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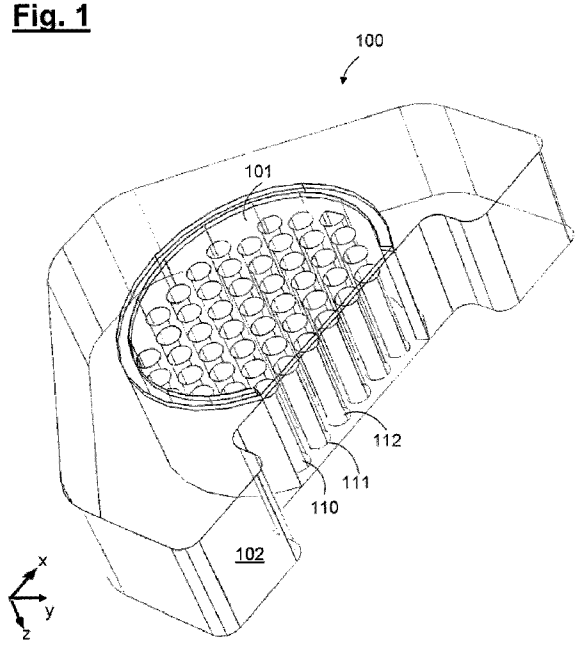
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— *of inventorship (Rule 4.17(iv))*

[Continued on next page]

(54) Title: ARRANGEMENT FOR THE THERMAL ACTUATION OF A MIRROR

Fig. 1



(57) Abstract: The invention concerns an arrangement for the thermal actuation of a mirror, in particular in a microlithographic projection exposure apparatus, the mirror having a mirror substrate (102, 202) and an optically effective surface (101, 201) and also at least one access channel (110, 111, 112, 210) extending from a surface of the mirror (100) not corresponding to the optically effective surface in the direction of this effective surface (101, 201),wherein a cooling element (120, 220)with a cooling power that can be set variably protrudes into the at least one access channel (110, 111, 112, 210), and wherein at least one heat source for coupling heating power that can be set variably into the region of the mirror substrate (102, 202) that is adjoining the optically effective surface is provided;wherein by setting the cooling power of the cooling element (120, 220)and the heating power of the at least one heat source, a thermal flux between the optically effective surface (101, 201) and said surface of the mirror (100) not corresponding to the optically effective surface is achievable, said thermal flux resulting in a temperature gradient and a related local variation of a value of the coefficient of thermal expansion in the mirror substrate (102, 202).

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2010/018753 A1 (NIPPON KOGAKU KK [JP]; SHIRAISHI MASAYUKI [JP]) 18 February 2010 (2010-02-18) cited in the application abstract figures 1,4 paragraphs [0001], [0009], [0010], [0048], [0058] -----	1-20
A	EP 1 376 192 A2 (NIPPON KOGAKU KK [JP]) 2 January 2004 (2004-01-02) abstract figures 1,4 paragraphs [0002], [0010] - [0012], [0025] - [0027] -----	1-27

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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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 2011/176121 A1 (LOOPSTRA ERIK ROELOF [NL] ET AL) 21 July 2011 (2011-07-21) abstract figures 1,4 paragraphs [0002], [0047] - [0053]	1-27
A	US 7 740 362 B1 (NEIL GEORGE R [US] ET AL) 22 June 2010 (2010-06-22) abstract figure 4 column 4, lines 37-55	1-27
A	WO 2009/026970 A1 (ZEISS CARL SMT AG [DE]; HAUF MARKUS [DE]; SCHOENHOFF ULRICH [DE]; TAYE) 5 March 2009 (2009-03-05) abstract figure 37	1-27
A	WO 2009/046955 A2 (ZEISS CARL SMT AG [DE]; HAUF MARKUS [DE]) 16 April 2009 (2009-04-16) cited in the application abstract figure 3 page 25, line 5 - page 26, line 27	1-27

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2014/054487

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2010018753 A1	18-02-2010	JP 2010045347 A	25-02-2010
		US 2010033704 A1	11-02-2010
		WO 2010018753 A1	18-02-2010
EP 1376192 A2	02-01-2004	EP 1376192 A2	02-01-2004
		US 2004036940 A1	26-02-2004
US 2011176121 A1	21-07-2011	JP 2011146703 A	28-07-2011
		US 2011176121 A1	21-07-2011
US 7740362 B1	22-06-2010	NONE	
WO 2009026970 A1	05-03-2009	CN 101784954 A	21-07-2010
		EP 2181357 A1	05-05-2010
		JP 2011520240 A	14-07-2011
		KR 20100067087 A	18-06-2010
		TW 200919111 A	01-05-2009
		US 2010201958 A1	12-08-2010
		WO 2009026970 A1	05-03-2009
WO 2009046955 A2	16-04-2009	CN 103299249 A	11-09-2013
		EP 2201435 A2	30-06-2010
		JP 5524067 B2	18-06-2014
		JP 2011512018 A	14-04-2011
		KR 20100075611 A	02-07-2010
		TW 200923594 A	01-06-2009
		US 2010200777 A1	12-08-2010
		US 2012026476 A1	02-02-2012
		US 2013088695 A1	11-04-2013
		US 2014098352 A1	10-04-2014
		WO 2009046955 A2	16-04-2009