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GB IT

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(62) Document number(s) of the earlier application(s) in
accordance with Art. 76 EPC:
99945375.6 / 1 112 433

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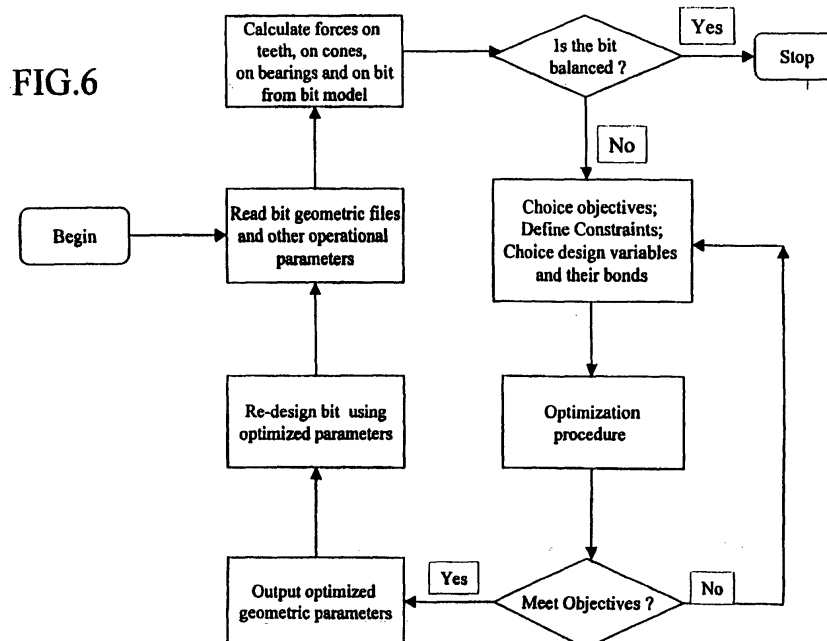
(54) **Force-balanced roller-cone bits, systems, drilling methods, and design methods**

(57) A method of designing a roller cone drill bit is disclosed. The method comprises:

- (a) calculating the force balance conditions of a bit;
- (b) defining design variables;
- (c) determine lower and upper bounds for the de-

- sign variables;
- (d) defining objective functions;
- (e) defining constraint functions;
- (f) performing an optimisation means; and
- (g) evaluating an optimised cutting structure by modelling.

Design Procedure of A Force Balanced Roller Cone





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EUROPEAN SEARCH REPORT

Application Number
EP 03 02 1140

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	EP 0 384 734 A (AMOCO CORP) 29 August 1990 (1990-08-29) * page 3, line 50 * * page 9, line 34 - line 45 *	1,14,15	E21B10/16
X,D	MA DEKUN ET AL: "Computer simulation of the interaction between roller bit and rock" PROCEEDINGS OF THE INTERNATIONAL MEETING ON PETROLEUM ENGINEERING. PART 1 (OF 2); BEIJING, CHINA NOV 14-17 1995, vol. 1, 1995, pages 309-317, XP002266077 Richardson, TX, USA * the whole document *	2,4-7,18	
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A	* column 5, line 28 - line 41; figure 7 *	24-28	
A	WARREN T M: "FACTORS AFFECTING TORQUE FOR A ROLLER CONE BIT" JPT J PET TECHNOL SEP 1984, vol. 36, no. 10, September 1984 (1984-09), pages 1500-1508, XP002266078 * the whole document *	1-30	TECHNICAL FIELDS SEARCHED (Int.Cl.7) E21B
A	WARREN TOMMY M ET AL: "Drag-bit performance modeling" SPE DRILL ENG JUN 1989, vol. 4, no. 2, June 1989 (1989-06), pages 119-127 15618, XP002266079 * the whole document *	1-30	
		-/--	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 2 January 2004	Examiner Bellingacci, F
<p>CATEGORY OF CITED DOCUMENTS</p> <p>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</p> <p>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</p> <p>& : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03.82 (P4/C01)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 02 1140

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)
A	<p>SHEPPARD M C ET AL: "Forces at the teeth of a drilling rollercone bit: theory and experiment"</p> <p>PROCEEDINGS: 1988 SPE ANNUAL TECHNICAL CONFERENCE AND EXHIBITION;HOUSTON, TX, USA OCT 2-5 1988, vol. DELTA, 1988, pages 253-260 18042, XP002266080</p> <p>Soc Pet Eng AIME Pap SPE 1988 Publ by Soc of Petroleum Engineers of AIME, Richardson, TX, USA</p> <p>* the whole document *</p> <p>-----</p>	1-30	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		2 January 2004	Bellingacci, F
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone</p> <p>Y : particularly relevant if combined with another document of the same category</p> <p>A : technological background</p> <p>O : non-written disclosure</p> <p>P : intermediate document</p> <p>T : theory or principle underlying the invention</p> <p>E : earlier patent document, but published on, or after the filing date</p> <p>D : document cited in the application</p> <p>L : document cited for other reasons</p> <p>& : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03.82 (P04C01)



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Application Number

EP 03 02 1140

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:



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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 03 02 1140

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: 1,14,18

Methods relating to the optimization of drill bits, wherein
no indication is given of which parameter is optimized

2. claims: 2-13,16,17,19-30

Methods and devices related to balanced drill bits

3. claim: 15

Method of optimizing the rate of penetration of a drill bit

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

EP 03 02 1140

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.

02-01-2004

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EPO FORM P0459

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