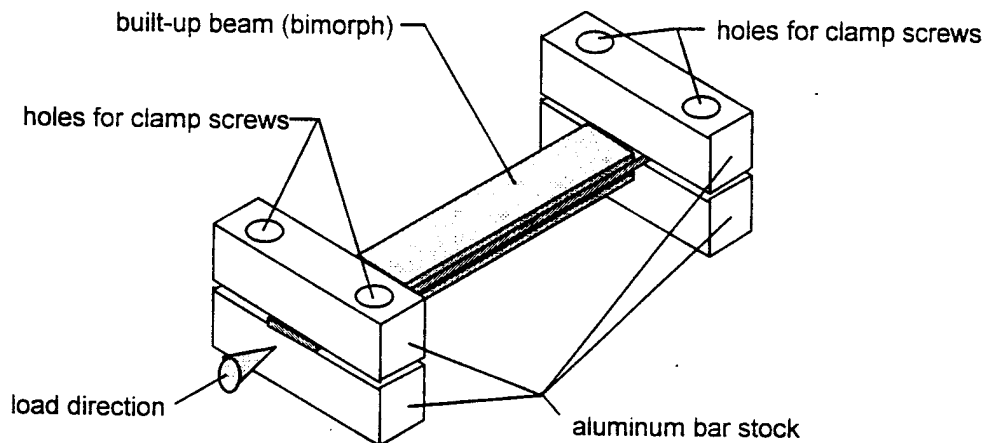




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H01L 41/08	A3	(11) International Publication Number: WO 98/45677 (43) International Publication Date: 15 October 1998 (15.10.98)
<p>(21) International Application Number: PCT/US98/03713</p> <p>(22) International Filing Date: 25 February 1998 (25.02.98)</p> <p>(30) Priority Data: 60/039,484 28 February 1997 (28.02.97) US</p> <p>(71) Applicant (for all designated States except US): THE PENN STATE RESEARCH FOUNDATION [US/US]; 304 Old Main, University Park, PA 16802 (US).</p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): LESIEUTRE, George, A. [US/US]; 2602 Acacia Drive, State College, PA 16803 (US). DAVIS, Christopher, L. [US/US]; 331 West College Avenue #24, State College, PA 16801 (US).</p> <p>(74) Agent: MONAHAN, Thomas, J.; The Pennsylvania State University, Intellectual Property Office, 113 Technology Center, University Park, PA 16802 (US).</p>	<p>(81) Designated States: BR, CA, JP, KR, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Published <i>With international search report.</i></p> <p>(88) Date of publication of the international search report: 7 January 1999 (07.01.99)</p>	

(54) Title: TRANSDUCER STRUCTURE WITH DIFFERING COUPLING COEFFICIENTS FEATURE



(57) Abstract

A coupling coefficient is a measure of the effectiveness with which a shape-changing material (or a device employing such a material) converts the energy in an imposed signal to useful mechanical energy. Device coupling coefficients are properties of the device and, although related to the material coupling coefficients, are generally different from them. This invention describes a class of devices wherein the apparent coupling coefficient can, in principle, approach 1.0, corresponding to perfect electromechanical energy conversion. The key feature of this class of devices is the use of destabilizing mechanical pre-loads to counter inherent stiffness. The approach is illustrated for piezoelectric and thermoelectrically actuated devices. The invention provides a way to simultaneously increase both displacement and force, distinguishing it from alternatives such as motion amplification, and allows transducer designers to achieve substantial performance gains for actuator and sensor devices.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/03713

A. CLASSIFICATION OF SUBJECT MATTER		
IPC(6) :HO1L 41/08 US CL :310/332, 348, 354 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. : 310/328, 330-332, 348, 353, 354		
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) U.S. PTO APS, WPIDS file on STN		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X/Y	US 5,284,058 A (JONES) 08 February 1994 (08/02/94) Fig. 3; claim 4; col. 3, ll. 11-21	1, 2, 4-6, 10, 11, 13, 14/9, 12, 14-20, 23, 24
X/Y	US 3,578,994 A (MASON) 18 May 1971 (18/05/71) Fig. 1; claim 2	1-3, 6-8/9, 12, 14, 17, 20
X/Y	US 4,494,409 A (KONDO) 22 January 1985 (22/01/85) Fig. 5; Abstract	1, 2, 10, 11, 15, 16, 21, 22/17, 19, 20, 23
X/Y	US 3,008,580 A (MASUDA) 16 April 1991 (16/04/91) Fig. 1, ll; col. 3, ll. 59-67	1-9, 15, 18-20/16,17
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* "A" "B" "L" "O" "P"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance earlier document published on or after the international filing date 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 referring to an oral disclosure, use, exhibition or other means document published prior to the international filing date but later than the priority date claimed	*T* "X" "Y" "&"
Date of the actual completion of the international search 14 SEPTEMBER 1998		Date of mailing of the international search report 30 OCT 1998
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230		Authorized officer Thomas M. Dougherty Telephone No. (703) 308-1628

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/03713

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 5-175569 A (KOIKE) 01 July 1993 (01/07/93) Fig. 1	12
A	US 5,677,485 A (NAKAMURA) 14 October 1978 (14/10/78) Fig. 2, col. 2, ll. 19-26	1-24
A	US 4,047,060 A (SCHAFFT) 06 September 1977 (06/09/77) Fig. 6; claim 1.	1-24
A,E	US 5,796,152 A (CARR ET AL.) 18 August 1998 (18/08/98) Fig. 10; col. 2, ll. 54-56; col. 2, line 65 to col. 3, line 13; claims 1, 2, 13	1-24
A,P	US 5,712,609 A (MEHREGANY) 27 January 1998 (27/01/98) Claim 2.	1-24
A	US 3,521,089 A (STETZER) 21 July 1970 (21/07/70) Figs. 1, 3	1-24
A	FR 1,123,132 A (ZELBSTEIN) 18 September 1956 (18/09/56) Fig. 2	1-24