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Datasheet for the decision of 24 October 2019

Case Number: T 1988/14 - 3.4.03

Application Number: 01962294.3

Publication Number: 1315984

IPC: G01V3/28, G01V3/30, G01V3/38

Language of the proceedings: EN

Title of invention:
ELECTROMAGNETIC WAVE RESISTIVITY TOOL WITH TILTED ANTENNA

Patent Proprietor:
HALLIBURTON ENERGY SERVICES, INC.

Former Opponent:
SCHLUMBERGER TECHNOLOGY CORPORATION

Headword:

Relevant legal provisions:
EPC Art. 123(2), 52(1), 54(3)
EPC 1973 Art. 54(1), 54(2), 54(4), 89

Keyword:

Amendments - added subject-matter (no)
Novelty - prior European application - non-enabling disclosure - (yes)
Inventive step - non-enabling disclosure - (yes)

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

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Case Number: T 1988/14 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 24 October 2019

Appellant: (Patent Proprietor)	HALLIBURTON ENERGY SERVICES, INC. 10200 Bellaire Boulevard Houston, TX 77072 (US)
Representative:	Jennings, Michael John A.A. Thornton & Co. 10 Old Bailey London EC4M 7NG (GB)

Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted on 23 July 2014 revoking European patent No. 1315984 pursuant to Article 101(2) and (3)(b) EPC.**

Composition of the Board:

Chairman G. Eliasson
Members: T. M. Häusser
T. Bokor

Summary of Facts and Submissions

I. The appeal of the proprietor concerns the decision of the opposition division revoking the European patent No. EP-B-1 315 984 (Article 101 (2) and (3)(b) EPC).

II. The opposition had been filed against the patent as a whole. Grounds of opposition were insufficiency of the disclosure, extension of subject-matter and lack of novelty and inventive step (Articles 100, 54(1), (2), (4) and 56 EPC 1973 and Articles 52(1) and 54(3) EPC).

III. Reference is made to the following documents:

E4: WO 00/50926,

E5: Koji Kashihara et al., *Proposal of A Directional Induction Tool*, The first annual well logging symposium of Japan, September 21-22, 1995,

E6: GB 2 279 149,

E11: US 5 278 507.

IV. At the oral proceedings before the board the appellant (patent proprietor) requested the setting aside of the decision under appeal and the maintenance of the patent in an amended form on the basis of the following documents:

Description:

Pages 3, 5 to 11 of the patent specification and pages 2, 4, and 12 filed during the oral proceedings before the board;

Claims:

No. 1-4 filed during the oral proceedings before the board;

Drawings:

Figures 1-37 of the patent specification.

With letter dated 11 May 2016 the former respondent (former opponent) withdrew its opposition and is therefore no longer party to the proceedings.

V. The wording of independent claim 1 of the sole request is as follows (board's labelling (A) to (E)):

"1. A geosteering method that comprises:
(A) transmitting an electromagnetic wave from a transmitter antenna into a formation, wherein the transmitter antenna is mounted on a downhole tool disposed in a plane oriented at a first angle with respect to the longitudinal axis of the tool, wherein the tool connects to a drilling apparatus;
(B) receiving an electromagnetic wave response from the formation with a receiver antenna spaced apart from said transmitter antenna along the tool axis, wherein the receiver antenna is mounted on the tool disposed in a plane oriented at a second angle with respect to the tool axis, wherein the first and second angles have different magnitudes;
(C) generating an orientation signal representative of the orientation of the tool with respect to a reference direction using a rotational position indicator attached to said tool;
(D) using a processor in the downhole tool to correlate the received electromagnetic wave response with the orientation signal from the rotational position indicator and to determine a bed boundary indication based on the received electromagnetic wave; and
(E) controlling a direction of the drilling apparatus based on the bed boundary indication."

VI. The appellant argued essentially as follows:

(a) Amendments

The appellant argued that the amendments effected in relation to claim 1 complied with the requirements of Article 123(2) EPC.

(b) Novelty

The appellant was of the opinion that the claimed subject-matter was new over document E4, since this document did not disclose a downhole processor performing the claimed operations.

(c) Inventive step

In the appellant's view the claimed subject involved an inventive step, in particular over documents E5, E6, and E11.

Reasons for the Decision

1. Amendments

1.1 Claims 1 to 4 of the sole request essentially correspond to claims 13 to 16 of the first auxiliary request and claims 1-4 of the second auxiliary request underlying the contested decision, except that the tool is specified as a "downhole tool" in present claim 1 instead of a "logging tool" or merely "tool" as in claim 13 of the former first auxiliary request and claim 1 of the former second auxiliary request.

1.2 In the decision under appeal the opposition division held that the subject-matter of claim 13 of the first

auxiliary request underlying the decision did not extend beyond the content of the application as filed (see point 2.4.3 of the Reasons).

1.3 The former respondent had argued that there was no basis in the application as filed for a "downhole" tool comprising a processor performing the claimed operations. Moreover, there was no disclosure of the feature that the tool "connects" to the drilling apparatus. Hence, claim 13 of the former first auxiliary request extended beyond the application as filed.

No objections had been raised against dependent claims 14 to 16 of that request.

1.4 The board notes that the subject-matter of claim 1 is generally based on claims 8 and 37 as originally filed and on page 28, lines 8 to 10 of the original description.

Moreover, the board agrees with the appellant in that the disclosure in the description of the application (see page 12, line 29 - page 13, line 2) that it is only "typically" the case that the tool is "threadably connected" to the drill collar and the drill bit provides the skilled person with the teaching that other types of connections are also possible. There is also no indication whatsoever that the invention as described would imply one special way of connecting the tool to the drilling apparatus. Hence there is a sufficient basis for the somewhat broader formulation in claim 1 that the tool "connects" to the drilling apparatus.

The fact that the tool is connected to the drilling apparatus and also that it comprises - according to

original claim 8 - the transmitter and receiver antennas for determining the resistivity of the earth formation implies that the tool is used in a "downhole" environment. Furthermore, from this claim it also follows that the tool comprises the processor which generates the desired bed boundary indication based on the signals from the receiver antenna and the rotational position indicator. This is also implied by the disclosure on page 13, lines 3 to 7 of the description of the application. Hence, the original disclosure provides a sufficient basis for a "downhole tool" comprising a processor performing the claimed operations.

The subject-matter of claim 1 is therefore directly and unambiguously derivable from the application as filed.

The description has been brought into conformity with the amended claims and supplemented with an indication of the relevant content of the prior art without extending beyond the content of the application as filed.

Accordingly, the board is satisfied that the amendments comply with the requirements of Article 123(2) EPC.

2. Novelty

2.1 Document E4

2.1.1 Document E4 is an International (PCT) application with a filing date (10 February 2000) before the priority date of the contested patent (13 July 2000) and a publication date (31 August 2000) after that priority date. Hence, the European patent application based on the PCT application E4 belongs to the state of the art according to Article 54(3) EPC for the contracting states under Article 54(4) EPC 1973 as far as the

priority of the contested patent is valid, which had not been questioned (Article 89 EPC 1973).

2.1.2 Document E4 discloses (page 7, line 2 - page 8, line 31; page 11, line 9 - page 12, line 28; page 20, lines 3-5; Figures 1, 4, 9) a drill string 14 comprising coil tubing 24 and a bottom hole assembly ("BHA") 26 coupled to the lower end of the coil tubing 24. In particular, the BHA 26 includes an azimuthally tunable resistivity tool, directional sensors for indicating the rotational angle about the tool axis, and a downhole data signaling unit 35. The resistivity tool 202 comprises transmitter coils 104, 108 and skewed receiver coils 216, 218, 220.

2.1.3 In the contested decision the opposition division held that the subject-matter of claim 1 of the second auxiliary request underlying the decision was not new over document E4. In particular, the opposition division did not consider the claimed processing operations to be limited to such embodiments where the processor is located in the downhole tool (see point 2.6.1 of the Reasons). This point of view had also been taken by the former respondent.

2.1.4 The opposition division's objection has been overcome by introducing into present claim 1 the indication that the tool is a "downhole tool" (see point 1.1 above). This implies that claim 1 has to be understood such that the claimed processing operations are in fact performed by a processor located in the downhole tool.

In document E4 there is no disclosure that the correlation of the received electromagnetic wave signals with the orientation signal and the determination of the bed boundary indication are performed by a processor in the

downhole tool (see feature (D) of claim 1). Rather, according to the method of document E4 amplitude and phase measurements are transmitted to the surface for further processing to determine formation resistivity, distance and direction to the bed boundary and the resistivity of the adjacent beds (document E4, page 9, lines 9-18; paragraph bridging pages 18-19).

The subject-matter of claim 1 and dependent claims 2 to 4 is therefore new over the European patent application based on the PCT application E4 (Articles 52(1) and 54(3) EPC and Articles 54(1) and (4) and 89 EPC 1973).

2.2 Document E5

2.2.1 The opposition division held that the subject-matter of claim 1 of the second auxiliary request underlying the decision was new over document E5 (see point 2.6.2 of the Reasons). The former respondent had argued that the claimed subject-matter lacked novelty over that document.

2.2.2 According to established case law of the Boards of Appeal subject-matter described in a document can only be regarded as having been made available to the public and therefore as comprised in the state of the art, if the information given therein to the skilled person is sufficient to enable him - at the relevant date of the document - to practise the technical teaching of the document, taking into account also common general knowledge at that time in the relevant technical field (see *Case Law of the Boards of Appeal of the EPO*, 9th edition 2019, section I.C.4.11).

2.2.3 Document E5 discloses (see page 1, left-hand column, paragraph 1; page 3, left-hand column, paragraph 1;

page 4, left-hand column; Figure 4) a proposal for tilt-coil directional induction methods for making deep azimuthal resistivity measurements around a borehole. A simple scale model prototype tool involving one tilted transmitter coil and two tilted receiver and corresponding bucking coils was used to perform model experiments. Each receiver and its bucking coil were wound in a slanted manner on a coil bobbin, which was slidingly arranged on a core body allowing adjustment to cancel direct coupling signals. The relevant model equations were deduced under the assumption that the tool body was non-conductive.

The only reference in document E5 to a measurement-while-drilling (MWD) tool is the following statement (page 1, right-hand column, paragraph 2):

> "*In a horizontal well, it [the tool] will be able to provide a true conductivity of a bed, and also used as a MWD navigation sensor to detect upper or lower beds*".

However, document E5 contains no indication at all how the components of the tool, in particular the transmitter, receiver and bucking coils are to be integrated into a drill string. On the other hand, there are attributes of the prototype of document E5 (slidingly arranged bobbins) and assumptions used for the derivation of the relevant model equations (non-conductive tool body) which appear incompatible with the harsh MWD operating conditions involving high vibrations, pressures and temperatures and the high torques on the drill string. Hence, the above statement does not constitute an enabling disclosure of a measurement-while-drilling tool. Features (A) and (E) are therefore not disclosed in document E5. Furthermore, this document

does not disclose a processor in a downhole tool performing the claimed operations (feature (B)) and a rotational position indicator (feature (C)), either.

2.2.4 The subject-matter of claim 1 and dependent claims 2 to 4 is therefore new over document E5 (Article 52(1) EPC and Article 54(1) and (2) EPC 1973).

3. Inventive step

3.1 Positions of the opposition division and the former respondent

Inventive step was not discussed in the decision under appeal. However, in the communication annexed to the summons to oral proceedings the opposition division stated its preliminary opinion that the subject-matter of the granted claims did not involve an inventive step over document E6 (see point 9 of the communication).

The former respondent had also argued lack of inventive step over document E11, in particular in view of document E6.

3.2 Closest state of the art

3.2.1 Document E6 discloses (see page 9, penultimate paragraph - page 10, paragraph 1; page 17, last paragraph - page 18, second paragraph; Figures 1, 7, and 8) a method of and an apparatus for directional induction logging with the aim of measuring the electric conductivity of a formation in a particular direction with respect to the circumference of a borehole 7. In particular, the second embodiment of document E6 concerns the monitoring of the upper and lower formations 24 and 26 in relation to a horizontal

borehole 7. A transmitting coil 1 and a receiving coil 2 are secured to a shaft 10 extending along the hole axis 18 of the borehole 7 such that these coils are inclined so as to face each other. A second transmitting coil 1' and second receiving coil 2' are also secured to the shaft 10 in a 180-degree symmetry with respect to the first transmitting and receiving coils 1 and 2. A weight 27 is secured to the shaft 10 and rotatably sustained by bearings 16 supporting the shaft such that one of the pairs of the transmitting and receiving coils is directed in the gravitational direction at all times. This apparatus permits measurement of the electric conductivity on the gravity side of the borehole and the opposite side thereof.

In relation to the second embodiment document E6 contains the following statement (page 19, penultimate paragraph):

> "*Further, when the apparatus is applied to a sensor for MWD (Measurement While Drilling), it constitutes a navigation tool for drilling a borehole without getting out of the intended formation.*"

A corresponding statement is also contained in the general description of the invention (see document E6, page 1):

> "*Among the fields of utility, to which the invention is applicable, are as follows.*
> *[...]*
> *(2) Measurement sensors in the MWD (Measurement While Drilling) techniques for making measurements during drilling a borehole:*
> *When carried out as a resistivity sensor in the MWD, the invention permits monitoring of upper and*

lower formations during horizontal drilling or the like."

However, the second embodiment of document E6 clearly relates to a wireline logging device which is designed for being lowered into an existing borehole for collecting data and removed afterwards. Furthermore, document E6 does not contain any indications on how the tool is to be adapted for being used as a measurement-while-drilling tool, in particular how it is to be incorporated into a drill string. Just like in the case of document E5 (see point 2.2.3 above) some of the (implied) attributes of the tool according to the second embodiment of E6 (non-conductive housing; weight 27 for controlling the orientation of the coils) do not appear to be compatible with the harsh MWD operating environment and the drill string's rotation under high torque conditions. Hence, document E6 does not disclose a measurement-while-drilling tool in an enabling manner. Consequently, this document is not considered the closest state of the art as it is not conceived for the same purpose as the claimed invention, namely for providing a geo-steering method.

3.2.2 On the other hand, document E11 discloses - as detailed below - subject-matter that is conceived for the same purpose as the claimed invention and has the most relevant technical features in common with it. Therefore, the board agrees with the former respondent in regarding document E11 as the closest state of the art.

3.3 Distinguishing features

3.3.1 Document E11 discloses (see column 6, line 44 - column 7, line 11; Figures 1 and 2) a logging tool 10 suspended in an earth borehole 12 on a string of drill pipe 14

from the earth's surface, such drill string including one or more drill collars 11. A transmitter section with transmitters 16, 18 and 20 is spaced along the length of the logging tool 10 from a receiver section 22 which includes a pair of receivers R_1 and R_2. The transmitters 16, 18 and 20 and the receivers R_1 and R_2 are covered with a non-conductive material. The body of tool 10 is made of steel in order to prevent the tool 10 from becoming a weak link in the drill string 14. Typically, one or more drill collars 24 with drill bits are connected to a lower end of the logging tool 10. The logging tool 10 also has the requisite electronic circuitry for processing the signals received by the receiver section 22, thereby converting the received signals into a log or another indication of formation resistivity.

3.3.2 Using the wording of claim 1 document E11 discloses therefore a geosteering method that comprises:

(A) transmitting an electromagnetic wave from a transmitter antenna (one of transmitters 16, 18 and 20) into a formation, wherein the transmitter antenna is mounted on a downhole tool (logging tool 10) disposed in a plane oriented at a first angle with respect to the longitudinal axis of the tool, wherein the tool (logging tool 10) connects to a drilling apparatus (drill pipe 14);

(B)' receiving an electromagnetic wave response from the formation with a receiver antenna (one of receivers R_1 and R_2) spaced apart from said transmitter antenna along the tool axis;

(D)' using a processor (electronic circuitry) in the downhole tool to convert the received signals into an indication of formation resistivity.

The subject-matter of claim 1 differs from the method of document D11 in

(B)'' the receiver antenna being mounted on the tool disposed in a plane oriented at a second angle with respect to the tool axis, wherein the first and second angles have different magnitudes;

(C) generating an orientation signal representative of the orientation of the tool with respect to a reference direction using a rotational position indicator attached to said tool;

(D)'' using the processor to correlate the received electromagnetic wave response with the orientation signal from the rotational position indicator and to determine a bed boundary indication based on the received electromagnetic wave; and

(E) controlling a direction of the drilling apparatus based on the bed boundary indication."

3.4 Objective technical problem

In accordance with the indications in the patent specification (see paragraph [0014]) it is the objective technical problem of the invention to provide an improved method for steering a downhole apparatus during a directional drilling operation in order to maintain the borehole within a desired earth formation.

3.5 Obviousness

3.5.1 Document E4 belongs to the state of the art according to Article 54(3) EPC and is therefore not to be considered in deciding whether there has been an inventive step (Article 56 EPC 1973).

3.5.2 Neither document E5 nor document E6 discloses a measurement-while-drilling tool and a corresponding method

in an enabling manner (see points 2.2.3 and 3.2.1 above). Hence, these documents do not provide the skilled person with a solution to the posed technical problem of improving the steering of a downhole apparatus during a directional drilling operation in order to maintain the borehole within a desired earth formation.

Moreover, neither the opposition division nor the former respondent had advanced any arguments that the major adaptations necessary for transforming the wireline logging methods disclosed in documents E5 and E6 into measurement-while-drilling methods were obvious for the skilled person in view of its common general knowledge. The board does not see any reasons for believing that this is the case, either.

3.5.3 Therefore, the subject-matter of claim 1 and dependent claims 2 to 4 involves an inventive step (Article 52(1) EPC and Article 56 EPC 1973).

4. Conclusion

For the above reasons the board is of the opinion that the patent - in the version according to the appellant's sole request - and the invention to which it relates meet the requirements of the EPC. Hence, the patent is to be maintained as amended in that version (Article 101(3)(a) EPC and Article 111(1) EPC 1973).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the opposition division with the order to maintain the patent as amended in the following version:

Description:

Pages 3, 5 to 11 of the patent specification, pages 2, 4, and 12 filed during the oral proceedings before the board;

Claims:

No. 1-4 filed during the oral proceedings before the board;

Drawings:

Figures 1-37 of the patent specification.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated