexible membrane to remain in contact with the substrate both when the system is not operated and during resonating. Although in description it is stated that "*the mass element is not permanently attached to the floor of the cavity [so that] the flexible membrane may be released from the cavity upon reduction or removal of the bias voltage*", such essential feature is not claimed in claim 1).

The subject-matter of claim 1 therefore differs from this known system in that the bias voltage drives the CMUT cells into the collapsed state.

The problem to be solved by the present invention may therefore be regarded as to avoid the use of a stress layer to bring the membrane in collapsed state.

Document D1 describes two method of producing the CMUT cells. The two methods also describe how to drive the membrane into a collapsed state. Both the methods are based on a stress layer which, once sacrificial material is removed from below the membrane, pushes said membrane in contact with the substrate.

Nonetheless document D1 also mentions, in the background of the invention, as an usual method for collapsing the membrane, the use of a bias voltage (par. 7).

Said bias voltage is also described as present in the CMUT of D1 (par. 74).

The skilled person would therefore regard it as a normal option to revert to the classical method of applying a bias voltage to collapse the membrane when he wants to avoid the use of a supplementary stress layer.

Thus the solution proposed in claim 1 of the present application cannot be considered to involve an inventive step (Article 33(3) PCT).

- 2.2 Furthermore, even when said collapsed state is not to be intended as a permanent state of the CMUT, the subject-matter of **claim 1** does not involve an inventive step in the light of documents D2 and D3.

Document D2 is considered to be the prior art closest to the subject-matter of claim 1, and in so far as this claim can be understood, this document shows the following features thereof:

an ultrasound system comprising:

a probe including an array of CMUT cells (10), each cell comprising a substrate (112) carrying a first electrode (S2) of an electrode arrangement, the substrate being spatially separated from a flexible membrane (114) including a second electrode (S1) of said electrode arrangement by a gap (8), the flexible membrane comprising a mass element in a central region; and

a voltage supply (104, 105) coupled to said probe and adapted to, in a transmission mode of the ultrasound system, provide the respective electrode arrangements of at least some of the CMUT cells with a voltage including:

a bias voltage component driving the at least some of the CMUT cells into a collapsed state in which a central part of the flexible membrane contacts the substrate, said central part including the central region (page 8, lines 1 - 2); and

a stimulus component having a set frequency for resonating the respective flexible membranes of the at least some of the CMUT cells in said collapsed state (page 7, lines 20 -22).

The subject-matter of claim 1 therefore differs from this known system in that the flexible membrane comprises a mass element in a central region forcing at least the central region of the flexible membrane of said cell to remain in contact with the substrate during said resonating.

The problem to be solved by the present invention may therefore be regarded as to provide a proper contact region in collapsed state.

The solution proposed in claim 1 of the present application cannot be considered to involve an inventive step (Articles 33(3) PCT).

In prior art several documents describe the use of a mass element on a vibrating membrane of a CMUT, and any of these masses formed on the center of the membrane of a CMUT, would obtain the claimed effect of restraining the contact position, when the CMUT is brought in a collapsed state.

Particularly, Document D3 (see fig. 1a and par. 36) describes the placement of mass parts (120) on a central portion of a vibrating membrane (104) of a CMUT in order to modify the properties of the membrane.

Among these properties it is clearly cited the collapse voltage (claim 6), which implies that the CMUT transducer described in D3 is operated in collapsed state, as the CMUT of document D2.

The skilled person would therefore regard it as a normal option to include the mass described in document D3 to the CMUT described in D2 in order to solve the problem posed.

2.3 The same reasoning applies, *mutatis mutandis*, to the subject-matter of the corresponding independent **claim 11**, which therefore is also considered not inventive.

2.4 Dependent **claims 2 - 10, 12 - 15** do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT with respect to inventive step, for the following reasons.

claims 2, 12 see D2, page 7, lines 10 - 15;

claims 3, 15 see D2, page 8, lines 21 - 25;

claim 4 see D5, (56), (60);

claims 5, 6 see D1, par. 54;

claim 7 see D3, fig. 1a;

claim 8 see D3, par 36;

claim 9 see D4, fig. 4;

claim 10 see D2, page 1, line 14;

claims 13, 14 see D6, par. 33.