



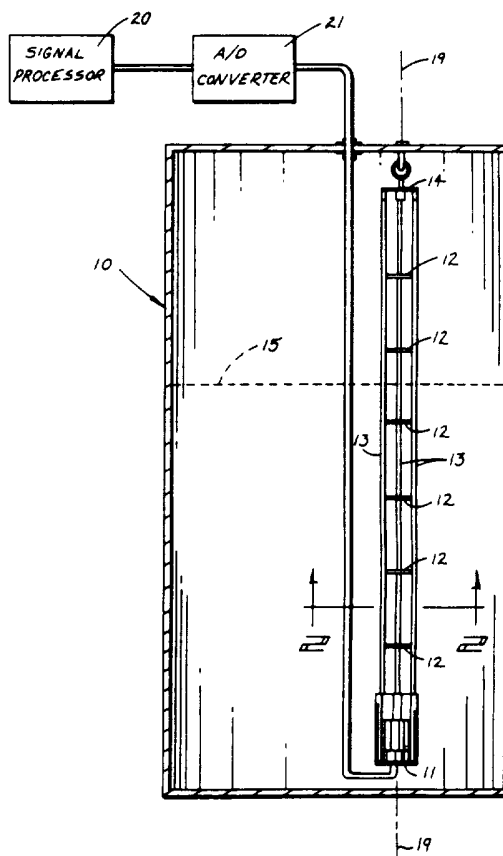
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification 5 : G01H 5/00, G01N 29/02, G01F 23/28</p>	<p>A3</p>	<p>(11) International Publication Number: WO 91/19191 (43) International Publication Date: 12 December 1991 (12.12.91)</p>
<p>(21) International Application Number: PCT/US91/03918 (22) International Filing Date: 4 June 1991 (04.06.91) (30) Priority data: 534,932 8 June 1990 (08.06.90) US (71) Applicant: CAMPBELL SCIENTIFIC, INC. [US/US]; P.O. Box 551, Logan, UT 84321 (US). (72) Inventors: CAMPBELL, Eric ; P.O. Box 551, Logan, UT 84321 (US). CAMPBELL, Gaylon ; NW 800 Fisk, Pull- man, WA 99163 (US). NORTON, Jeff ; HEERS, Art ; P.O. Box 551, Logan, UT 84321 (US). (74) Agents: ST. JOHN, Richard, J. et al.; W. 601 Main Ave- nue, Suite 815, Spokane, WA 99201-0679 (US).</p>	<p>(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (Eu- ropean patent), JP, KP, KR, LK, LU, LU (European pa- tent), MC, MG, ML (OAPI patent), MN, MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent).</p> <p>Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p> <p>(88) Date of publication of the international search report: 19 March 1992 (19.03.92)</p>	

(54) Title: MULTI-LEVEL PROBE AND SYSTEM FOR MEASUREMENT OF PHYSICAL CONDITIONS IN LIQUID-CONTAINING TANKS

(57) Abstract

A multi-level probe for sonic range measurements utilizes a plurality of parallel reflectors that each include an opening arranged coaxially about a beam of ultrasonic energy transmitted along a reference axis from an associated transducer. The opening in each reflector permits most of the sonic energy to pass to a subsequent reflective surface, while the periphery about the opening provides echo signals for determining physical conditions in the environment through which the sonic energy has passed. A novel system is used for determining physical conditions that are a function of time differences between signals from different reflectors, calculated with a highly efficient digital signal processing algorithm.



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⁺ Any designation of "SU" has effect in the Russian Federation. It is not yet known whether any such designation has effect in other States of the former Soviet Union.

INTERNATIONAL SEARCH REPORT

International Application No **PCT/US 91/03918**

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl. 5	G 01 H 5/00	G 01 N 29/02 G 01 F 23/28
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int. Cl. 5	G 01 H	G 01 N G 01 F
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
P, Y	EP, A, 0384373 (ERIKSSON) 29 August 1990, see the whole document ---	1, 5, 14, 24
Y	EP, A, 0106677 (GILBARCO INC.) 25 April 1984, see claims; figures (cited in the application) ---	1, 5, 14, 24
A	US, A, 3636754 (LYNNWORTH et al.) 25 January 1972, see abstract; figures ---	1, 5, 14, 24
A	EP, A, 0115987 (ELF FRANCE) 15 August 1984, see abstract ---	1, 5, 14, 24
A	US, A, 3214974 (ALTMAN et al.) 2 November 1965, see the whole document (cited in the application) ---	1, 5, 14, 24
	-/-	
<p>¹⁰ Special categories of cited documents:</p> <ul style="list-style-type: none"> "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 in order 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 "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 		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
02-12-1991	13 JAN 1992	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	Mme N. KUIPER	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	GB,A,2167185 (T.E. EVANS et al.) 21 May 1986, see abstract; figures 1,5 ---	1,5,14, 24
A,P	EP,A,0406915 (MATSUSHITA EL. IND. CO.) 9 January 1991, see page 6, line 7 - page 7, line 40; figure 2 ---	26,29, 30,33
A	REVIEW OF SCIENTIFIC INSTRUMENTS, vol. 56, no. 6, June 1985, (Woodbury, NY, US), P.J. KORTBEEK et al.: "Apparatus for sound velocity measurements in gases up to 10 kbar; Experimental data for argon", pages 1269-1273 -----	26

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

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V. OBSERVATION WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹

This International search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claim numbers _____ because they relate to subject matter not required to be searched by this Authority, namely: _____

2. Claim numbers _____ 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. Claim numbers _____ because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ²

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

1. Claims 1-25
2. Claims 26-33

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims: _____
3. 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 claim numbers: _____
4. As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- The additional search fees were accompanied by applicant's protest.
- No protest accompanied the payment of additional search fees.