



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) **EP 1 076 155 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**14.02.2001 Bulletin 2001/07**

(51) Int Cl.7: **E21B 47/09, E21B 47/024**

(21) Application number: **99306279.3**

(22) Date of filing: **09.08.1999**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE**  
Designated Extension States:  
**AL LT LV MK RO SI**

(71) Applicant: **SHELL INTERNATIONALE RESEARCH  
MAATSCHAPPIJ B.V.**  
**2596 HR Den Haag (NL)**

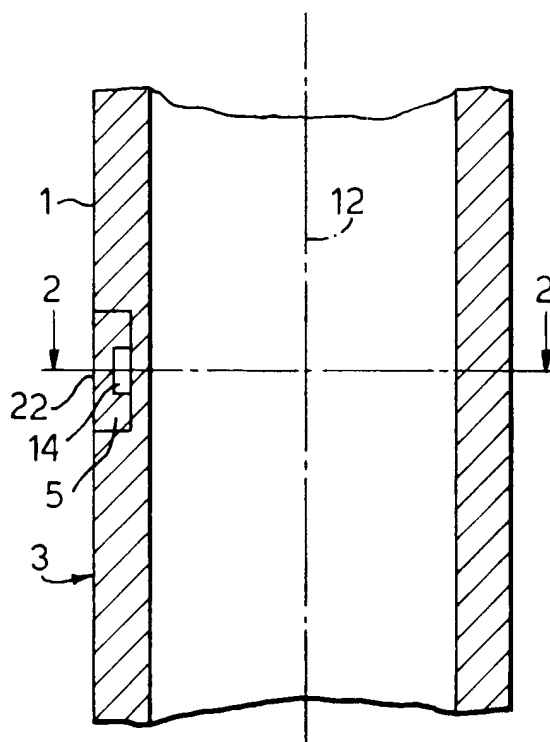
(72) Inventor: **Heijnen, Wilhelmus Hubertus Paulus  
Maria**  
**29336 Nienhagen (DE)**

(54) **Coding system for use in a wellbore**

(57) A coding system for use in a wellbore formed in an earth formation is provided. The system comprises a tubular conduit (3) extending in the wellbore and being provided with at least one transmitter array, each transmitter array being arranged at a selected wellbore location and including at least one transmitter arranged in a

selected pattern representative for said location. Each transmitter induces a field selected from a magnetic field and an electromagnetic field into the interior of the conduit. Further is provided a sensor (30) suitable to be lowered through the conduit and to interact with each field, and means for generating a signal representative of the interaction of the sensor with each field.

**Fig.1.**



## Description

**[0001]** The present invention relates to a coding system for use in a wellbore formed in an earth formation. It is common practice to lower wellbore tools or equipment through a conduit extending into the wellbore for a variety of purposes, the conduit being, for example a wellbore casing extending from surface to a reservoir zone of the earth formation. The tools or equipment generally are to be lowered to a selected depth at which a dedicated function is to be performed, e.g. drilling of a branch borehole, setting of packers, etc. In case of a multilateral wellbore having a main wellbore and one or more branch wellbores, selective access to the branch wellbores is generally required, implying that identification of the position of the connections of the branch wellbores to the main wellbore is required. In each such application it is important that the tool or equipment is accurately positioned at the required depth. One way of identifying a selected wellbore depth is to provide dimensional changes to the casing at the selected depth, for example a section of reduced diameter through which a specific wellbore component cannot pass. However, such diameter changes reduce the wellbore diameter. In case of a multilateral wellbore the change of diameter at each branch connection results in a wellbore having a lower part of unacceptably diameter reduction.

**[0002]** It is an object of the invention to provide an adequate coding system for use in a wellbore, which overcomes the problems inherent to coding by dimensional changes.

**[0003]** In accordance with the invention there is provided a coding system for use in a wellbore formed in an earth formation, comprising a tubular conduit extending in the wellbore and being provided with at least one transmitter array, each transmitter array being arranged at a selected wellbore location and including at least one transmitter arranged in a selected pattern representative for said location, each transmitter inducing a field selected from a magnetic field and an electromagnetic field into the interior of the conduit, a sensor suitable to be lowered through the conduit and to interact with each field, and means for generating a signal representative of the interaction of the sensor with each field.

**[0004]** The transmitters are arranged in a pattern unique to the location of the array, therefore the induced fields form a pattern of fields also unique to the location. Since the sensor interacts with each field, the interaction of the sensor with the pattern of fields, and the produced signal, also are unique to the location so that the array pattern can be identified. The depth location is then inferred from the unique relationship between the array pattern and the depth location.

**[0005]** In a preferred embodiment the wellbore is a multilateral wellbore including a main wellbore and at least one branch wellbore extending from a branch point of the main wellbore, said transmitter array being located substantially at said branch point. The depth location

of the branch points can thereby be inferred without the need for dimensional changes at the branch points. The invention will be described hereinafter in more detail and by way of example with reference to the accompanying drawings in which:

Fig. 1 schematically shows a longitudinal cross-section of a wellbore casing applied in an embodiment of the coding system of the invention;

Fig. 2 schematically shows cross-section 2-2 of Fig. 1;

Fig. 3 schematically shows a longitudinal side view of a sensor tool applied in the embodiment relating to Fig. 1; and

Fig. 4 schematically shows cross-section 4-4 of Fig. 3.

**[0006]** Referring to Figs. 1 and 2 there is shown a section 1 of a tubular wellbore casing 3 extending in a wellbore (not shown) formed in an earth formation (not shown). The casing section 1 is made of non-magnetic metal, for example ..... The outer surface of the casing section 1 is provided with four recesses 5, 7, 9, 11 arranged at substantially equal depth and at selected mutual angular intervals  $\alpha_1, \alpha_2, \alpha_3, \alpha_4$  relative to the longitudinal axis 12 of the casing 3. The intervals  $\alpha_1, \alpha_2, \alpha_3, \alpha_4$  are uniquely related to said depth. The recesses 5, 7, 9, 11 are provided with an array of transmitters in the form of permanent magnets, 14, 16, 18, 20 locked into the recesses by locking member 22, 24, 26, 28. Thus, magnet 14 is arranged in recess 5 and locked by locking member 22, magnet 16 is arranged in recess 7 and locked by locking member 24, magnet 18 is arranged in recess 9 and locked by locking member 26, and magnet 20 is arranged in recess 11 and locked by locking member 28. Similar to the arrangement of the recesses, the magnets are arranged at mutual angular intervals  $\alpha_1, \alpha_2, \alpha_3, \alpha_4$  relative to the longitudinal axis 12. Although the magnets 16, 18, 20 are not visible in the cross-section of Fig. 1, their position has been indicated in dotted lines for the purpose of clarity. Each magnet 14, 16, 18, 20 induces a magnetic field (not shown) into the interior of the casing section 1.

**[0007]** Referring further to Figs. 3 and 4 there is shown a sensor tool 30 supported by wire line 32 from a control facility (not shown) at surface. The tool 30 is provided with a plurality of electric circuits (not shown), each circuit including an electric relay 34 arranged to actuate a change in the circuit upon entering the magnetic field induced by one of the magnets 14, 16, 18, 20. The relays are arranged at regular angular intervals along the outer circumference of the tool 30. Each circuit is in electric contact with the control facility via an electric conductor (not shown) extending along the wireline 32. The control facility is capable of receiving a signal from each circuit indicating said change of the circuit.

**[0008]** During normal operation the sensor tool 30 is lowered from surface into the casing 3. When the tool

30 arrives at the location of the magnets 14, 16, 18, 20, each magnet will be in close proximity of one of the relays 34. As a result four of the relays 34 enter the magnetic fields induced by the magnets, said four relays being located at mutual angular intervals  $\alpha_1, \alpha_2, \alpha_3, \alpha_4$  relative to the longitudinal axis (not shown) of the tool. Each one of the four relays thereby actuates a change in the corresponding circuit, resulting in a corresponding signal being transmitted from the circuit through the electric conductor to the control facility at surface. From the four signals being received at the control facility the mutual angular intervals  $\alpha_1, \alpha_2, \alpha_3, \alpha_4$  of the four relays are deduced. The depth of the tool 30 in the wellbore is then determined from the unique relationship between the angular intervals  $\alpha_1, \alpha_2, \alpha_3, \alpha_4$  and the depth of the magnets 14, 16, 18, 20 in the wellbore.

### Claims

1. A coding system for use in a wellbore formed in an earth formation, comprising a tubular conduit extending in the wellbore and being provided with at least one transmitter array, each transmitter array being arranged at a selected wellbore location and including at least one transmitter arranged in a selected pattern representative for said location, each transmitter inducing a field selected from a magnetic field and an electromagnetic field into the interior of the conduit, a sensor suitable to be lowered through the conduit and to interact with each field, and means for generating a signal representative of the interaction of the sensor with each field.
2. The coding system of claim 1, wherein each transmitter array includes a plurality of transmitters arranged at substantially equal depth in the wellbore and at selected mutual angular orientations around the wellbore axis.
3. The coding system of claim 1 or 2, wherein each transmitter induces a magnetic field in the interior of the wellbore.
4. The coding system of claim 3, wherein transmitter is a permanent magnet.
5. The coding system of claim 2 or 3, wherein the tubular conduit is made of a non-magnetic material.
6. The coding system of any one of claims 3-5, wherein the sensor includes a plurality of electric circuits, each circuit including an electric relay actuating a change in the circuit upon entering the magnetic field.
7. The coding system of any one of claims 1-6, wherein the tubular conduit is a casing of the wellbore.
8. The coding system of any one of claims 1-7, wherein the wellbore is a multilateral wellbore including a main wellbore and at least one branch wellbore extending from a branch point of the main wellbore, said transmitter array being located substantially at said branch point.
9. The coding system substantially as described hereinbefore with reference to the drawings.

Fig.1.

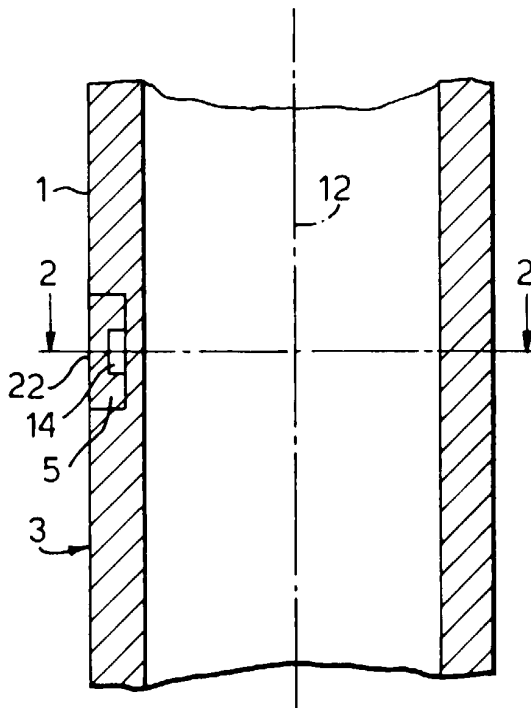


Fig.2.

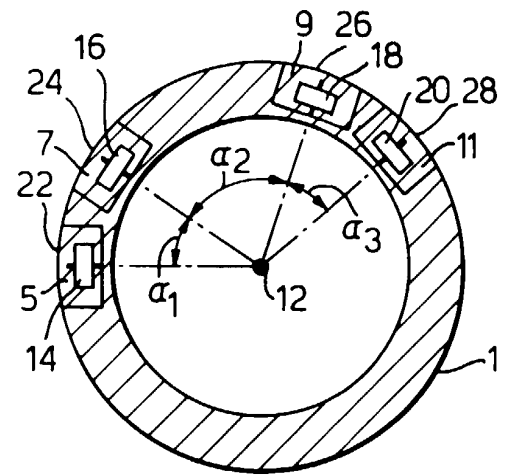


Fig.3.

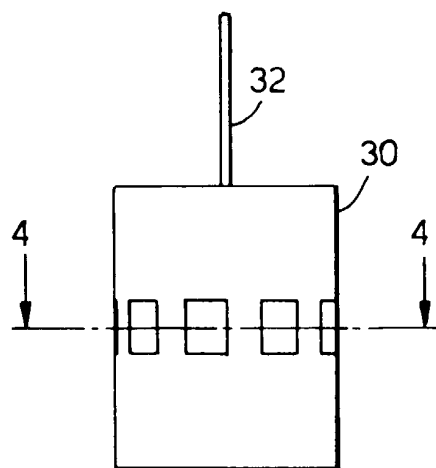
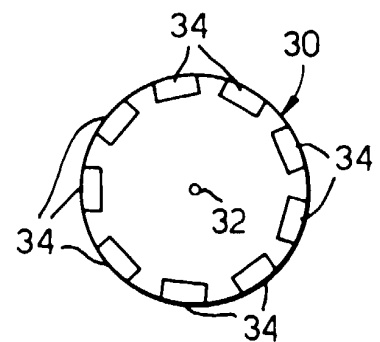


Fig.4.





European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 99 30 6279

| 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) |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 3 105 548 A (OWNBY)<br>1 October 1963 (1963-10-01)<br>* column 3, line 40 - line 55 *<br>* column 5, line 45 - line 58 *<br>* column 6, line 41 - line 69 *<br>---     | 1-4,6,9                                            | E21B47/09<br>E21B47/024                      |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 4 244 424 A (TALBOT)<br>13 January 1981 (1981-01-13)<br>* column 3, line 24 - line 30 *<br>* column 4, line 52 - line 54 *<br>* column 4, line 61 - column 5, line 5 * | 1-5,7,9                                            |                                              |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ---                                                                                                                                                                       | 6                                                  |                                              |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 5 666 050 A (BOULDIN)<br>9 September 1997 (1997-09-09)<br>* column 3, line 14 - line 37 *<br>* column 4, line 9 - line 14 *<br>---                                     | 6                                                  |                                              |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 4 121 657 A (MC CLURE)<br>24 October 1978 (1978-10-24)<br>* column 2, line 32 - line 50 *<br>---                                                                       | 1,3,9                                              |                                              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                           |                                                    | TECHNICAL FIELDS<br>SEARCHED (Int.Cl.7)      |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 3 513 912 A (BOOP)<br>26 May 1970 (1970-05-26)<br>* column 2, line 22 - line 27 *<br>* column 3, line 16 - line 31 *<br>* column 3, line 66 - line 73 *<br>---         | 1-4,7,9                                            | E21B                                         |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | EP 0 301 671 A (SHELL INTERNATIONALE<br>RESEARCH MAATSCHAPPIJ B.V.)<br>1 February 1989 (1989-02-01)<br>* abstract *<br>* column 5, line 50 - column 6, line 4 *<br>---    | 1-5,7,9                                            |                                              |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 5 351 755 A (HOWLETT)<br>4 October 1994 (1994-10-04)<br>* column 2, line 31 - line 51 *<br>* column 3, line 3 - line 7 *<br>---                                        | 1-4,7,9                                            |                                              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ---<br>-/--                                                                                                                                                               |                                                    |                                              |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                           |                                                    |                                              |
| Place of search<br>THE HAGUE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                           | Date of completion of the search<br>7 January 2000 | Examiner<br>Sogno, M                         |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                                                           |                                                    |                                              |

EPO FORM 1503 03 82 (P04C01)



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 99 30 6279

| 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) |
| X                                                                                                                                                                                                                                                      | US 5 394 950 A (GARDES)<br>7 March 1995 (1995-03-07)<br>* column 4, line 61 - column 5, line 36 *<br>* column 6, line 25 - line 49 *<br>---- | 1-5,8,9                                                                                                                                                                                                                                                                      |                                              |
| A                                                                                                                                                                                                                                                      | US 5 720 344 A (NEWMAN)<br>24 February 1998 (1998-02-24)<br>* abstract *<br>-----                                                            | 1                                                                                                                                                                                                                                                                            |                                              |
| The present search report has been drawn up for all claims                                                                                                                                                                                             |                                                                                                                                              |                                                                                                                                                                                                                                                                              | TECHNICAL FIELDS SEARCHED (Int.Cl.7)         |
| Place of search<br>THE HAGUE                                                                                                                                                                                                                           |                                                                                                                                              | Date of completion of the search<br>7 January 2000                                                                                                                                                                                                                           | Examiner<br>Sogno, M                         |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |                                                                                                                                              | T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                              |

EPO FORM 1503 03/82 (P04/C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 99 30 6279

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  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

07-01-2000

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                                                                                      | Publication<br>date                                                                                          |
|-------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| US 3105548 A                              | 01-10-1963          | NONE                                                                                                                            |                                                                                                              |
| US 4244424 A                              | 13-01-1981          | CA 1117000 A<br>DE 3011922 A<br>FR 2452586 A<br>GB 2049761 A,B<br>JP 1214284 C<br>JP 55129588 A<br>JP 58046640 B<br>MX 147543 A | 26-01-1982<br>09-10-1980<br>24-10-1980<br>31-12-1980<br>27-06-1984<br>07-10-1980<br>18-10-1983<br>13-12-1982 |
| US 5666050 A                              | 09-09-1997          | NONE                                                                                                                            |                                                                                                              |
| US 4121657 A                              | 24-10-1978          | NONE                                                                                                                            |                                                                                                              |
| US 3513912 A                              | 26-05-1970          | NONE                                                                                                                            |                                                                                                              |
| EP 301671 A                               | 01-02-1989          | AU 607522 B<br>AU 2011988 A<br>CA 1333412 A<br>DE 3869690 A<br>NO 173523 C                                                      | 07-03-1991<br>02-02-1989<br>06-12-1994<br>07-05-1992<br>22-12-1993                                           |
| US 5351755 A                              | 04-10-1994          | NONE                                                                                                                            |                                                                                                              |
| US 5394950 A                              | 07-03-1995          | NONE                                                                                                                            |                                                                                                              |
| US 5720344 A                              | 24-02-1998          | AU 4802897 A<br>CA 2201567 A<br>GB 2334055 A<br>WO 9817891 A                                                                    | 15-05-1998<br>21-04-1998<br>11-08-1999<br>30-04-1998                                                         |

EPO FORM P0459

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