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(54) **DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH FROM DRILLING DATA AND DRILL BIT PARAMETERS**

(57) A method for monitoring a drilling operation including: providing a drill bit for drilling a wellbore into a geological formation using a drilling motor for rotating the drill bit; determining depth of cut (DOC) of the drill bit and torque exerted on the drill bit by the drilling motor using parameters measured while drilling the wellbore; simulating drilling of a hypothetical wellbore using a hypothetical drill bit similar or identical to the drill bit and determining a function that provides strength of a hypothetical geological formation from the DOC of the hypothetical drill bit and the torque exerted on the hypothetical drill bit; and determining strength of the geological formation using the function and the determined DOC and the torque.

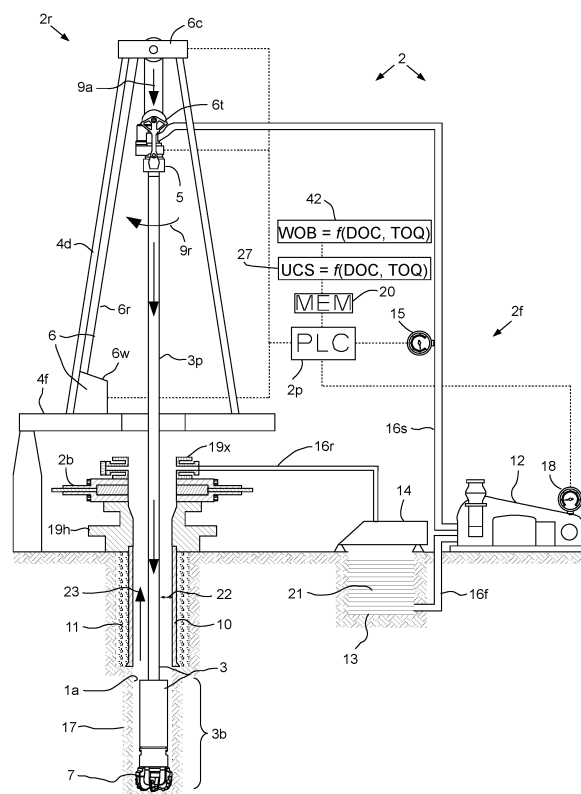


FIG. 10



PARTIAL EUROPEAN SEARCH REPORT

Application Number

under Rule 62a and/or 63 of the European Patent Convention.
This report shall be considered, for the purposes of
subsequent proceedings, as the European search report

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2015/090498 A1 (HARELAND GEIR [CA]) 2 April 2015 (2015-04-02) * figures 1-30 * * paragraphs [0037], [0052], [0124], [0205] * * the whole document * -----	1-10	INV. E21B44/00 E21B49/00 E21B7/06 E21B33/134 E21B43/26
X	US 9 970 266 B2 (RESOURCE ENERGY SOLUTIONS INC [CA]) 15 May 2018 (2018-05-15) * figures 2,3,9 * * depth of cut ~ directly related to Omega (RPM); column 16, lines 54,58 * * bit wear, lithology; columns 15-24 * * column 43; figure 31 * * rock compressive strength 2055; page 10, lines 27-37 * * the whole document * ----- - / - -	1-10	TECHNICAL FIELDS SEARCHED (IPC) E21B

INCOMPLETE SEARCH

The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC so that only a partial search (R.62a, 63) has been carried out.

Claims searched completely :

Claims searched incompletely :

Claims not searched :

Reason for the limitation of the search:

see sheet C

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EPO FORM 1503 03.82 (P04E07)

Place of search	Date of completion of the search	Examiner
The Hague	26 November 2024	van Berlo, André
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		



PARTIAL EUROPEAN SEARCH REPORT

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EPO FORM 1503 03.82 (P04C10)

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (IPC)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	US 2001/030063 A1 (DYKSTRA MARK W [US] ET AL) 18 October 2001 (2001-10-18) * figures 3-5,19-22 * * the whole document * * paragraph [0065] * -----	1-10	
X	AL-UMRAN MOHAMMED ET AL: "Specific Design Process Associated With Simulation Tools Improve PDC Bi-Centre Application Definition, and Deliver Solution in Directional Environment", VAREL INTERNATIONAL, 3 November 2008 (2008-11-03), pages 1-14, XP093227987, DOI: 10.2118/117286-MS * pages 7-10; figures 6,7,8,9,11 * * the whole document * * columns 15-24 * * column 43 * -----	1	TECHNICAL FIELDS SEARCHED (IPC)
X	PELFRENE GILLES ET AL: "Statistical Optimization of PDC Bit Designs Based on 3D Simulations Applied to Demanding Directional Applications", DAY 3 WED, NOVEMBER 13, 2019, vol. 1, 11 November 2019 (2019-11-11), XP093227998, DOI: 10.2118/197359-MS * figure 16 * * the whole document * -----	1	



**INCOMPLETE SEARCH
SHEET C**

Application Number

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Claim(s) completely searchable:

1-10

Claim(s) not searched:

11-15

Reason for the limitation of the search:

In response to the Clarification Request (Rule 62a EPC) the applicant has indicated to elect claim 1-10 to be searched.



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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☒ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due 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 those claims for which no payment was due.

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:

☐ 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:

☐ The present supplementary 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 (Rule 164 (1) EPC).

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

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5 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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US 2001030063 A1	18-10-2001	BE 1016272 A3 GB 2370592 A US 2001030063 A1 US 2003029642 A1 US 2004216926 A1 US 2005284660 A1 US 2006278436 A1 US 2011114392 A1 US 2012024609 A1	04-07-2006 03-07-2002 18-10-2001 13-02-2003 04-11-2004 29-12-2005 14-12-2006 19-05-2011 02-02-2012