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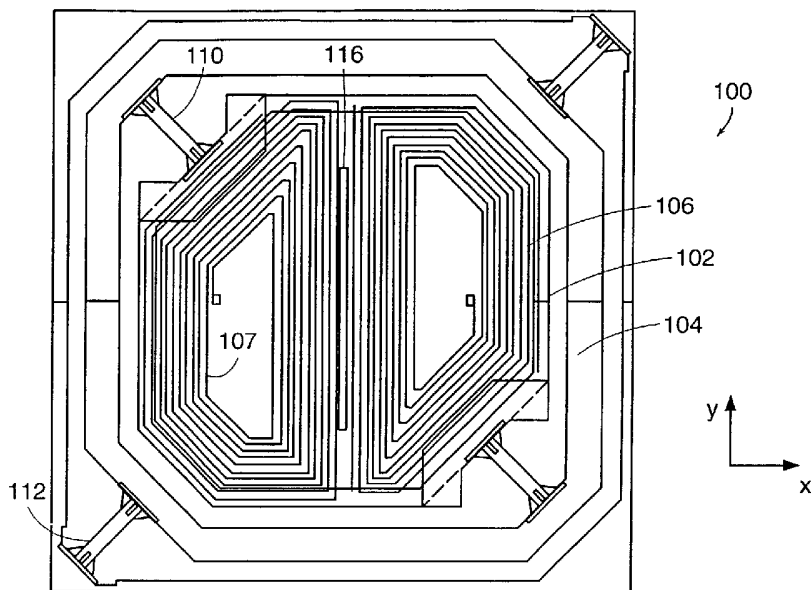
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Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv)) for US only

[Continued on next page]

(54) Title: MAGNETICALLY ACTUATED MICRO-ELECTRO-MECHANICAL APPARATUS AND METHOD OF MANUFACTURE



(57) Abstract: An array of magnetically actuated MEMS mirror devices (100) is provided having stationary magnets configured to provide strong magnetic fields in the plane of the mirrors without any magnets or magnet system components in the plane of the mirrors. Also, a magnetically actuated mirror device is provided that includes an improved actuation coil configuration (106, 107) that provides greater torque during mirror actuation. In addition, a mechanism is provided to detect the angular deflection of a moveable mirror. Also, an improved process is provided for manufacturing MEMS mirror devices.



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— *of inventorship (Rule 4.17(iv)) for US only*

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/26529

A. CLASSIFICATION OF SUBJECT MATTER IPC(7) :Please See Extra Sheet. US CL :Please See Extra Sheet. 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) U.S. : Please See Extra Sheet. Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched NONE Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Please See Extra Sheet.		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,421,381A (UEDA et al) 20 December 1983 (20/12/83), col. 2, 30 to col. 7, line 18.	1-45, 56-75
A	US 5,912,608 A (ASADA) 15 June 1999 (15/06/99), col. 2, line 50 to col. 6, line 17.	1-45, 56-75
A	US 5,648,618 A (NEUKERMANS et al) 15 July 1997 (15/07/97), col. 3, line 23 to col. 9, line 67.	1-45, 56-75
A	US 6,044,705 A (NEUKERMANS et al) 04 April 2000 (04/04/00), col. 7, line 17 to col. 23, line 48.	1-84
A	JP 60-107017 (TANABE et al) 12 June 1985 (12/06/85), pages 2-8, Figs. 1,2,4,5.	1-45, 56-75
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier document published on or after the international filing date	"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
"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)	"&"	document member of the same patent family
"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		
Date of the actual completion of the international search 15 FEBRUARY 2002	Date of mailing of the international search report 3 APRIL 2002	
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-7724	Authorized officer LOHA BEN <i>Deborah Perry Leeper</i> Telephone No. 703-308-4820 Paralegal Specialist Technology Center 2800	

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER: IPC (7):

GO2B 26/00, 26/02, 26/08; HO1F 7/08; HO2K 33/00, 5/16; GO1C 19/00; GO1L 3/00

A. CLASSIFICATION OF SUBJECT MATTER: US CL :

359/291, 295, 230, 214, 224, 298, 198; 335/222; 310/36, 90; 73/504.02, 862.08

B. FIELDS SEARCHED

Minimum documentation searched
Classification System: U.S.

359/291, 295, 230, 214, 224, 298, 198, 290, 292, 199, 196, 212, 223, 846, 972; 335/222, 223, 229; 310/36, 90, 309, 333; 73/504.02, 862.08, 504.12; 348/770, 771

B. FIELDS SEARCHED

Electronic data bases consulted (Name of data base and where practicable terms used):

WEST:(1) excit\$6 SAME (coil\$1 or circuit) and magnet\$6 SAME MEMS and (axis or axes) SAME MEMS. (2) coil\$1 NEAR6 pair\$1 SAME magnet\$6 and magnet\$6 SAME (MEMS or mirror\$1) and coil\$1 WITH opposi\$4 and silicon and angle\$1 and insulat\$3 and excit\$6 SAME (coil\$1 or circuit).

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING

This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I, claims 1-34, 42, 59-75 and 81-84, drawn to an array of electro-magnetically actuated MEMS devices, classified in class 359, subclass 224.

Group II, claims 35-41, 43-45 and 56-58, drawn to an apparatus and method for determining an angular deflection of a mirror, classified in class 359, subclass 230.

Group III, claims 46-50, 51-55 and 76-80, drawn to a method of fabricating a magnetically actuated mirror device, classified in class 359, subclass 291.

The inventions listed as Groups I, II and III do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: Patentability of each invention does not depend on patentability of other inventions. Each invention has acquired a separate status in the art because of their divergent subject matter as pointed out above.

INTERNATIONAL SEARCH REPORT

International application No.
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Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international 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 II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra 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 fee, this Authority did not invite payment of any additional fee.
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.

No protest accompanied the payment of additional search fees.