



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification 4 : G01B 7/14, 7/30, G08C 19/06 G08C 19/12, G05D 3/00, H01F 21/00 H03B 28/00, H03C 3/00</p>	A3	<p>(11) International Publication Number: <b>WO 88/ 09479</b> (43) International Publication Date: 1 December 1988 (01.12.88)</p>
<p>(21) International Application Number: PCT/US88/01768 (22) International Filing Date: 26 May 1988 (26.05.88) (31) Priority Application Numbers: 055,422 175,760 (32) Priority Dates: 28 May 1987 (28.05.87) 31 March 1988 (31.03.88) (33) Priority Country: US (71)(72) Applicant and Inventor: AUCHTERLONIE, Richard, C. [US/US]; 5701 N. Sheridan #29-q, Chicago, IL 60660 (US). (81) Designated States: AT (European patent), AU, BE (European patent), BR, CH (European patent), DE, DE (European patent), FR (European patent), GB, GB (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), SE (European patent).</p>		<p><b>Published</b> <i>With international search report. 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: 15 December 1988 (15.12.88)</p>
<p>(54) Title: ABSOLUTE POSITION SENSOR USING MULTIPLE WAVELENGTHS OF OFFSET PITCH PHASE PATTERNS</p>		
<p>(57) Abstract</p> <p>For enabling a resolver (120) to have absolute position sensing over a wide displacement range while still obtaining the resolution, accuracy and precision obtainable by operation in an incremental mode, the resolver is provided with a number of terminals (<math>\phi_1</math>, <math>\phi_1</math>, <math>\phi_2</math>, <math>\phi_2</math>) for providing offset pitch phase indications (<math>C_1</math>, <math>C_2</math>) as a function of position. a microcomputer (171) is programmed to execute a decoding procedure (160) for reading the offset pitch phase indications and from them computing the absolute position. This method is applicable to linear as well as rotary position sensing. By using multiplexing, digital signal processing and large-scale circuit integration (170) for interfacing the resolver (120) to the microcomputer (171), the method can achieve absolute position sensing with high reliability and low cost. The offset pitch phase indications are readily provided by inductive coupling between a multiplicity of windings (123, 124, 125, 126, 127), including a set of offset pitch windings (124, 125, 126, 127) connected to the terminals. A phase indicating signal is picked up using either a relatively moving pick-up device (50, 51, 52) or a stationary coil (123) linked by a ferromagnetic core (121). A radio-frequency powered modulator (409) is provided for wireless transmission of the phase indicating signal from the moving pick-up device. The offset pitch windings are formed by photolithography on a plurality of laminations or layers (<math>W_1</math>-<math>W_4</math>), or by winding coils in proper registration, for example, on a multi-layer, multi-pitch coil form (530).</p>		

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# INTERNATIONAL SEARCH REPORT

International Application No. **PCT/US88/01768**

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC IPC(4): G01B 7/14; G01B 7/30; G08C 19/06; G08C 19/12; G05D 3/00; H01F 21/00; H03C 3/00; H03B 28/00 <span style="float: right;">Cont'd</span>		
II. FIELDS SEARCHED		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
US	324/207, 208; 318/657-661; 331/179; 332/16R, 16T, 21-24; 336/45, 115, 121-123, 129, 130, 136; 340/870.18, 870.31-870.36	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup>		
Category *	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	US, A, 3,441,888, FARRAND, 29 April 1969 See col. 4, lines 23-62.	1-4, 10, 11, 16-21
Y	US, A, 4,005,396, FUJIWARA ET AL, 25 January 1977 Note col. 3, lines 25-49.	1-4, 10, 11, 16-21
Y	JP, A, 58-26204, HATSUTA, 16 February 1983 See abstract.	1-4, 10, 11, 16-21
Y	SU, A, 817,738, ALKIN, 30 March 1981 See abstract.	1-4, 10, 11, 16-21
Y	US, A, 3,223,889, SCHWEITZER, 14 December 1965 See col. 5, lines 25-65.	5-9
Y	US, A, 3,428,896 SCHWEITZER, 18 February 1969 See col. 4, lines 9-25.	5-9
A	US, A, 4,001,798, ROBINSON, 04 January 1977	
A	US, A, 3,473,100, ANGER, 14 October 1969	
A	US, A, 4,403,218, BEAL ET AL, 06 September 1983	
A	US, A, 4,297,698, PAUWELS ET AL, 27 October 1981	
A	US, A, 4,134,065, BAUER ET AL, 09 January 1979	
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>* Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"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</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"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.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
01 November 1988	<b>21 NOV 1988</b>	
International Searching Authority	Signature of Authorized Officer	
ISA/US	Gerard R. Strecker	

Classification of Subject Matter (Cont'd)

U.S. Cl. 324/207, 208; 336/45, 115, 136; 318/660;  
331/179; 340/870.18, 870.32

## FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V.  OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE <sup>1</sup>

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 <sup>12</sup> 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 <sup>13</sup>; specifically:

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

VI.  OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING <sup>2</sup>

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

I. Claims 1-4 and 6-23, drawn to a method and apparatus for position sensing; Class 324, subclass 207.

II. Claims 5-9, drawn to a position sensor and transmitter circuit; Class 340, subclass 870.31

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. Telephone Practice

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.

The invention as defined by Group I (claims 1-4 and 10-23) is drawn to an apparatus and method for sensing position which is classified in Class 324, subclass 207, whereas the invention defined by Group II (claims 5-9) is drawn to a position sensor with transmitter circuit, classified in Class 340, subclass 870.31. The Group I position sensor apparatus claims constitute a subcombination of the position sensor and transmitter circuit of Group II, however the combination of Group II does not require the particulars of the Group I subcombination for its patentability.