

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
27 May 2004 (27.05.2004)

PCT

(10) International Publication Number  
WO 2004/044532 A3

(51) International Patent Classification<sup>7</sup>: G01F 1/74, 1/708, 1/712, 1/66

(21) International Application Number: PCT/US2003/036436

(22) International Filing Date: 12 November 2003 (12.11.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
60/425,436 12 November 2002 (12.11.2002) US  
60/426,724 15 November 2002 (15.11.2002) US

(71) Applicant: CIDRA CORPORATION [US/US]; 50 Barnes Park North, Wallingford, CT 06492 (US).

(72) Inventors: FERNALD, Mark, R.; 35 Tyler Road, Enfield, CT 06082 (US). DAVIS, Michael, A.; 172 Stevens Lane, Glastonbury, CT 06033 (US). KERSEY, Alan, D.; 75 Taylor Town Road, South Glastonbury, CT 06073 (US). GYSLING, Daniel, L.; 763 Chestnut Hill Road, Glastonbury, CT 06033 (US). BAILEY, Timothy, J.; 703 Maple Road, Longmeadow, MA 01106 (US).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

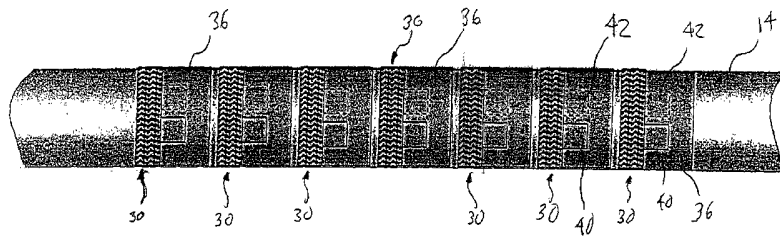
Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

(88) Date of publication of the international search report: 28 October 2004

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: AN APPARATUS HAVING AN ARRAY OF PIEZOELECTRIC FILM SENSORS FOR MEASURING PARAMETERS OF A PROCESS FLOW WITHIN A PIPE



(57) Abstract: A apparatus (10, 110, 170) is provided that measures the speed of sound and/or vortical disturbances propagating in a single phase fluid flow and/or multiphase mixture to determine parameters, such as mixture quality, particle size, vapor/mass ratio, liquid/vapor ratio, mass flow rate, enthalpy and volumetric flow rate of the flow in a pipe, by measuring acoustic and/or dynamic pressures. The apparatus includes a spatial array of unsteady pressure sensors (15-18) placed at predetermined axial locations  $x_1 - x_N$  disposed axially along the pipe (14). The pressure sensors (15-18) provide acoustic pressure signals  $P_1(t) - P_N(t)$  to a signal processing unit (30) which determines the speed of sound  $a_{mix}$  propagating through of the process flow (12) flowing in the pipe (14). The pressure sensors are piezoelectric film sensors that are mounted or clamped onto the outer surface of the pipe at the respective axial location.

WO 2004/044532 A3

**INTERNATIONAL SEARCH REPORT**

International Application No

PCT/US 03/36436

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 7 G01F1/74 G01F1/708 G01F1/712 G01F1/66

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)

IPC 7 G01F

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, PAJ, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 354 147 B1 (CIDRA CORP.) 12 March 2002 (2002-03-12) cited in the application abstract; figures 1,19,20,29,30 column 2, line 1 - line 11 column 2, line 59 - column 3, line 9 column 19, line 12 - line 40	1-11, 13-18, 21,24-27
Y	-----	12,19, 20,22,23
Y	US 5 357 486 A (PEARCE RICHARD E) 18 October 1994 (1994-10-18) abstract; figures 1-3 column 3 -----	12
	-/--	

Further documents are listed in the continuation of box C.

Patent family members are listed in 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.
- \*Z\* document member of the same patent family

Date of the actual completion of the international search

27 August 2004

Date of mailing of the international search report

02/09/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Vorropoulos, G

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 03/36436

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 01/02810 A (CIDRA CORP) 11 January 2001 (2001-01-11) abstract; figure 1 page 3, line 16 - line 21 page 7, line 8 - line 17 page 10, line 15 - line 26	19,20, 22,23
A	WO 00/60317 A (PANAMETRICS) 12 October 2000 (2000-10-12) abstract; figures 1,1A,1B	1
A	WO 93/14382 A (GUDMUNDSSON JON STEINAR) 22 July 1993 (1993-07-22) abstract; figure 3	1

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 03/36436

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6354147	B1	12-03-2002	
		AU 746996 B2	09-05-2002
		CA 2335457 A1	06-01-2000
		CN 1307675 T	08-08-2001
		EP 1090274 A1	11-04-2001
		NO 20006620 A	22-02-2001
		US 2002152802 A1	24-10-2002
		US 2002134144 A1	26-09-2002
		WO 0000793 A1	06-01-2000
		AU 4961699 A	17-01-2000
<hr/>			
US 5357486	A	18-10-1994	NONE
<hr/>			
WO 0102810	A	11-01-2001	
		AU 5770700 A	22-01-2001
		CA 2381891 A1	11-01-2001
		EP 1194745 A1	10-04-2002
		US 2002129662 A1	19-09-2002
		WO 0102810 A1	11-01-2001
		US 2002194932 A1	26-12-2002
<hr/>			
WO 0060317	A	12-10-2000	
		EP 1173733 A1	23-01-2002
		WO 0060317 A1	12-10-2000
		US 2003172743 A1	18-09-2003
		US 6626049 B1	30-09-2003
<hr/>			
WO 9314382	A	22-07-1993	
		NO 920155 A	14-07-1993
		WO 9314382 A1	22-07-1993