



- (51) **International Patent Classification:**
H03H 9/46 (2006.01) *H03H 7/01* (2006.01)
H03H 9/02 (2006.01) *H01P 7/06* (2006.01)
H01P 1/219 (2006.01)
- (21) **International Application Number:**
PCT/US2010/039374
- (22) **International Filing Date:**
21 June 2010 (21.06.2010)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
12/488,404 19 June 2009 (19.06.2009) 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, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, 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, 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(ii))
- 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))

[Continued on next page]

(54) **Title:** MEMS TUNABLE RESONATOR IN A CAVITY

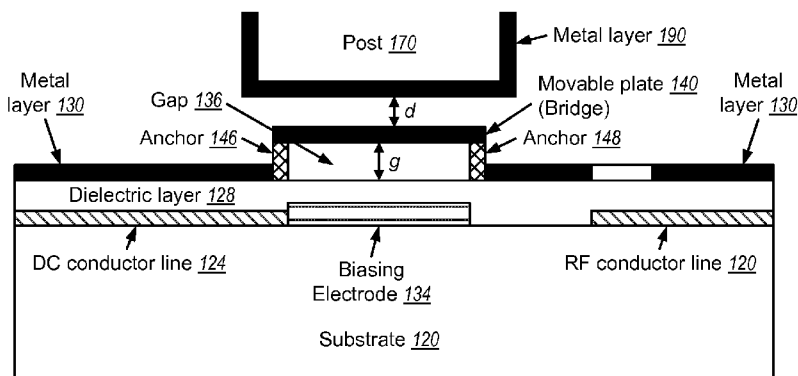


FIG. 6

(57) **Abstract:** Tunable MEMS resonators having adjustable resonance frequency and capable of handling large signals are described. In one exemplary design, a tunable MEMS resonator includes (i) a first part (160) having a cavity (180) and a post (170) and (ii) a second part (110) mated to the first part (160) and including a movable plate (140) located under the post (170). Each part may be covered with a metal layer (130, 190) on the surface facing the other part. The movable plate (140) may be mechanically moved by a DC voltage to vary the resonance frequency of the MEMS resonator. The cavity (180) may have a rectangular or circular shape and may be empty or filled with a dielectric material. The post (170) may be positioned in the middle of the cavity (180). The movable plate (140) may be attached to the second part (i) via an anchor (144) and operated as a cantilever or (ii) via two anchors (146, 148) and operated as a bridge.





— *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:
7 April 2011

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2010/039374

A. CLASSIFICATION OF SUBJECT MATTER		
INV.	H03H9/46 H03B5/12	H03H9/02 H01P1/219 H01P7/06 H03H7/01
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) H03H H01P H01H H03B		
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 practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 852 935 A1 (IMEC INTER UNI MICRO ELECTR [BE]) 7 November 2007 (2007-11-07)	1-3,6,7, 13,15, 20,21, 23,28
Y	paragraphs [0045] - [0051]; figure 6 -----	4,26
X	US 2008/252401 A1 (MARGOMENOS ALEXANDROS [US] ET AL) 16 October 2008 (2008-10-16)	1-3, 5-12,17, 20,21, 23,28
	paragraphs [0013] - [0017]; figure 1 -----	
X	EP 1 429 457 A2 (FORSCHUNGSZENTRUM JÜLICH GMBH) 16 June 2004 (2004-06-16)	1,5-8, 10,11, 20,21, 23,28
	paragraph [0029]; figure 4 -----	
	-/--	
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> 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 document 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		Date of mailing of the international search report
3 February 2011		16/02/2011
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 Naumann, Olaf

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2010/039374

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/170656 A1 (NASIRI STEVEN S [US] ET AL NASIRI STEVEN S [US] ET AL) 4 August 2005 (2005-08-04) paragraphs [0028] - [0031], [0 51], [0 52]; figures 1,2 -----	1,3,5-7, 14
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X	US 2008/116999 A1 (PARK EUN-SEOK [KR] ET AL) 22 May 2008 (2008-05-22) paragraphs [0042] - [0046], [0 50] - [0055]; figures 2-4 -----	1,2,6-8, 11,16, 17,20, 21,28
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A	EP 1 885 018 A1 (MATSUSHITA ELECTRIC IND CO LTD [JP] PANASONIC CORP [JP]) 6 February 2008 (2008-02-06) figures 1,215 -----	22
Y	WO 2004/084340 A1 (FILTRONIC LK OY [FI]; ALA-KOJOLA JOUNI [FI]) 30 September 2004 (2004-09-30) figures 7-9 -----	4
A		22
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Y		26
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A		26
X	US 7 095 295 B1 (STALFORD HAROLD L [US] ET AL) 22 August 2006 (2006-08-22) column 6, lines 8-15, 55-65; figures 1-4, 7, 8, 12 column 15, lines 3-5 -----	29,30
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/039374

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/025595 A1 (XU JI-HAI [US] ET AL XU JI-HAI [US] ET AL) 28 February 2002 (2002-02-28) figures 4-8	29,30
A	----- US 2006/056132 A1 (YOSHIDA KOICHI [JP] ET AL) 16 March 2006 (2006-03-16) paragraphs [0091], [0093] -----	18,19

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Information on patent family members

International application No PCT/US2010/039374

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2010/039374

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.:

1-21, 23, 28

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: 1-21, 23, 28

MEMS resonator with cavity, post, movable plate and particulars of geometry etc. and method for varying the resonance frequency with a DC voltage; implementation in a filter or wireless communication system. Solves the technical problem of implementing a MEMS resonator.

2. claim: 22

Tunable filter device with multiple MEMS resonators coupled together via inter-resonator coupling with a cavity and a movable plate (NB: without the feature of a post); solves the technical problem of improving performance, such as out-of-band attenuation, roll-off, higher Q (cf. fig. 9, 10).

3. claims: 24-27

Oscillator with amplifier, MEMS resonator, movable plate (NB: without the feature of a post), implementation including transistors coupled to the MEMS resonator. Solves the technical problem of providing a tunable oscillator (cf. fig. 14)

4. claims: 29, 30

Method for setting the resonance frequency of a MEMS resonator to a maximum resonance frequency and a minimum resonance frequency; solves the technical problem of shaping the tuning range of the resonance frequency of a MEMS resonator
