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(54) Phased array ultrasonic inspection method for industrial applications

(57) A method for inspecting a component (10) includes exciting a number of transducers (12) forming an array (14) to produce an ultrasonic transmission beam (beam) focused into the component. The array and the component are separated by a standoff (18). A number of echo signals are generated using the transducers, and the echo signals are processed in a number of channels. The processing includes both dynamical focus and providing a dynamic aperture (24) on receive, both of which compensate for refraction of the beam at the component/standoff interface. A single-turn inspection method includes: (a) positioning the array facing the component, (b) exciting the transducers, (c) generating a number of echo signals, (d) changing the relative angular orientation of the array and the component around an axis (26) and repeating steps (b) and (c), and (e) processing the echo signals to form at least one processed echo signal.

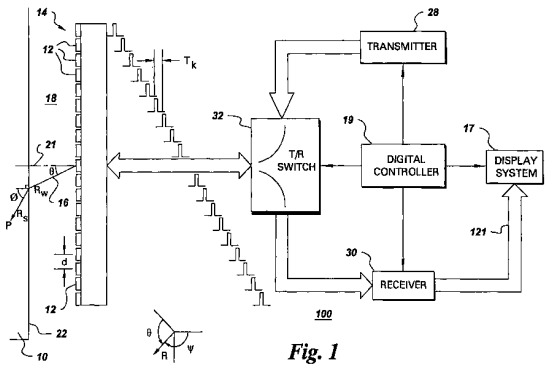

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 03 25 5786

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	US 4 471 785 A (RAMSEY JR S DAVID ET AL) 18 September 1984 (1984-09-18)	1	G01N29/06 G01N29/26
A	* abstract; claims 1-5; figures 1A,2,3,5, * * column 1, line 22 - column 8, line 38 *	2	G01S15/89
D,Y	US 4 180 791 A (TIEMANN JEROME J) 25 December 1979 (1979-12-25)	1	
A	* abstract; claim 1; figures 1-4 * * column 1, line 66 - column 5, line 35 *	2	
A	EP 1 043 584 A (NIPPON KOKAN KK) 11 October 2000 (2000-10-11) * abstract; claims 1,4; figure 1 * * column 1, line 5 - column 7, line 40 *	1,2	
A	US 4 317 369 A (JOHNSON STEVEN A) 2 March 1982 (1982-03-02) * abstract; figures 1,2,5 * * column 1, line 11 - column 6, line 60 *	1,2	
A	US 5 052 394 A (CARPENTER DAVID A ET AL) 1 October 1991 (1991-10-01) * the whole document *	1,2	TECHNICAL FIELDS SEARCHED (Int.Cl.7) G01N G01S
T	"GE LOGIQ 9" SOUND TECHNOLOGIES, [Online] XP002263270 Retrieved from the Internet: <URL:www.soundvet.com/Pages/US/GE_L9.html www.soundvet.com/Pages/US/GE_L9.html> [retrieved on 2003-11-28]	1,2	

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	28 November 2003	Uttenthaler, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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Application Number
EP 03 25 5786

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1,2

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LACK OF UNITY OF INVENTION SHEET B

Application Number
EP 03 25 5786

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1,2

   Method of inspecting a component using an ultrasonic phased array with dynamic focusing and aperture control and compensation for refraction of the ultrasonic transmission beam at the object interface.

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2. claims: 3,4

   Method of inspecting a component by a separate excitation signal pulse to each of the transducers in an array to steer the ultrasonic transmission beam along a selected ray path at a certain angle relative to the surface of the inspected object and adjusting the steering by transmit delay compensation of refraction of the beam at the object interface.

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3. claim: 5

   Method of inspecting a component using an ultrasonic phased array along a curved surface of a component across a standoff with compensation for a surface geometry effect on the ultrasonic transmission beam.

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4. claims: 6,7

   Single-turn method of inspecting a component by positioning an ultrasonic transducer array and changing the relative angular orientation of the array and the component around an axis.

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5. claim: 8

   Method of inspecting a product flow through a pipe using an ultrasonic transducer array by determing Doppler frequency shifts.

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6. claim: 9

   Method of inspecting a component by simultaneously exciting a first set of transducers in an array and by processing the echo signals to form a set of beam form image data.

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7. claim: 10

European Patent Office

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 03 25 5786

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

Method of inspecting a component using a single array of transducers by exciting a transmit set of transducers and producing an ultrasonic transmission beam at an angle relative to the surface and receiving the echoes with a receive set of transducers and by processing the echo signals to form a set of beam form image data.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 03 25 5786

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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28-11-2003

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

专利名称(译)	用于工业应用的相控阵超声波检测方法		
公开(公告)号	EP1398627A3	公开(公告)日	2004-04-07
申请号	EP2003255786	申请日	2003-09-16
[标]申请(专利权)人(译)	通用电气公司		
申请(专利权)人(译)	通用电气公司		
当前申请(专利权)人(译)	通用电气公司		
[标]发明人	BATZINGER THOMAS JAMES GILMORE ROBERT SNEE LI WEI NIETERS EDWARD JAMES HATFIELD WILLIAM THOMAS KLAASSEN RICHARD EUGENE BARSHINGER JAMES NORMAN HAIDER BRUNO HANS CHALEK CARL LAWRENCE MCEILLIGOTT ROBERT JOHN FRANKLIN DAVID CHARLES		
发明人	BATZINGER, THOMAS JAMES GILMORE, ROBERT SNEE LI, WEI NIETERS, EDWARD JAMES HATFIELD, WILLIAM THOMAS KLAASSEN RICHARD, EUGENE BARSHINGER, JAMES NORMAN HAIDER, BRUNO HANS CHALEK, CARL LAWRENCE MCEILLIGOTT, ROBERT JOHN FRANKLIN, DAVID CHARLES		
IPC分类号	A61B8/00 G01N29/04 G01N29/06 G01N29/26 G01N29/32 G01N29/34 G01N29/38 G01N29/44 G01S7/523 G01S15/89 G10K11/34 G01S7/52		
CPC分类号	G01N29/4436 G01N29/069 G01N29/262 G01N29/32 G01N29/341 G01N29/38 G01N2291/011 G01N2291/02836 G01N2291/044 G01N2291/048 G01N2291/106 G01S15/8913 G01S15/8918 G01S15/8925 G01S15/894 G01S15/8979 G10K11/346		
优先权	10/244637 2002-09-16 US		
其他公开文献	EP1398627B1 EP1398627A2		
外部链接	Espacenet		

摘要(译)

一种用于检查部件（10）的方法包括激励形成阵列（14）的多个换能器（12），以产生聚焦到该部件中的超声波发射束（束）。阵列和组件由支座（18）分开。使用换能器产生许多回波信号，并且在多个通道中处理回波信号。该处理包括动态聚焦和在接收时提供动态光圈（24），两者都补偿光束在元件/支座接口处的折射。单匝检查方法包括：（a）使阵列面向组件定位，（b）激励换能器，（c）产生多个回波信号，（d）改变阵列和周围组件的相对角度方向轴（26）和重复步骤（b）和（c），以及（e）处理回波信号以形成至少一个处理后的回波信号。

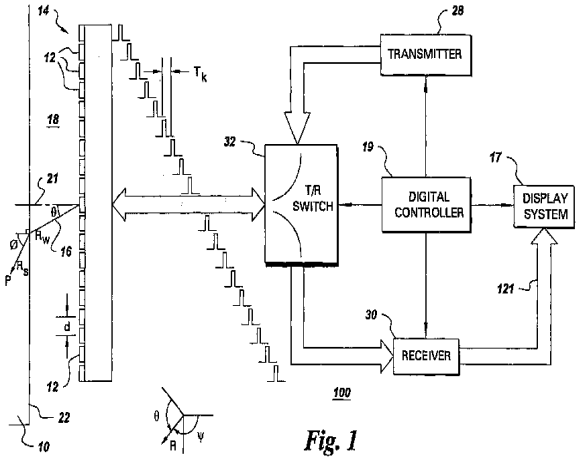
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Fig. 1