UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/588,026	11/10/2020	10830013	36362.0150U4	7130

23859 7590 10/21/2020

Ballard Spahr LLP
SUITE 1600
999 PEACHTREE STREET
ATLANTA, GA 30309-4421

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Christopher L. DRENTH, Burlington, CANADA;
LONGYEAR TM, INC, Salt Lake City, UT;
GLOBALTECH CORPORATION PTY LTD, Residence Not Provided;
Gordon STEWART, Claremont, AUSTRALIA;
Khaled HEJLEH, Peppermint Grove, AUSTRALIA;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

REFLEX EXHIBIT 1002 - 1/304

Document Description: Issue Fee Payment (PTO-85B)

Issue Fee Transmittal Form

Application Number	Filing Date	First Named Inventor	Atty. Docket No.	Confirmation No.
16588026	30-Sep-2019	Christopher DRENTH	36362.0150U4	7130

TITLE OF INVENTION :

CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

Entity Status	Application Type	Art Unit	Class - Subclass	EXAMINER
Regular Undiscounted	Utility under 35 USC 111(a)	3676	044000	MICHAEL WILLS III

Issue Fee Due	Publication Due	Total Fee(s) Due	Date Due	Prev. Paid Fee
$1000	$0	$1000	09-Oct-2020	$0

1.Change of Correspondence Address and/or Indication Of Fee Address (37 CFR 1.33 & 1.363)

Current Correspondence Address:	Current Indicated Fee Address :
23859 Ballard Spahr LLP SUITE 1600 999 PEACHTREE STREET ATLANTA GA 30309-4421 UNITED STATES 678-420-9300 USpatentmail@ballardspahr.com	
☐ Change of correspondence address requested, system generated AIA/122-EFS form attached	☐ Fee Address indication requested, system generated SB/47-EFS form attached

2.Entity Status

Change in Entity Status

○ Applicant certifying micro entity status; system generated Micro Entity certification form attached. See 37 CFR 1.29.
Note: Absent a valid certification of micro entity status, issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment. If this box is checked, you will be prompted to choose a micro entity status on the gross income basis (37 CFR 1.29(a)) or the institution of higher education basis (37 CFR 1.29(d)), and make the applicable certification online.

○ Applicant asserting small entity status. See 37 CFR 1.27.
Note: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

◉ Applicant changing to regular undiscounted fee status.
Note: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

Document Description: Issue Fee Payment (PTO-85B)

3.The Following Fee(s) Are Submitted:

☒ Issue Fee

☐ I authorize USPTO to apply my previously paid issue fee to the current fees due

☐ Publication Fee

☐ The Director is hereby authorized to apply my previously paid issue fee to the current fee due and to charge deficient fees to Deposit Account Number _____

☐ Advance Order - # of copies _____

☒ If i**n addition to** the payment of the issue fee amount submitted with this form, there are any discrepancies in any amount(s) due, the Director is authorized to charge any deficiency or credit any overpayment, to Deposit Account Number 14-0629 . The **issue fee must be submitted** with this form. **If payment of the issue fee does not accompany this form, checking this box and providing a deposit account number will NOT be effective to satisfy full payment of the fee(s) due.**

4.Firm and/or Attorney Names To Be Printed

NOTE: If no name is listed, no name will be printed
For printing on the patent front page, list to be displayed as entered

1. BALLARD SPAHR LLP
2.
3.

5.Assignee Name(s) and Residence Data To Be Printed

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

Name	City	State	Country	Category
LONGYEAR TM, INC.	SALT LAKE CITY	UTAH	united states	corporation
GLOBALTECH CORPORATION PTY LTD	CANNING		australia	corporation

Document Description: Issue Fee Payment (PTO-85B)

6.Signature

I certify, in accordance with 37 CFR 1.4(d)(4) that I am an attorney or agent registered to practice before the Patent and Trademark Office who has filed and has been granted power of attorney in this application. I also certify that this Fee(s) Transmittal form is being transmitted to the USPTO via EFS-WEB on the date indicated below.

Signature	/Joseph P. Anderson III/	**Date**	10-05-2020
Name	Joseph P. Anderson	**Registration Number**	59245

Electronic Patent Application Fee Transmittal

Application Number:	16588026
Filing Date:	30-Sep-2019
Title of Invention:	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME
First Named Inventor/Applicant Name:	Christopher L. DRENTH
Filer:	Joseph P. Anderson
Attorney Docket Number:	36362.0150U4

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPL ISSUE FEE	1501	1	1000	1000
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1000**

Electronic Acknowledgement Receipt

EFS ID:	40755581
Application Number:	16588026
International Application Number:	
Confirmation Number:	7130
Title of Invention:	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME
First Named Inventor/Applicant Name:	Christopher L. DRENTH
Customer Number:	23859
Filer:	Joseph P. Anderson
Filer Authorized By:	
Attorney Docket Number:	36362.0150U4
Receipt Date:	05-OCT-2020
Filing Date:	30-SEP-2019
Time Stamp:	13:35:00
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1000
RAM confirmation Number	E202005D34584818
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	Web85b.pdf	48766 a9f9e943ce3b7c55f6b0899f14cdc7fc66871d06	no	3
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	31965 42296218967bc152331c2510eb488b7f715db201	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	80731		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/588,026	09/30/2019	3676	2220	36362.0150U4	25	1

CONFIRMATION NO. 7130

CORRECTED FILING RECEIPT

23859
Ballard Spahr LLP
SUITE 1000
999 PEACHTREE STREET
ATLANTA, GA 30309-3915

OC000000119423287

Date Mailed: 08/24/2020

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Christopher L. DRENTH, Burlington, CANADA;
Gordon STEWART, Claremont, AUSTRALIA;
Khaled HEJLEH, Peppermint Grove, AUSTRALIA;

Applicant(s)

LONGYEAR TM, INC, Salt Lake City, UT;
GLOBALTECH CORPORATION PTY LTD, Residence Not Provided;

Power of Attorney: The patent practitioners associated with Customer Number 23859

Domestic Priority data as claimed by applicant

This application is a CON of 16/017,334 06/25/2018 PAT 10465463
which is a CON of 14/692,484 04/21/2015 PAT 10047581
which claims benefit of 61/982,052 04/21/2014

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

REFLEX EXHIBIT 1002 - 9/304

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 10/16/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/588,026**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

Title

CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

Preliminary Class

175

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop

REFLEX EXHIBIT 1002 - 11/304

technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

REFLEX EXHIBIT 1002 - 12/304

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

23859 7590 07/09/2020

Ballard Spahr LLP
SUITE 1000
999 PEACHTREE STREET
ATLANTA, GA 30309-3915

EXAMINER	
WILLS III, MICHAEL R	
ART UNIT	PAPER NUMBER
3676	

DATE MAILED: 07/09/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/588,026	09/30/2019	Christopher L. DRENTH	36362.0150U4	7130

TITLE OF INVENTION: CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	10/09/2020

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

23859 7590 07/09/2020

Ballard Spahr LLP
SUITE 1000
999 PEACHTREE STREET
ATLANTA, GA 30309-3915

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/588,026	09/30/2019	Christopher L. DRENTH	36362.0150U4	7130

TITLE OF INVENTION: CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	10/09/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
WILLS III, MICHAEL R	3676	175-044000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

REFLEX EXHIBIT 1002 - 14/304

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/588,026	09/30/2019	Christopher L. DRENTH	36362.0150U4	7130

23859 7590 07/09/2020

Ballard Spahr LLP
SUITE 1000
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EXAMINER	
WILLS III, MICHAEL R	
ART UNIT	PAPER NUMBER
3676	

DATE MAILED: 07/09/2020

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

REFLEX EXHIBIT 1002 - 15/304

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

REFLEX EXHIBIT 1002 - 16/304

Notice of Allowability	Application No. 16/588,026	Applicant(s) DRENTH et al.	
	Examiner MICHAEL R WILLS III	Art Unit 3676	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to remarks filed June 18, 2020.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-25 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/MICHAEL R WILLS III/
Primary Examiner, Art Unit 3676

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/588,026	DRENTH et al.
	Examiner	Art Unit
	MICHAEL R WILLS III	3676

CPC - Searched*		
Symbol	Date	Examiner
E21B25/16	03/15/2020	MW

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
See East Search History	03/15/2020	MW
Forward/Backward Search	03/15/2020	MW
Inventor Name Search	03/15/2020	MW
Global Dossier	03/15/2020	MW
Updated Search	06/30/2020	MW

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	See East Search History	06/30/2020	MW

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/588,026	DRENTH et al.
	Examiner	**Art Unit**
	MICHAEL R WILLS III	3676

CPC							
Symbol						**Type**	**Version**
E21B	/	25	/	16		F	2013-01-01

CPC Combination Sets								
Symbol						**Type**	**Set**	**Ranking**	**Version**
	/		/						

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	25	
/MICHAEL R WILLS III/ Primary Examiner, Art Unit 3676	30 June 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	8

U.S. Patent and Trademark Office — Part of Paper No.: 20200630

REFLEX EXHIBIT 1002 - 19/304

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/588,026	DRENTH et al.
	Examiner	**Art Unit**
	MICHAEL R WILLS III	3676

INTERNATIONAL CLASSIFICATION				
CLAIMED				
E21B	/	25	/	16

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	25	
/MICHAEL R WILLS III/ Primary Examiner, Art Unit 3676	30 June 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	8

U.S. Patent and Trademark Office

Part of Paper No.: 20200630

REFLEX EXHIBIT 1002 - 20/304

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/588,026	DRENTH et al.
	Examiner	Art Unit
	MICHAEL R WILLS III	3676

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	18	10	21	19										
2	2	8	11	22	20										
3	3	9	12	23	21										
4	4	10	13	24	22										
5	5	11	14	25	23										
6	6	12	15	14	24										
7	7	13	16	15	25										
16	8	19	17												
17	9	20	18												

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 25	
/MICHAEL R WILLS III/ Primary Examiner, Art Unit 3676 (Primary Examiner)	30 June 2020 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 8

U.S. Patent and Trademark Office

Part of Paper No.: 20200630

REFLEX EXHIBIT 1002 - 21/304

PTO/SB/08a (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	Christopher L. Drenth
Art Unit	3676
Examiner Name	WILLS III, MICHAEL R
Attorney Docket Number	36362.0150U4

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. * CITE NO.: Those application(s) which are marked with an single asterisk (*) next to the Cite No. are not supplied (under 37 CFR 1.98(a)(2)(iii)) because that application was filed after June 30, 2003 or is available in the IFW. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: June 16, 2020 Electronic Signature: /Benjamin D. Kirk/ (Benjamin D. Kirk)

1628126

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.R.W/

PTO/SB/08b (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	2	of	2

Complete if Known	
Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	Christopher L. Drenth
Art Unit	3676
Examiner Name	WILLS III, MICHAEL R
Attorney Docket Number	36362.0150U4

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	A	"Devicore BBT Directional Core Drilling Borehole Planning Service" Retrieved from the Internet:URL:http://www.devico.com/products/devicore-bbt [stored on the Wayback Machine on February 14, 2014]	

Examiner Signature	/MICHAEL R WILLS III/	Date Considered	06/30/2020

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.R.W/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	"16588026"	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/06/30 16:06
L2	221	(E21B25/16).cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/06/30 16:08
L3	6,704	cavity and instrument and orientation and transmitter and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/06/30 16:09
L4	469	cavity and instrument and orientation and transmitter and window and (wire line or wireline)	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/06/30 16:10
L5	5	cavity and instrument and orientation and transmitter and window and (wire line or wireline) and core barrel	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/06/30 16:10
L6	5	cavity and instrument and orientation and transmitter and window and core barrel	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/06/30 16:10
L7	5	cavity and instrument and core orientation and transmitter and window and core barrel	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/06/30 16:11
L11	5	cavity and instrument and orientation and transmitter and window and core barrel	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/06/30 16:12
S1	1	"14692484"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/06/16 07:57
S2	79	(("DRENTH") near3 ("CHRISTOPHER")).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/10 12:08
S3	145	(("STEWART") near3 ("GORDON")).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/10 12:21
S4	47	(("STEWART") near3 ("GORDON")).INV.	EPO; JPO; DERWENT	ADJ	ON	2017/08/10 12:21
S5	7	(("HEJLEH") near3 ("KHALED")).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/10 14:08

S6	2	("20120145461" | "6732818").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/10 15:04
S7	201	(E21B25/16).cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/10 15:07
S8	440,855	(power source or battery) and (body or housing)and (instrument or sensor)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/10 16:21
S9	0	WO "2008113127"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 10:41
S10	3	"2008113127"	US-PGPUB; USPAT; USOCR; DERWENT	ADJ	ON	2017/08/11 10:41
S11	201	(E21B25/16).cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:12
S12	48	S11 and (battery or power source)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:12
S13	3	(US-20150300162-$ or US-20150136488-$ or US-20150029035-$).did.	US-PGPUB	ADJ	ON	2017/08/11 11:15
S14	3	S13 and (battery or power source)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:15
S15	3	S13 and (battery or power source or power supply)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:19
S16	48	S11 and (battery or power source or power supply)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:19
S17	21	S11 and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:45
S18	0	702/2.cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:46
S19	921	702/2.ccls.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:46
S20	236	S19 and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:46

S21	8	S19 and window and core$3 and orientat$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:47
S22	606	E21B$.cpc.and window and core$3 and orientat$3 and (battery or power source or power supply)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:48
S23	606	E21B$.cpc. and window and core$3 and orientat$3 and (battery or power source or power supply)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:48
S24	263	E21B$.cpc. and window and core$3 and orientat$3 and (battery or power source or power supply) and wireline	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:54
S25	300	E21B$.cpc. and window and core$3 and orientat$3 and (battery or power source or power supply) and (wireline or wire line)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:54
S26	346	E21B$.cpc. and window and cor$3 and orientat$3 and (battery or power source or power supply) and (wireline or wire line)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 12:07
S27	1,730	window and cor$3 and orientat$3 and (battery or power source or power supply) and (wireline or wire line)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 12:08
S28	114	S27 AND ((E21B17/028 OR E21B47/09 OR E21B25/16).CPC.)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 12:20
S29	2	("20120145461" | "6732818").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:07
S30	0	("2012/0145461").URPN.	USPAT	ADJ	ON	2017/08/12 14:07
S31	20	("1701724" | "1773915" | "2120240" | "2489566" | "2974739" | "3059707" | "3148740" | "3207239" | "4128134" | "4558749" | "4883131").PN. OR ("6732818").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:07
S32	28	("20040036474" | "3618221" | "3875796" | "4128134" | "4311201" | "4389792" | "4765414" | "4883131" | "5048619" | "5052502" | "5105894" | "5310013" | "6006844" | "6082453" | "6412575" | "6592875" | "6659196" | "6732818" | "6871410" | "7296638").PN. OR ("7584055").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:07
S33	38	("1773915" | "2652232" | "3115196" | "5957221").PN. OR ("7296638").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:08

S34	846	E21B25/00.cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:09
S35	9	S34 and window and core$3 and orientat$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:09
S36	69	S34 and core$3 and orientat$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:09
S37	38	("1773915" | "2652232" | "3115196" | "5957221").PN. OR ("7296638").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:10
S38	101	("2489566" | "2735652" | "2820610" | "3059707" | "3127943" | "3481412" | "3548958" | "4601354" | "4765414" | "4815342" | "4955438" | "4981183" | "4982802" | "5009273" | "5010765" | "5010789" | "5020612" | "5029653" | "5038873" | "5042596" | "5090492" | "5099934" | "5103921" | "5109935" | "5111892" | "5119892" | "5131478" | "5165494" | "5178222" | "5253720" | "5322135" | "5339915" | "5351765" | "5448227" | "5568838").PN. OR ("6006844").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:11
S39	40	("2820610" | "3059707" | "3346059" | "4515225" | "4562560" | "4715022" | "4765414").PN. OR ("4955438").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:11
S40	0	("2015/0300162").URPN.	USPAT	ADJ	ON	2017/08/12 14:11
S41	0	("2015/0136488").URPN.	USPAT	ADJ	ON	2017/08/12 14:11
S42	0	("2015/0029035").URPN.	USPAT	ADJ	ON	2017/08/12 14:11
S43	1	"14962484"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:20
S44	12	"5601152"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:22
S45	1	"14692484"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:30
S46	203	(E21B25/16).cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:35

S47	0	core barrel and cavity and electronic intrument and sensor and power source and core and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:37
S48	1	core barrel and cavity and electronic instrument and sensor and power source and core and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:37
S49	1	core barrel and cavity and orientation and sensor and power source and core and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:38
S50	4,551	cavity and orientation and sensor and power source and core and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:38
S51	141	electronic instrument and cavity and orientation and sensor and power source and core and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:39
S56	2	("2944792").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/02/17 15:54
S57	204	(E21B25/16).cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/02/17 15:57
S64	3	"14692484"	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 09:35
S65	296	((("DRENTH") near3 ("CHRISTOPHER")) OR (("STEWART") near3 ("GORDON")) OR (("HEJLEH") near3 ("KHALED"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	ADJ	ON	2019/03/01 09:36
S66	213	(E21B25/16).cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 09:38
S67	0	WO "20133126955"	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 10:15
S68	6	(US-20150300162-$ or US-20150136488-$ or US-20150029035-$).did. or (US-6006844-$ or US-4955438-$ or US-7296638-$).did.	US-PGPUB; USPAT	ADJ	ON	2019/03/01 10:17
S69	3	S68 and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 10:17
S70	21	(US-0145461-$ | US-0300162-$ | US-10047581-$ | US-15782230-$ | US-1626126-$ | US-2944792-$ | US-2134921-$ | US-2243173-$ | US-3134600-$ | US-4955438-$ | US-	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:09

		5601152-$ | US-6732818-$ | US-7296638-$ | US-20120145461-$ | US-20150300162-$).DID.				
S71	39	("1773915" | "2652232" | "3115196" | "5957221").PN. OR ("7296638").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:17
S72	20	("3049185" | "3194326" | "3333647" | "4279315" | "4558749").PN. OR ("5601152").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:17
S73	34	("1752388" | "1867024" | "1870696" | "20010013429" | "20040065482" | "20050025594" | "20090317202" | "20100054884" | "20120241223" | "2484365" | "2689109" | "2708103" | "3140749" | "3517754" | "4848454" | "4951761" | "5161859" | "5601152" | "6698981" | "6799648" | "7281594" | "7296641" | "8763282" | "8960336" | "9162371").PN. OR ("D826299").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:17
S74	39	("1773915" | "2652232" | "3115196" | "5957221").PN. OR ("7296638").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:18
S75	7	("20120145461" | "2944792" | "4955438" | "5601152" | "6732818" | "7296638").PN. OR ("10047581").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:18
S76	0	(S68 or S70) and pressure fiting	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:22
S77	2	(S68 or S70) and pressure fitting	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:22
S78	4	(S68 or S70) and fitting	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:24
S79	2	(S68 or S70) and port same check valve	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:24
S80	11	(S66) and port same check valve	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:33
S81	3	S66 and pressure fitting	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:33
S82	1	"16017334"	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/06/24 00:58

S83	3	"14692484"	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/06/24 01:00
S84	3	cavity and wire line and port and window and electronic instrument and sensor and power source and transmitter	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/06/24 01:24
S85	217	E21B25/16.cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/06/24 01:24
S91	3	"16017334"	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 13:39
S92	9	"10047581"	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 14:25
S93	1	"16588026"	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 14:45
S94	0	E21B25/1.cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:09
S95	221	E21B25/16.cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:09
S96	312	((("DRENTH") near3 ("Christopher")) OR (("STEWART") near3 ("Gordon")) OR (("HEJLEH") near3 ("Khaled"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	ADJ	ON	2020/03/15 15:12
S97	8	("20120145461" | "2944792" | "4955438" | "5601152" | "6732818" | "7296638").PN. OR ("10047581").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:13
S98	8	(US-10047581-$ | US-10465463-$ | US-15782230-$ | US-19188334-$ | US-2946574-$ | US-3016744-$ | US-3134600-$).DID.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:15
S99	8	(US-10047581-$ | US-10465463-$ | US-15782230-$ | US-19188334-$ | US-2946574-$ | US-3016744-$ | US-3134600-$).DID.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:15
S100	23	(US-0145461-$ | US-0300162-$ | US-0305995-$ | US-10047581-$ | US-10465463-$ | US-15782230-$ | US-2944792-$ | US-2134921-$ | US-2243173-$ | US-3134600-$ | US-4955438-$ | US-5601152-$ | US-	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:16

		6732818-$ | US-7296638-$ | US-20120145461-$ | US-20150300162-$ | US-20180305995-$).DID.				
S101	0	barrel and cavity and intrument and transmitter and orientation data	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:22
S102	25	barrel and cavity and instrument and transmitter and orientation data	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:23

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L8	2	cavity and instrument and core orientation and transmitter and window and core barrel	USPAT	ADJ	ON	2020/06/30 16:11
L9	2	cavity and instrument and core orientation and transmitter and window	USPAT	ADJ	ON	2020/06/30 16:11
L10	2	cavity and instrument and orientation and transmitter and window and core barrel	USPAT	ADJ	ON	2020/06/30 16:11
S52	0	core barrel and cavity and electronic instrument and sensor and power source and core and window	USPAT	ADJ	ON	2017/10/30 11:37
S53	0	core barrel and cavity and orientation and sensor and power source and core and window	USPAT	ADJ	ON	2017/10/30 11:38
S54	1,848	cavity and orientation and sensor and power source and core and window	USPAT	ADJ	ON	2017/10/30 11:38
S55	72	electronic instrument and cavity and orientation and sensor and power source and core and window	USPAT	ADJ	ON	2017/10/30 11:39
S58	73	electronic instrument and cavity and orientation and sensor and power source and core and window	USPAT	ADJ	ON	2018/02/17 15:57
S59	0	electronic instrument and cavity and orientation and sensor and power source and core and window and (wireline or wire line) and orientation	USPAT	ADJ	ON	2018/02/17 15:59
S60	0	electronic instrument and cavity and orientation and sensor and power source and core and window and (wireline or wire line)	USPAT	ADJ	ON	2018/02/17 15:59
S61	73	electronic instrument and cavity and orientation and sensor and power source and core and window and orientation	USPAT	ADJ	ON	2018/02/17 15:59

S62	71	electronic instrument and cavity and orientation and sensor and power source and core and window and orientation and port	USPAT	ADJ	ON	2018/02/17 15:59
S63	71	electronic instrument and cavity and orientation and sensor and power source and core and window and orientation and port and cavity	USPAT	ADJ	ON	2018/02/17 16:00
S86	80	electronic instrument and cavity and orientation and sensor and power source and core and window and orientation and port and cavity	USPAT	ADJ	ON	2019/06/24 01:21
S87	0	electronic instrument and cavity and orientation and sensor and power source and core and window and orientation and port and cavity and core barrell head assembly	USPAT	ADJ	ON	2019/06/24 01:22
S88	80	electronic instrument and cavity and orientation and sensor and power source and core and window and orientation and port and base	USPAT	ADJ	ON	2019/06/24 01:22
S89	57	electronic instrument and cavity and orientation and sensor and power source and core and window and orientation and port and transmitter	USPAT	ADJ	ON	2019/06/24 01:22
S90	1	cavity and wire line and port and window and electronic instrument and sensor and power source and transmitter	USPAT	ADJ	ON	2019/06/24 01:24

6/30/2020 4:12:40 PM
C:\Users\mwills1\Documents\EAST\Workspaces\16588026.wsp

Bibliographic Data

Application No: 16/588,026

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /MICHAEL R WILLS III/ Examiner's Signature | Initials

Title: CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/30/2019	175	3676	36362.0150U4
RULE			

APPLICANTS

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GLOBALTECH CORPORATION PTY LTD, Canning Vale, WA, UNITED STATES

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Gordon STEWART Claremont, AUSTRALIA

Khaled HEJLEH Peppermint Grove, AUSTRALIA

CONTINUING DATA

This application is a CON of 16017334 06/25/2018 PAT 10465463

16017334 is a CON of 14692484 04/21/2015 PAT 10047581

14692484 has PRO of 61982052 04/21/2014

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

10/16/2019

STATE OR COUNTRY

CANADA

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Ballard Spahr LLP

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ATLANTA, GA 30309-3915

UNITED STATES

FILING FEE RECEIVED

$2,220

ATTORNEY DOCKET NO. 36362.0150U4
PATENT
VIA EFS-WEB

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	)	
	)	
DRENTH et al.	)	Art Unit: 3676
	)	
Application No.: 16/588,026	)	Examiner: Wills III, Michael R.
	)	
Filing Date: September 30, 2019	)	Confirmation No.: 7130
	)	
FOR: **CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME**	)	

RESPONSE TO NON-FINAL OFFICE ACTION

MAIL STOP AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Ballard Spahr LLP
Customer Number 23859

June 18, 2020

Commissioner:

In response to the Office Action dated March 19, 2020 (the "Office Action"), please amend the above-referenced application as set forth below and consider the Remarks that follow.

A **Listing of Claims** begins on page 2 of this Response.

Remarks begin on page 6 of this Amendment.

REFLEX EXHIBIT 1002 - 35/304

Electronic Acknowledgement Receipt

EFS ID:	39764117
Application Number:	16588026
International Application Number:	
Confirmation Number:	7130
Title of Invention:	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME
First Named Inventor/Applicant Name:	Christopher L. DRENTH
Customer Number:	23859
Filer:	Joseph P. Anderson
Filer Authorized By:	
Attorney Docket Number:	36362.0150U4
Receipt Date:	18-JUN-2020
Filing Date:	30-SEP-2019
Time Stamp:	16:53:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		36362_0150U4_Response_to_NonFinal_Office_Action.PDF	151886 627f67e83903507b479b18f75d4d14c585c9d973	yes	7

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Arguments/Remarks Made in an Amendment	6	7
	Claims	2	5
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Warnings:			
Information:			
	Total Files Size (in bytes):	151886	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

REMARKS

Claims 1-25 are pending. No claims have been amended or canceled, and no claims have been added. Therefore, claims 1-25 will remain under consideration.

Double Patent Rejections

Claims 1-25 were rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-25 of U.S. Patent No. 10,465,463. As requested by the Office Action, submitted herewith is an eTerminal Disclaimer to obviate the double patenting rejection. Accordingly, Applicant respectfully requests that the nonstatutory double patenting rejections be withdrawn.

REFLEX EXHIBIT 1002 - 38/304

CONCLUSION

In view of the above amendments and/or remarks, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue. The Examiner is invited and encouraged to contact directly the undersigned is such contact may enhance the efficient prosecution of this application to issue.

An electronic payment in the amount of $160.00, representing the large-entity fee for a terminal disclaimer, is submitted herewith. No additional fee(s) are believed due; however, the Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 14-0629.

Respectfully submitted,

Electronic signature: /Joseph P. Anderson, III/
Joseph P. Anderson, III
Registration No.: 59,245
BALLARD SPAHR LLP
Correspondence Customer Number: 23859

REFLEX EXHIBIT 1002 - 39/304

LISTING OF CLAIMS

1. (Original) A core barrel head assembly having an exterior surface and comprising:

a first interior cavity;

a selectively sealed interior cavity spaced distally from the first interior cavity and having a closed proximal end;

a threaded proximal end portion for coupling to a wire line retrieval portion of a head assembly;

a base portion, wherein the first interior cavity extends distally from the threaded proximal end portion to the base portion;

a window that extends from the exterior surface into optical communication with the sealed interior cavity proximate the closed proximal end of the sealed interior cavity;

at least one electronic instrument that is configured to obtain core orientation data, wherein the at least one electronic instrument comprises at least one digital and/or electro-mechanical sensor in a core orientation data recording tool; and

a transmitter configured to transmit core orientation data,

wherein the sealed interior cavity is sized and shaped to enclose the at least one electronic instrument.

2. (Original) The core barrel head assembly of Claim 1, further comprising:

a port positioned proximate the base portion and extending from the exterior surface into fluid communication with the first interior cavity; and

a grease fitting mounted in the port to allow for selective passage of grease or other lubricant to and from the exterior surface of the barrel head assembly into communication with the first interior cavity.

3. (Original) The core barrel head assembly of Claim 1, wherein the sealed interior cavity is sized and shaped to hermetically enclose the transmitter.

4. (Original) The core barrel head assembly of Claim 1, further comprising an orientation indicator module comprising a light emitter.

5. (Original) The core barrel head assembly of Claim 4, wherein the core barrel head assembly comprises a plurality of windows that extend from the exterior surface into optical communication with the sealed interior cavity proximate the closed proximal end of the

REFLEX EXHIBIT 1002 - 40/304

sealed interior cavity, wherein the orientation indicator module is sized and shaped to sealingly close the sealed interior cavity from any intrusion of pressurized fluid into the sealed interior cavity via the plurality of windows.

6. (Original) The core barrel head assembly of Claim 5, wherein the orientation indicator module is configured to orient or otherwise position the plurality of light emitters so that each light emitter underlies one window.

7. (Original) The core barrel head assembly of Claim 6, wherein the orientation indicator module further comprises at least one first O-ring seal for preventing any pressurized fluid from entering the sealed interior cavity from the plurality of windows, wherein the at least one first O-ring seal is mounted on an exterior portion of the orientation indicator module and is configured to seal between an exterior portion of the orientation indicator module and a portion of an interior surface of the sealed interior cavity.

8. (Original) The core barrel head assembly of Claim 1, further comprising an open and threaded distal end portion, wherein the sealed interior cavity extends distally to the open and threaded distal end portion of the core barrel head assembly.

9. (Original) The core barrel head assembly of Claim 8, further comprising a seal coupler that is configured to be sealingly received in the open threaded distal end portion of the core barrel head assembly.

10. (Original) The core barrel head assembly of Claim 9, further comprising at least one second O-ring seal for preventing any pressurized fluid from entering the sealed interior cavity, wherein the at least one second O-ring seal is mounted on a portion of the seal coupler and is configured to seal between a portion of the seal coupler and a portion of an interior surface of the open and threaded distal end portion of the core barrel head assembly.

11. (Original) The core barrel head assembly of Claim 6, further comprising a check valve assembly configured to affect a hermetical seal of the sealed interior cavity and to provide fluid control for wire line operation.

12. (Original) The core barrel head assembly of Claim 11, wherein the check valve assembly comprises a coupled proximal end assembly and a distally tapered seat that defines an interior chamber for operative receipt of a check ball.

13. (Original) The core barrel head assembly of Claim 12, further comprising a distal end portion, wherein the proximal end assembly of the check valve assembly defines a female

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threaded coupling that is configured to be threadably coupled to male threads defined on an exterior surface of the distal end portion of the core barrel head assembly.

14. (Original) The core barrel head assembly of Claim 12, wherein the interior chamber of the check valve assembly extends to a distal end of the check valve assembly, and wherein the check valve assembly further defines at least one port that extends from an exterior surface of the check valve assembly and is in fluid communication with the interior chamber of the check valve assembly.

15. (Original) The core barrel head assembly of Claim 14, wherein the interior chamber has a distally tapered seat that is adapted to selectively receive the check ball that is sized to selectively block the distally tapered seat.

16. (Original) The core barrel head assembly of Claim 15, wherein the interior chamber is sized and shaped to allow the check ball to selectively move axially between an open position, in which the check ball is spaced proximally away from the surface of the tapered seat so that pressurized fluid can move through the distal end of the check valve assembly and subsequently through the interior chamber to exit out of the at least one port, and a closed position, in which the check ball is pressurized against the surface of the tapered seat so that pressurized fluid cannot move through the check valve assembly.

17. (Original) The core barrel head assembly of Claim 1, wherein the exterior surface defines a plurality of female planar stops.

18. (Original) The core barrel head assembly of Claim 1, wherein the at least one electronic instrument is programmed to obtain orientation data when the at least one electronic instrument senses no relative movement of the at least one electronic instrument.

19. (Original) The core barrel head assembly of Claim 18, wherein the at least one electronic instrument is programmed to obtain orientation data when the at least one electronic instrument senses no vibrations, and wherein the at least one electronic instrument is programmed to not obtain orientation data when the at least one electronic instrument determines that the core barrel head assembly is in motion while descending down or ascending up the hole and during drilling.

20. (Original) The core barrel head assembly of Claim 1, wherein the at least one electronic instrument is programmed to obtain orientation data based on a predetermined time interval scheme.

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21. (Original) The core barrel head assembly of Claim 1, wherein the at least one electronic instrument is configured to obtain orientation data at random periods of time.

22. (Original) The core barrel head assembly of Claim 1, wherein the at least one electronic instrument is programmed to:

record orientation data relating to an orientation of the at least electronic instrument in a borehole; and

receive an interrogation command from an external communication device.

23. (Original) The core barrel head assembly of Claim 1, wherein the transmitter is configured to transmit core orientation data to a remote device through the window.

24. (Original) The core barrel head assembly of Claim 4, wherein the light emitter underlies the window, and wherein following retrieval of the core barrel head assembly from down a borehole, the light emitter is configured to provide a visual indication that a desired rotational orientation of the core barrel head assembly has been achieved.

25. (Original) The core barrel head assembly of Claim 24, wherein the light emitter is further configured to provide a visual indication that further rotation of the core barrel head assembly is required to reach the desired rotational orientation.

REFLEX EXHIBIT 1002 - 43/304

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/588,026	Filing Date 09/30/2019	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	06/18/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 25	Minus	** 25	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/TARA A WASHINGTON/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	16588026
Filing Date	30-Sep-2019
First Named Inventor	Christopher DRENTH
Attorney Docket Number	36362.0150U4
Title of Invention	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
Longyear TM, Inc.	50 %
Globaltech Corporation PTY LTD	50 %

The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)

10465463

as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

(●) Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

( ) I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.

Applicant claims the following fee status:

( ) Small Entity

( ) Micro Entity

(●) Regular Undiscounted

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

(●) An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

Registration Number 59245

( ) A sole inventor

( ) A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application

( ) A joint inventor; all of whom are signing this request

Signature	/Joseph P. Anderson III/
Name	/Joseph P. Anderson III

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	16588026
Filing Date:	30-Sep-2019
Title of Invention:	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME
First Named Inventor/Applicant Name:	Christopher L. DRENTH
Filer:	Joseph P. Anderson
Attorney Docket Number:	36362.0150U4

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	1814	1	160	160
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**160**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 16588026

Filing Date: 30-Sep-2019

Applicant/Patent under Reexamination: DRENTH

Electronic Terminal Disclaimer filed on June 18, 2020

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt

EFS ID:	39762477
Application Number:	16588026
International Application Number:	
Confirmation Number:	7130
Title of Invention:	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME
First Named Inventor/Applicant Name:	Christopher L. DRENTH
Customer Number:	23859
Filer:	Joseph P. Anderson
Filer Authorized By:	
Attorney Docket Number:	36362.0150U4
Receipt Date:	18-JUN-2020
Filing Date:	30-SEP-2019
Time Stamp:	15:51:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$160
RAM confirmation Number	E20206HF51049445
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	34716 f433cf731937db9425dc830ae10682d6623b0dc1	no	3
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30508 d3c347a146d5bb6a4ef346a24dd7d31076ee780f	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	65224		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	Christopher L. Drenth
Art Unit	3676
Examiner Name	WILLS III, MICHAEL R
Attorney Docket Number	36362.0150U4

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. * CITE NO.: Those application(s) which are marked with an single asterisk (*) next to the Cite No. are not supplied (under 37 CFR 1.98(a)(2)(iii)) because that application was filed after June 30, 2003 or is available in the IFW. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: June 16, 2020 Electronic Signature: /Benjamin D. Kirk/ (Benjamin D. Kirk)

PTO/SB/08b (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 2 of 2

Complete if Known	
Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	Christopher L. Drenth
Art Unit	3676
Examiner Name	WILLS III, MICHAEL R
Attorney Docket Number	36362.0150U4

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	A	"Devicore BBT Directional Core Drilling Borehole Planning Service" Retrieved from the Internet:URL:http://www.devico.com/products/devicore-bbt [stored on the Wayback Machine on February 14, 2014]	

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

Electronic Patent Application Fee Transmittal

Application Number:	16588026
Filing Date:	30-Sep-2019
Title of Invention:	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME
First Named Inventor/Applicant Name:	Christopher L. DRENTH
Filer:	Benjamin D Kirk/Sharon DeLee
Attorney Docket Number:	36362.0150U4

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	240	240
		Total in USD ($)		**240**

Electronic Acknowledgement Receipt

EFS ID:	39729161
Application Number:	16588026
International Application Number:	
Confirmation Number:	7130
Title of Invention:	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME
First Named Inventor/Applicant Name:	Christopher L. DRENTH
Customer Number:	23859
Filer:	Benjamin D Kirk
Filer Authorized By:	
Attorney Docket Number:	36362.0150U4
Receipt Date:	16-JUN-2020
Filing Date:	30-SEP-2019
Time Stamp:	11:46:07
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$240
RAM confirmation Number	E20206FB46343128
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	36362_0150U4_SIDS_Transmittal.PDF	153028 c3d3a78adcfd3b2a234336957a75bd9acbc39c4a	no	2
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	36362_0150U4_SIDS_SB08.PDF	226575 6ae616cd9e220f2b8ff1f5f98d8f0ff8c143caf5	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Non Patent Literature	36362_0150U4_Devicore_BBT1.pdf	704704 389fdf44c08f02a098dff78bc2e4d39b6ff6dc94	no	2
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30791 d6f227984df61f869c824514b15b0cf7c96aef5c	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1115098		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: June 16, 2020
Electronic Signature for Benjamin D. Kirk /Benjamin D. Kirk/

ATTORNEY DOCKET NO. 36362.0150U4
VIA EFS-WEB
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	)	
	)	
CHRISTOPHER L. DRENTH, ET AL.	)	Art Unit: 3676
	)	
Application No.: 16/588,026	)	Examiner: WILLS III, MICHAEL R
	)	
Filing Date: September 30, 2019	)	Confirmation No.: 7130
	)	
For:	)	
CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME	)	

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

MAIL STOP AMENDMENT
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

BALLARD SPAHR LLP
Customer No. 23859

June 16, 2020

Commissioner:

Pursuant to the requirements set forth in 37 C.F.R. § 1.56, Applicant now submits a list of documents known to Applicant or Applicant's attorneys. Pursuant to 37 C.F.R. § 1.98(a)(2)(iv), and for the Examiner's review, Applicant has enclosed (1) copies of documents from the prosecution of related non-U.S. patent applications, (2) copies of non-U.S. patents or non-U.S. patent application publications, and (3) copies of non-patent literature. In accordance with 37 C.F.R. § 1.98(a)(2), copies of any cited U.S. patent or U.S. patent application publication documents are not enclosed.

Applicant respectfully requests consideration of all documents submitted in the present Supplemental Information Disclosure Statement and List and entry into the record for the present application (Application No. 16/588,026).

Pursuant to 37 C.F.R. § 1.97(c)(2), Applicant submits that this document is timely filed in that the Patent and Trademark Office has not yet mailed to Applicant a final action on the merits, a notice of allowance, or any action that otherwise closes prosecution. With this Information Disclosure Statement, Applicant submits a credit card payment in the amount of $240 pursuant to 37 C.F.R. § 1.17(p). Applicant submits that this is the correct fee due; however, Applicant hereby authorizes the Commissioner to charge

REFLEX EXHIBIT 1002 - 60/304

to Deposit Account No. 14-0629 any fee that may be required to effect the consideration and entry of this Information Disclosure Statement and List and the references contained therein.

Respectfully submitted,

Electronic signature: /Benjamin D. Kirk/
Benjamin D. Kirk
Registration No.: 74,848
BALLARD SPAHR LLP
Correspondence Customer Number: 23859

REFLEX EXHIBIT 1002 - 61/304

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/588,026	09/30/2019	Christopher L. DRENTH	36362.0150U4

CONFIRMATION NO. 7130

POA ACCEPTANCE LETTER

23859
Ballard Spahr LLP
SUITE 1000
999 PEACHTREE STREET
ATLANTA, GA 30309-3915

OC000000116332517

Date Mailed: 04/23/2020

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/15/2020.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/mbeyene/

REFLEX EXHIBIT 1002 - 62/304

Electronic Acknowledgement Receipt

EFS ID:	39168507
Application Number:	16588026
International Application Number:	
Confirmation Number:	7130
Title of Invention:	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME
First Named Inventor/Applicant Name:	Christopher L. DRENTH
Customer Number:	23859
Filer:	Joseph P. Anderson/Sharon DeLee
Filer Authorized By:	Joseph P. Anderson
Attorney Docket Number:	36362.0150U4
Receipt Date:	15-APR-2020
Filing Date:	30-SEP-2019
Time Stamp:	17:19:49
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	36362_0150U4_POA.pdf	529400 a82d6ce261d68811aa77efef6f30162e3347455e	no	5

Warnings:

Information:	
Total Files Size (in bytes):	529400

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
Approved for use through 11/30/2014. OMB 0651-0051
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	DRENTH, Christopher L.
Title	Core Barrel Head Assembly With An Integrated Sample Orientation Tool And System For Using Same
Art Unit	3676
Examiner Name	WILLS, Michael R. III
Attorney Docket Number	36362.0150U4

SIGNATURE of Applicant or Patent Practitioner

Signature	/Joseph P. Anderson III/	Date (Optional)	
Name	Joseph P. Anderson III	Registration Number	59,245
Title (if Applicant is a juristic entity)	Patent Practitioner		
Applicant Name (if Applicant is a juristic entity)	Longyear TM, Inc., and Globaltech Corporation PTY LTD		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of two forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/80 (07-17)
Approved for use through 03/31/2021. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no person is required to respond to a collection of information unless it displays a valid OMB control number

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

[X] Practitioners associated with Customer Number: 23859

OR

[ ] Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

[X] The address associated with Customer Number:

OR

[ ]

Firm or individual name		
Address		
City	State	Zip
Country		
Telephone	Email	

Assignee name and address: Longyear TM, Inc.
2455 S. 3600 W.
Salt Lake City, Utah 84119

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of the practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee.

Signature	Date
Name: Robert Closner	Telephone
Title: Vice President and General Counsel, Longyear TM, Inc.	

This collection of information is required by 37 CFR 1.31, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public, which is to update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 18 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/80 (07-12)
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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

☐ Practitioners associated with Customer Number: 23859

OR

☒ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignments documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

☒ The address associated with Customer Number:

OR

☐	Firm or Individual Name			
	Address			
	City		State	Zip
	Country			
	Telephone		Email	

Assignee Name and Address: GLOBALTECH CORPORATION PTY LTD
ABN 18 087 281 418 of 1/48
Vinnicombe Drive
Canning Vale, Australia 6155

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be Filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of The practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	Digitally signed by Khaled Hejleh Date: 2015.09.10 10:42:35 +08'00'	Date	
Name		Telephone	
Title	Managing Director		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Longyear TM, Inc., and Globaltech Corporation PTY LTD

Application No./Patent No.: 16/588,026 Filed/Issue Date: September 30, 2019

Titled: Core Barrel Head Assembly With An Integrated Sample Orientation Tool And System For Using Same

Longyear TM, Inc., and Globaltech Corporation PTY LTD, a Corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☑ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 051087, Frame 0682, or for which a copy thereof is attached.

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

   1. From: _____ To: _____

      The document was recorded in the United States Patent and Trademark Office at

      Reel _____, Frame _____, or for which a copy thereof is attached.

   2. From: _____ To: _____

      The document was recorded in the United States Patent and Trademark Office at

      Reel _____, Frame _____, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**.

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PTO/AIA/96 (08-12)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Joseph P. Anderson III/	April 15, 2020
Signature	Date
Joseph P. Anderson III	59245
Printed or Typed Name	Title or Registration Number

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/588,026	09/30/2019	Christopher L. DRENTH	36362.0150U4	7130

23859 7590 03/19/2020

Ballard Spahr LLP
SUITE 1000
999 PEACHTREE STREET
ATLANTA, GA 30309-3915

EXAMINER
WILLS III, MICHAEL R

ART UNIT	PAPER NUMBER
3676	

NOTIFICATION DATE	DELIVERY MODE
03/19/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

USpatentmail@ballardspahr.com

Office Action Summary	Application No. 16/588,026	Applicant(s) DRENTH et al.	
	Examiner MICHAEL R WILLS III	Art Unit 3676	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 30 September 2019.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-25 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-25 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 30 September 2019 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Double Patenting

2. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(l)(1) - 706.02(l)(3) for applications not subject to examination under the first inventor

to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

3. Claims 1-25 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-25 of U.S. Patent No. US Patent 10,465,463. Although the claims at issue are not identical, they are not patentably distinct from each other because they both are claiming a core barrel head assembly having an exterior surface and comprising: a first interior cavity; a selectively sealed interior cavity spaced distally from the first interior cavity and having a closed proximal end; a threaded proximal end portion for coupling to a wire line retrieval portion of a head assembly; a base portion, wherein the first interior cavity extends distally from the threaded proximal end portion to the base portion; a window that extends from the exterior surface into optical communication with the sealed interior cavity proximate the closed proximal end of the sealed interior cavity; at least one electronic instrument that is configured to obtain core orientation data, wherein the at least one electronic instrument comprises at least one digital and/or electro-mechanical sensor in a core orientation data recording tool; and a transmitter configured to transmit core orientation data, wherein the sealed interior cavity is sized and shaped to enclose the at least one electronic instrument.. The only difference is U.S. Patent No.

10,465,463 includes the limitation a port positioned proximate the base portion and extending from the exterior surface into fluid communication with the first interior cavity. However this limitation is included in claim 2 of the current application and claim2 depends from claim Additionally, U.S. Patent No. 10,465,463 teaches a power source in claim 1 but a power source for an electronic instrument is well known in the art.

Conclusion

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MICHAEL R WILLS III whose telephone number is (571)272-5521. The examiner can normally be reached on Monday-Friday 8:30am to 5:00pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Waseem Moorad can be reached on 5712703436. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would

like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MICHAEL R WILLS III/
Primary Examiner, Art Unit 3676

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/588,026	DRENTH et al.
	Examiner	Art Unit
	MICHAEL R WILLS III	3676

CPC - Searched*		
Symbol	Date	Examiner
E21B25/16	03/15/2020	MW

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
See East Search History	03/15/2020	MW
Forward/Backward Search	03/15/2020	MW
Inventor Name Search	03/15/2020	MW
Global Dossier	03/15/2020	MW

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 5

Complete if Known	
Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	Christopher L. Drenth
Art Unit	3676
Examiner Name	Not Yet Assigned
Attorney Docket Number	36362.0150U4

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	A	US-2,944,792-A	07-12-1960	Gros	
	B	US-4,955,438	09-11-1990	Juergens et al.	
	C	US-5,601,152	02-11-1997	Harrison	
	D	US-6,732,818	05-11-2004	Gregory	
	E	US-7,296,638	11-20-2007	Beach et al.	
	F	US-10,047,581	08-14-2018	Drenth et al.	
	G	US-10,465,463	11-05-2019	Drenth et al.	
	H	US-2012/0145461-A1	06-14-2012	Cravatte	
	I	US-2015/0300162-A1	10-22-2015	Drenth et al.	
	J	US-2018/0305995-A1	10-25-2018	Drenth et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	A	AU-2015249889-B2	08-01-2019	Globaltech Corp Pty Ltd		
	B	CN-101649727-A	02-17-2010	Univ China Mining	Machine Translation	√
	C	CN-201396092-Y	02-03-2010	Univ China Mining	Machine Translation	√
	D**	EP-2134921-A1	12-23-2009	2iC Australia Pty Ltd.		
	E	EP-3134600	03-01-2017	Longyear Tm, Inc	Corresponds to WO 2015/164394A1	√
	F**	GB-2243173-A	10-23-1991	Seafloors Eng Inc		
	G**	WO-2006/024111	03-09-2006	AUSTRALIAN MUD COMPANY LTD		

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5]Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: February 21, 2020 Electronic Signature: /Benjamin D. Kirk/ (Benjamin D. Kirk)

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.R.W/

PTO/SB/08a (07-09)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 2 of 5

Complete if Known	
Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	Christopher L. Drenth
Art Unit	3676
Examiner Name	Not Yet Assigned
Attorney Docket Number	36362.0150U4

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	H**	WO-2007/104103-A1	09-20-2007	2ic Australia Pty Ltd,		
	I**	WO-2007/137356	12-06-2007	2IC AUSTRALIA PTY LTD		
	J**	WO-2008/113127-A1	09-25-2008	2ic Australia Pty Ltd,		
	K**	WO-2010/094060	08-26-2010	IMDEX TECHNOLOGY AUSTRALIA PTY		
	L**	WO-2013/040641	03-28-2013	IMDEX GLOBAL BV		
	M**	WO-2013/126955	09-06-2013	GLOBALTECH CORP PTY LTD		

Examiner Signature	/MICHAEL R WILLS III/	Date Considered	03/15/2020

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5]Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.R.W/

PTO/SB/08a (07-09)
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 3 of 5

Complete if Known	
Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	Christopher L. Drenth
Art Unit	3676
Examiner Name	Not Yet Assigned
Attorney Docket Number	36362.0150U4

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	N**	WO-2014/053012-A1	04-10-2014	Minnovare Pty Ltd		
	O**	WO-2014/089618	06-19-2014	2IC AUSTRALIA PTY LTD		
	P**	WO-2015/164394-A1	10-29-2015	Longyear Tm, Inc		

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5]Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.R.W/

PTO/SB/08b (07-09)
Approved for use through 11/30/2020. OMB 0651-0031
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	4	of	5

Complete if Known	
Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	Christopher L. Drenth
Art Unit	3676
Examiner Name	Not Yet Assigned
Attorney Docket Number	36362.0150U4

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	A**	International Search Report and Written Opinion were mailed on 7/24/2015 by the International Searching Authority for International Application No. PCT/US2015/026907, filed on 4/21/2015 and published as WO 2015/164394 on 10/29/2015 (Applicant- Longyear TM, Inc.) (Attorney Docket36362.0150P1) (11 Pages)	
	B**	International Preliminary Report on Patentability was mailed on 10/25/2016 by the International Searching Authority for International Application No. PCT/US2015/026907, filed on 4/21/2015 and published as WO 2015/164394 on 10/29/2015 (Applicant- Longyear TM, Inc.) (Attorney Docket36362.0150P1) (9 Pages)	
	C**	Third Party Observations dated August 17, 2016 for International Patent Application No. PCT/US2015/026907 (Applicant- Longyear TM, Inc.) (42 pages)	
	D**	Examination Report was issued on 8/14/2018 by the Australian Patent Office for AU Application No. 2015249889, which was filed on 4/21/2015 (Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150AU1) (3 pages)	
	E	Notice of Acceptance was issued on 7/23/2019 by the Australian Patent Office for AU Application No. 2015249889, which was filed on 4/21/2015 (Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150AU1) (3 pages)	
	F**	Office Action was issued on 7/11/2018 by the Chilean Patent Office for CL Application No. 2016-002684, which was filed on 4/21/2015 (Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150CL1) (3 pages)	
	G	First Office Action was issued on 9/10/2018 by the SIPO for CN Application No.2015800211077, filed on 4/21/2015 and published CN 107109899 as 8/29/2017 on (Applicant- Longyear TM, Inc.) (Attorney Docket 36362.0150CN1) (5 Pages)	
	H	Second Office Action was issued on 1/19/2020 by the SIPO for CN Application No.2015800211077, filed on 4/21/2015 and published CN 107109899 as 8/29/2017 on (Applicant- Longyear TM, Inc.) (Attorney Docket 36362.0150CN1) (6 Pages)	
	I**	Extended European Search Report issued on 10/17/2017 by the European Patent Office for Application No. 15782230.5, which was filed on April 21, 2015 and published as EP 3134600 on March 1, 2017 (Inventor- Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150EP1) (9 pages)	
	J**	Preliminary Amendment was mailed on 2/28/2017 to the USPTO for U.S. Application No. 14/692,484, which was filed on April 21, 2015 and granted as 10,047,581 on 8/14/2018 (Inventor- Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150U2) (7 pages)	

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] Applicant's unique citation designation number (optional). [2] Applicant is to place a check mark here if English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.R.W/

PTO/SB/08b (07-09)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	5	of	5

Complete if Known	
Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	Christopher L. Drenth
Art Unit	3676
Examiner Name	Not Yet Assigned
Attorney Docket Number	36362.0150U4

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	K**	Non Final Rejection was issued on 8/18/2017 by the USPTO for U.S. Application No. 14/692,484, which was filed on April 21, 2015 and granted as 10,047,581 on 8/14/2018 (Inventor- Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150U2) (7 pages)	
	L**	Response to Non Final Rejection was mailed on 10/18/2017 to the USPTO for U.S. Application No. 14/692,484, which was filed on April 21, 2015 and granted as 10,047,581 on 8/14/2018 (Inventor-Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150U2) (9 pages)	
	M**	Notice of Allowance was issued on 11/8/2017 by the USPTO for U.S. Application No. 14/692,484, which was filed on April 21, 2015 and granted as 10,047,581 on 8/14/2018 (Inventor- Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150U2) (5 pages)	
	N**	Notice of Allowance was issued on 4/12/2018 by the USPTO for U.S. Application No. 14/692,484, which was filed on April 21, 2015 and granted as 10,047,581 on 8/14/2018 (Inventor- Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150U2) (7 pages)	
	O**	Issue Notification was issued on 7/25/2018 by the USPTO for U.S. Application No. 14/692,484, which was filed on April 21, 2015 and granted as 10,047,581 on 8/14/2018 (Inventor- Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150U2) (1 page)	
	P	Non Final Rejection was issued on 3/14/2019 by the USPTO for U.S. Application No. 16/017,334, filed on 6/25/2018 and granted as 10,465,463 on 11/5/2019 (Inventor-CHRISTOPHER L. DRENTH) (Attorney Docket 36362.0150U3) (11 Pages)	
	Q	Response Non Final Rejection was mailed on 6/12/2019 to the USPTO for U.S. Application No. 16/017,334, filed on 6/25/2018 and granted as 10,465,463 on 11/5/2019 (Inventor-CHRISTOPHER L. DRENTH) (Attorney Docket 36362.0150U3) (9 Pages)	
	R	Notice of Allowance was issued on 3/14/2019 by the USPTO for U.S. Application No. 16/017,334, filed on 6/25/2018 and granted as 10,465,463 on 11/5/2019 (Inventor-CHRISTOPHER L. DRENTH) (Attorney Docket 36362.0150U3) (5 Pages)	
	S	Issue Notification was issued on 3/14/2019 by the USPTO for U.S. Application No. 16/017,334, filed on 6/25/2018 and granted as 10,465,463 on 11/5/2019 (Inventor-CHRISTOPHER L. DRENTH) (Attorney Docket 36362.0150U3) (1 Page)	

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] Applicant's unique citation designation number (optional). [2] Applicant is to place a check mark here if English language Translation is attached.

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I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: February 21, 2020
Electronic Signature for Benjamin D. Kirk /Benjamin D. Kirk/

ATTORNEY DOCKET NO. 36362.0150U4
VIA EFS-WEB
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	)	
	)	
CHRISTOPHER L. DRENTH, ET AL.	)	Art Unit: 3676
	)	
Application No.: 16/588,026	)	Examiner: *Not Yet Assigned*
	)	
Filing Date: September 30, 2019	)	Confirmation No.: 7130
	)	
For: **CORE BARREL HEAD ASSEMBLYWITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME**	)	

INFORMATION DISCLOSURE STATEMENT

MAIL STOP AMENDMENT
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

BALLARD SPAHR LLP
Customer No. 23859

February 21, 2020

Commissioner:

Pursuant to the requirements set forth in 37 C.F.R. § 1.56, Applicant now submits a list of documents known to Applicant or Applicant's attorneys. Pursuant to 37 C.F.R. § 1.98(a)(2)(iv), and for the Examiner's review, Applicant has enclosed (1) copies of documents from the prosecution of related U.S. and non-U.S. patent applications, and (2) copies of non-U.S. patents or non-U.S. patent application publications. In accordance with 37 C.F.R. § 1.98(a)(2), copies of any cited U.S. patent or U.S. patent application publication documents are not enclosed.

Applicant has enclosed an English language abstract of any non-U.S. Patent or Patent Application which is written in a foreign language.

In accordance with 37 C.F.R. § 1.98(d), those documents which are marked with a double asterisk (**) next to the Cite No. in the attached form PTO/SB/08 are not supplied because they were previously cited by or submitted to the Office in prior application numbers 14/692,484 filed April 21, 2015, and 16/017,334 filed June 25, 2018 and relied upon in this application for an earlier filing date under 35 U.S.C. 120.

Regarding the documents from the prosecution of related U.S. and non-U.S. patent applications, Applicant notes that 37 C.F.R. § 1.98(b) does not mention, and thus does not require, that Applicant provide any particular set of identifying information. While 37 C.F.R. § 1.98(a)(1) requires Applicant to provide a

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.R.W/

REFLEX EXHIBIT 1002 - 82/304

list of such documents, it does not require Applicant to include in that list specific identifying information. 37 C.F.R. § 1.98(a)(2)(iv) further requires Applicant to provide a copy of such documents. Thus, the rules do not require that Applicant provide any particular set of information about these documents prior to the Examiner's consideration of all the cited information. Nevertheless, in order to be as helpful as possible, Applicant has provided (a) information regarding the source of the documents, and (b) a title or description of each document. Accordingly, in the list required by 37 C.F.R. § 1.98(a)(1), Applicant has identified the prosecution record of U.S. and non-U.S. patent applications as the source for each document. The information provided mirrors the requirements for cited U.S. and non-U.S. patent applications as set forth by 37 C.F.R. § 1.98(b).

Applicant respectfully requests consideration of all documents submitted in the present Information Disclosure Statement and List and entry into the record for the present application (Application No. 16/588,026).

Applicant would like to bring to the Examiner's attention the existence of the following U.S patent applications.

INFORMATION DISCLOSURE STATEMENT for Application No. 16/588,026 (Attorney Docket No. 36362.0150U4) Disclosure of U.S. Patent Applications				
Examiner's Initials	**App. No. (Pub./Patent No.)**	**Filing Date (Pub./Issue Date)**	**1st Named Inventor (Applicant)**	**Attorney Docket No.**
	61/982,052	04/21/2014	Christopher L. Drenth	36362.0150U1-
	14/692,484 (10,047,581)	04/21/2015 (8/14/2018)	Christopher L. Drenth	36362.0150U2-
	16/017,334 (10,465,463)	06/25/2018 (11/5/2019)	Christopher L. Drenth	36362.0150U3

Applicants would like to bring to the Examiner's attention the existence of the following non-U.S. patent applications.

INFORMATION DISCLOSURE STATEMENT for Application No. 16/017,334 (Attorney Docket No. 36362.0150U3) Disclosure of Non-U.S. Patent Applications					
Examiner's Initials	**Country**	**Application No. (Publication No.)**	**Filing Date**	**1st Named Inventor (Applicant)**	**Attorney Docket No.**
	AU	2015249889	04/21/2015	Longyear TM, Inc.	36362.0150AU1

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REFLEX EXHIBIT 1002 - 83/304

ATTORNEY DOCKET NO. 36362.0150U4
APPLICATION NO. 16/588,026

INFORMATION DISCLOSURE STATEMENT for Application No. 16/017,334 (Attorney Docket No. 36362.0150U3) Disclosure of Non-U.S. Patent Applications					
Examiner's Initials	**Country**	**Application No. (Publication No.)**	**Filing Date**	**1st Named Inventor (Applicant)**	**Attorney Docket No.**
	AU	2019257536 (AU 2015249889)	4/21/2015 (11/14/2019)	Longyear TM, Inc.	36362.0150AU2
	BR	BR112016024554.7	04/21/2015	Longyear TM, Inc.	36362.0150BR1
	CA	2946574	04/21/2015	Longyear TM, Inc.	36362.0150CA1
	CL	2016-002684	04/21/2015	Longyear TM, Inc.	36362.0150CL1
	CN	2015800211077	04/21/2015	Longyear TM, Inc.	36362.0150CN1
	EP	15782230.5 (EP 3134600)	04/21/2015 (9/4/2019)	Longyear TM, Inc.	36362.0150EP1
	EP	19188334.7	4/21/2015	Longyear TM, Inc.	36362.0150EP2
	PCT	PCT/US2015/026907 (WO2015/164394)	04/21/2015 (10/29/2015)	Longyear TM, Inc.	36362.0150P1-
	PE	2111-2016	04/21/2015	Longyear TM, Inc.	36362.0150PE1
	ZA	2016/07259	04/21/2015	Longyear TM, Inc.	36362.0150ZA1

Pursuant to 37 C.F.R. § 1.97(b)(3), Applicant submits that this document is timely filed in that the Patent and Trademark Office has not yet mailed to Applicant a first Office Action on the merits. Applicant submits that no fee is due; however, Applicant hereby authorizes the Commissioner to charge to Deposit Account No. 14-0629 any fee that may be required to effect the consideration and entry of this Information Disclosure Statement and List and the references contained therein.

Respectfully submitted,

Electronic signature: /Benjamin D. Kirk/
Benjamin D. Kirk
Registration No.: 74,848
BALLARD SPAHR LLP
Correspondence Customer Number: 23859

/MICHAEL R WILLS III/ 03/15/2020

3016744

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.R.W/

REFLEX EXHIBIT 1002 - 84/304

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	3	"16017334"	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 13:39
L2	9	"10047581"	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 14:25
L3	1	"16588026"	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 14:45
L4	0	E21B25/1.cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:09
L5	221	E21B25/16.cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:09
L6	312	((("DRENTH") near3 ("Christopher")) OR (("STEWART") near3 ("Gordon")) OR (("HEJLEH") near3 ("Khaled"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	ADJ	ON	2020/03/15 15:12
L7	8	("20120145461" | "2944792" | "4955438" | "5601152" | "6732818" | "7296638").PN. OR ("10047581").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:13
L8	8	(US-10047581-$ | US-10465463-$ | US-15782230-$ | US-19188334-$ | US-2946574-$ | US-3016744-$ | US-3134600-$).DID.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:15
L9	8	(US-10047581-$ | US-10465463-$ | US-15782230-$ | US-19188334-$ | US-2946574-$ | US-3016744-$ | US-3134600-$).DID.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:15
L10	23	(US-0145461-$ | US-0300162-$ | US-0305995-$ | US-10047581-$ | US-10465463-$ | US-15782230-$ | US-2944792-$ | US-2134921-$ | US-2243173-$ | US-3134600-$ | US-4955438-$ | US-5601152-$ | US-6732818-$ | US-7296638-$ | US-20120145461-$ | US-20150300162-$ | US-20180305995-$).DID.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:16
L11	0	barrel and cavity and intrument and transmitter and orientation data	US-PGPUB;	ADJ	ON	2020/03/15 15:22

			USPAT; USOCR			
L12	25	barrel and cavity and instrument and transmitter and orientation data	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/03/15 15:23
S1	1	"14692484"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/06/16 07:57
S2	79	(("DRENTH") near3 ("CHRISTOPHER")).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/10 12:08
S3	145	(("STEWART") near3 ("GORDON")).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/10 12:21
S4	47	(("STEWART") near3 ("GORDON")).INV.	EPO; JPO; DERWENT	ADJ	ON	2017/08/10 12:21
S5	7	(("HEJLEH") near3 ("KHALED")).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/10 14:08
S6	2	("20120145461" | "6732818").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/10 15:04
S7	201	(E21B25/16).cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/10 15:07
S8	440855	(power source or battery) and (body or housing)and (instrument or sensor)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/10 16:21
S9	0	WO "2008113127"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 10:41
S10	3	"2008113127"	US-PGPUB; USPAT; USOCR; DERWENT	ADJ	ON	2017/08/11 10:41
S11	201	(E21B25/16).cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:12
S12	48	S11 and (battery or power source)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:12
S13	3	(US-20150300162-$ or US-20150136488-$ or US-20150029035-$).did.	US-PGPUB	ADJ	ON	2017/08/11 11:15
S14	3	S13 and (battery or power source)	US-PGPUB; USPAT;	ADJ	ON	2017/08/11 11:15

			USOCR			
S15	3	S13 and (battery or power source or power supply)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:19
S16	48	S11 and (battery or power source or power supply)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:19
S17	21	S11 and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:45
S18	0	702/2.cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:46
S19	921	702/2.ccls.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:46
S20	236	S19 and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:46
S21	8	S19 and window and core$3 and orientat$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:47
S22	606	E21B$.cpc.and window and core$3 and orientat$3 and (battery or power source or power supply)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:48
S23	606	E21B$.cpc. and window and core$3 and orientat$3 and (battery or power source or power supply)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:48
S24	263	E21B$.cpc. and window and core$3 and orientat$3 and (battery or power source or power supply) and wireline	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:54
S25	300	E21B$.cpc. and window and core$3 and orientat$3 and (battery or power source or power supply) and (wireline or wire line)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 11:54
S26	346	E21B$.cpc. and window and cor$3 and orientat$3 and (battery or power source or power supply) and (wireline or wire line)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 12:07
S27	1730	window and cor$3 and orientat$3 and (battery or power source or power supply) and (wireline or wire line)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 12:08
S28	114	S27 AND ((E21B17/028 OR E21B47/09 OR E21B25/16).CPC.)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/11 12:20
S29	2	("20120145461" | "6732818").PN.	US-	ADJ	ON	2017/08/12

			PGPUB; USPAT; USOCR			14:07
S30	0	("2012/0145461").URPN.	USPAT	ADJ	ON	2017/08/12 14:07
S31	20	("1701724" | "1773915" | "2120240" | "2489566" | "2974739" | "3059707" | "3148740" | "3207239" | "4128134" | "4558749" | "4883131").PN. OR ("6732818").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:07
S32	28	("20040036474" | "3618221" | "3875796" | "4128134" | "4311201" | "4389792" | "4765414" | "4883131" | "5048619" | "5052502" | "5105894" | "5310013" | "6006844" | "6082453" | "6412575" | "6592875" | "6659196" | "6732818" | "6871410" | "7296638").PN. OR ("7584055").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:07
S33	38	("1773915" | "2652232" | "3115196" | "5957221").PN. OR ("7296638").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:08
S34	846	E21B25/00.cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:09
S35	9	S34 and window and core$3 and orientat$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:09
S36	69	S34 and core$3 and orientat$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:09
S37	38	("1773915" | "2652232" | "3115196" | "5957221").PN. OR ("7296638").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:10
S38	101	("2489566" | "2735652" | "2820610" | "3059707" | "3127943" | "3481412" | "3548958" | "4601354" | "4765414" | "4815342" | "4955438" | "4981183" | "4982802" | "5009273" | "5010765" | "5010789" | "5020612" | "5029653" | "5038873" | "5042596" | "5090492" | "5099934" | "5103921" | "5109935" | "5111892" | "5119892" | "5131478" | "5165494" | "5178222" | "5253720" | "5322135" | "5339915" | "5351765" | "5448227" | "5568838").PN. OR ("6006844").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:11
S39	40	("2820610" | "3059707" | "3346059" | "4515225" | "4562560" | "4715022" | "4765414").PN. OR ("4955438").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/08/12 14:11
S40	0	("2015/0300162").URPN.	USPAT	ADJ	ON	2017/08/12 14:11
S41	0	("2015/0136488").URPN.	USPAT	ADJ	ON	2017/08/12 14:11

REFLEX EXHIBIT 1002 - 88/304

S42	0	("2015/0029035").URPN.	USPAT	ADJ	ON	2017/08/12 14:11
S43	1	"14962484"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:20
S44	12	"5601152"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:22
S45	1	"14692484"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:30
S46	203	(E21B25/16).cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:35
S47	0	core barrel and cavity and electronic intrument and sensor and power source and core and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:37
S48	1	core barrel and cavity and electronic instrument and sensor and power source and core and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:37
S49	1	core barrel and cavity and orientation and sensor and power source and core and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:38
S50	4551	cavity and orientation and sensor and power source and core and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:38
S51	141	electronic instrument and cavity and orientation and sensor and power source and core and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/10/30 11:39
S56	2	("2944792").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/02/17 15:54
S57	204	(E21B25/16).cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/02/17 15:57
S64	3	"14692484"	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 09:35
S65	296	((("DRENTH") near3 ("CHRISTOPHER")) OR (("STEWART") near3 ("GORDON")) OR (("HEJLEH") near3 ("KHALED"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	ADJ	ON	2019/03/01 09:36
S66	213	(E21B25/16).cpc.	US-PGPUB; USPAT;	ADJ	ON	2019/03/01 09:38

			USOCR			
S67	0	WO "20133126955"	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 10:15
S68	6	(US-20150300162-$ or US-20150136488-$ or US-20150029035-$).did. or (US-6006844-$ or US-4955438-$ or US-7296638-$).did.	US-PGPUB; USPAT	ADJ	ON	2019/03/01 10:17
S69	3	S68 and window	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 10:17
S70	21	(US-0145461-$ | US-0300162-$ | US-10047581-$ | US-15782230-$ | US-1626126-$ | US-2944792-$ | US-2134921-$ | US-2243173-$ | US-3134600-$ | US-4955438-$ | US-5601152-$ | US-6732818-$ | US-7296638-$ | US-20120145461-$ | US-20150300162-$).DID.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:09
S71	39	("1773915" | "2652232" | "3115196" | "5957221").PN. OR ("7296638").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:17
S72	20	("3049185" | "3194326" | "3333647" | "4279315" | "4558749").PN. OR ("5601152").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:17
S73	34	("1752388" | "1867024" | "1870696" | "20010013429" | "20040065482" | "20050025594" | "20090317202" | "20100054884" | "20120241223" | "2484365" | "2689109" | "2708103" | "3140749" | "3517754" | "4848454" | "4951761" | "5161859" | "5601152" | "6698981" | "6799648" | "7281594" | "7296641" | "8763282" | "8960336" | "9162371").PN. OR ("D826299").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:17
S74	39	("1773915" | "2652232" | "3115196" | "5957221").PN. OR ("7296638").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:18
S75	7	("20120145461" | "2944792" | "4955438" | "5601152" | "6732818" | "7296638").PN. OR ("10047581").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:18
S76	0	(S68 or S70) and pressure fiting	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:22
S77	2	(S68 or S70) and pressure fitting	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:22
S78	4	(S68 or S70) and fitting	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:24

S79	2	(S68 or S70) and port same check valve	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:24
S80	11	(S66) and port same check valve	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:33
S81	3	S66 and pressure fitting	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/03/01 11:33
S82	1	"16017334"	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/06/24 00:58
S83	3	"14692484"	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/06/24 01:00
S84	3	cavity and wire line and port and window and electronic instrument and sensor and power source and transmitter	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/06/24 01:24
S85	217	E21B25/16.cpc.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/06/24 01:24

3/15/2020 3:24:18 PM
C:\Users\mwills1\Documents\EAST\Workspaces\16588026.wsp

Bibliographic Data

Application No: 16/588,026

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /MICHAEL R WILLS III/ (Examiner's Signature) ____ (Initials)

Title: CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/30/2019	175	3676	36362.0150U4
RULE			

APPLICANTS

LONGYEAR TM, INC, Salt Lake City, UT, UNITED STATES

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INVENTORS

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Gordon STEWART Claremont, AUSTRALIA

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CONTINUING DATA

This application is a CON of 16017334 06/25/2018 PAT 10465463

16017334 is a CON of 14692484 04/21/2015 PAT 10047581

14692484 has PRO of 61982052 04/21/2014

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

10/16/2019

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(Use as many sheets as necessary)

Sheet 1 of 5

Complete if Known	
Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	Christopher L. Drenth
Art Unit	3676
Examiner Name	Not Yet Assigned
Attorney Docket Number	36362.0150U4

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	A	US-2,944,792-A	07-12-1960	Gros	
	B	US-4,955,438	09-11-1990	Juergens et al.	
	C	US-5,601,152	02-11-1997	Harrison	
	D	US-6,732,818	05-11-2004	Gregory	
	E	US-7,296,638	11-20-2007	Beach et al.	
	F	US-10,047,581	08-14-2018	Drenth et al.	
	G	US-10,465,463	11-05-2019	Drenth et al.	
	H	US-2012/0145461-A1	06-14-2012	Cravatte	
	I	US-2015/0300162-A1	10-22-2015	Drenth et al.	
	J	US-2018/0305995-A1	10-25-2018	Drenth et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	A	AU-2015249889-B2	08-01-2019	Globaltech Corp Pty Ltd		
	B	CN-101649727-A	02-17-2010	Univ China Mining	Machine Translation	√
	C	CN-201396092-Y	02-03-2010	Univ China Mining	Machine Translation	√
	D**	EP-2134921-A1	12-23-2009	2iC Australia Pty Ltd.		
	E	EP-3134600	03-01-2017	Longyear Tm, Inc	Corresponds to WO 2015/164394A1	√
	F**	GB-2243173-A	10-23-1991	Seafloors Eng Inc		
	G**	WO-2006/024111	03-09-2006	AUSTRALIAN MUD COMPANY LTD		

Examiner Signature		Date Considered	

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Dated: February 21, 2020 Electronic Signature: /Benjamin D. Kirk/ (Benjamin D. Kirk)

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Sheet 2 of 5

Complete if Known	
Application Number	16/588,026
Filing Date	September 30, 2019
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Examiner Name	Not Yet Assigned
Attorney Docket Number	36362.0150U4

U. S. PATENT DOCUMENTS

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	H**	WO-2007/104103-A1	09-20-2007	2ic Australia Pty Ltd,		
	I**	WO-2007/137356	12-06-2007	2IC AUSTRALIA PTY LTD		
	J**	WO-2008/113127-A1	09-25-2008	2ic Australia Pty Ltd,		
	K**	WO-2010/094060	08-26-2010	IMDEX TECHNOLOGY AUSTRALIA PTY		
	L**	WO-2013/040641	03-28-2013	IMDEX GLOBAL BV		
	M**	WO-2013/126955	09-06-2013	GLOBALTECH CORP PTY LTD		

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Sheet 3 of 5

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	N**	WO-2014/053012-A1	04-10-2014	Minnovare Pty Ltd		
	O**	WO-2014/089618	06-19-2014	2IC AUSTRALIA PTY LTD		
	P**	WO-2015/164394-A1	10-29-2015	Longyear Tm, Inc		

Examiner Signature		Date Considered	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet	4	of	5

Complete if Known	
Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	Christopher L. Drenth
Art Unit	3676
Examiner Name	Not Yet Assigned
Attorney Docket Number	36362.0150U4

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	A**	International Search Report and Written Opinion were mailed on 7/24/2015 by the International Searching Authority for International Application No. PCT/US2015/026907, filed on 4/21/2015 and published as WO 2015/164394 on 10/29/2015 (Applicant- Longyear TM, Inc.) (Attorney Docket36362.0150P1) (11 Pages)	
	B**	International Preliminary Report on Patentability was mailed on 10/25/2016 by the International Searching Authority for International Application No. PCT/US2015/026907, filed on 4/21/2015 and published as WO 2015/164394 on 10/29/2015 (Applicant- Longyear TM, Inc.) (Attorney Docket36362.0150P1) (9 Pages)	
	C**	Third Party Observations dated August 17, 2016 for International Patent Application No. PCT/US2015/026907 (Applicant- Longyear TM, Inc.) (42 pages)	
	D**	Examination Report was issued on 8/14/2018 by the Australian Patent Office for AU Application No. 2015249889, which was filed on 4/21/2015 (Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150AU1) (3 pages)	
	E	Notice of Acceptance was issued on 7/23/2019 by the Australian Patent Office for AU Application No. 2015249889, which was filed on 4/21/2015 (Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150AU1) (3 pages)	
	F**	Office Action was issued on 7/11/2018 by the Chilean Patent Office for CL Application No. 2016-002684, which was filed on 4/21/2015 (Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150CL1) (3 pages)	
	G	First Office Action was issued on 9/10/2018 by the SIPO for CN Application No.2015800211077, filed on 4/21/2015 and published CN 107109899 as 8/29/2017 on (Applicant- Longyear TM, Inc.) (Attorney Docket 36362.0150CN1) (5 Pages)	
	H	Second Office Action was issued on 1/19/2020 by the SIPO for CN Application No.2015800211077, filed on 4/21/2015 and published CN 107109899 as 8/29/2017 on (Applicant- Longyear TM, Inc.) (Attorney Docket 36362.0150CN1) (6 Pages)	
	I**	Extended European Search Report issued on 10/17/2017 by the European Patent Office for Application No. 15782230.5, which was filed on April 21, 2015 and published as EP 3134600 on March 1, 2017 (Inventor- Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150EP1) (9 pages)	
	J**	Preliminary Amendment was mailed on 2/28/2017 to the USPTO for U.S. Application No. 14/692,484, which was filed on April 21, 2015 and granted as 10,047,581 on 8/14/2018 (Inventor- Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150U2) (7 pages)	

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Sheet	5	of	5

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Application Number	16/588,026
Filing Date	September 30, 2019
First Named Inventor	Christopher L. Drenth
Art Unit	3676
Examiner Name	Not Yet Assigned
Attorney Docket Number	36362.0150U4

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	K**	Non Final Rejection was issued on 8/18/2017 by the USPTO for U.S. Application No. 14/692,484, which was filed on April 21, 2015 and granted as 10,047,581 on 8/14/2018 (Inventor- Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150U2) (7 pages)	
	L**	Response to Non Final Rejection was mailed on 10/18/2017 to the USPTO for U.S. Application No. 14/692,484, which was filed on April 21, 2015 and granted as 10,047,581 on 8/14/2018 (Inventor-Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150U2) (9 pages)	
	M**	Notice of Allowance was issued on 11/8/2017 by the USPTO for U.S. Application No. 14/692,484, which was filed on April 21, 2015 and granted as 10,047,581 on 8/14/2018 (Inventor- Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150U2) (5 pages)	
	N**	Notice of Allowance was issued on 4/12/2018 by the USPTO for U.S. Application No. 14/692,484, which was filed on April 21, 2015 and granted as 10,047,581 on 8/14/2018 (Inventor- Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150U2) (7 pages)	
	O**	Issue Notification was issued on 7/25/2018 by the USPTO for U.S. Application No. 14/692,484, which was filed on April 21, 2015 and granted as 10,047,581 on 8/14/2018 (Inventor- Drenth et al.; Applicant- Longyear TM, Inc.) (Attorney Docket No.- 36362.0150U2) (1 page)	
	P	Non Final Rejection was issued on 3/14/2019 by the USPTO for U.S. Application No. 16/017,334, filed on 6/25/2018 and granted as 10,465,463 on 11/5/2019 (Inventor-CHRISTOPHER L. DRENTH) (Attorney Docket 36362.0150U3) (11 Pages)	
	Q	Response Non Final Rejection was mailed on 6/12/2019 to the USPTO for U.S. Application No. 16/017,334, filed on 6/25/2018 and granted as 10,465,463 on 11/5/2019 (Inventor-CHRISTOPHER L. DRENTH) (Attorney Docket 36362.0150U3) (9 Pages)	
	R	Notice of Allowance was issued on 3/14/2019 by the USPTO for U.S. Application No. 16/017,334, filed on 6/25/2018 and granted as 10,465,463 on 11/5/2019 (Inventor-CHRISTOPHER L. DRENTH) (Attorney Docket 36362.0150U3) (5 Pages)	
	S	Issue Notification was issued on 3/14/2019 by the USPTO for U.S. Application No. 16/017,334, filed on 6/25/2018 and granted as 10,465,463 on 11/5/2019 (Inventor-CHRISTOPHER L. DRENTH) (Attorney Docket 36362.0150U3) (1 Page)	

Examiner Signature		Date Considered	

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[1] Applicant's unique citation designation number (optional). [2] Applicant is to place a check mark here if English language Translation is attached.

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Dated: February 21, 2020
Electronic Signature for Benjamin D. Kirk /Benjamin D. Kirk/

ATTORNEY DOCKET NO. 36362.0150U4
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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	)	
	)	
CHRISTOPHER L. DRENTH, ET AL.	)	Art Unit: 3676
	)	
Application No.: 16/588,026	)	Examiner: *Not Yet Assigned*
	)	
Filing Date: September 30, 2019	)	Confirmation No.: 7130
	)	
For: **CORE BARREL HEAD ASSEMBLYWITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME**	)	

INFORMATION DISCLOSURE STATEMENT

MAIL STOP AMENDMENT
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

BALLARD SPAHR LLP
Customer No. 23859

February 21, 2020

Commissioner:

Pursuant to the requirements set forth in 37 C.F.R. § 1.56, Applicant now submits a list of documents known to Applicant or Applicant's attorneys. Pursuant to 37 C.F.R. § 1.98(a)(2)(iv), and for the Examiner's review, Applicant has enclosed (1) copies of documents from the prosecution of related U.S. and non-U.S. patent applications, and (2) copies of non-U.S. patents or non-U.S. patent application publications. In accordance with 37 C.F.R. § 1.98(a)(2), copies of any cited U.S. patent or U.S. patent application publication documents are not enclosed.

Applicant has enclosed an English language abstract of any non-U.S. Patent or Patent Application which is written in a foreign language.

In accordance with 37 C.F.R. § 1.98(d), those documents which are marked with a double asterisk (**) next to the Cite No. in the attached form PTO/SB/08 are not supplied because they were previously cited by or submitted to the Office in prior application numbers 14/692,484 filed April 21, 2015, and 16/017,334 filed June 25, 2018 and relied upon in this application for an earlier filing date under 35 U.S.C. 120.

Regarding the documents from the prosecution of related U.S. and non-U.S. patent applications, Applicant notes that 37 C.F.R. § 1.98(b) does not mention, and thus does not require, that Applicant provide any particular set of identifying information. While 37 C.F.R. § 1.98(a)(1) requires Applicant to provide a

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list of such documents, it does not require Applicant to include in that list specific identifying information. 37 C.F.R. § 1.98(a)(2)(iv) further requires Applicant to provide a copy of such documents. Thus, the rules do not require that Applicant provide any particular set of information about these documents prior to the Examiner's consideration of all the cited information. Nevertheless, in order to be as helpful as possible, Applicant has provided (a) information regarding the source of the documents, and (b) a title or description of each document. Accordingly, in the list required by 37 C.F.R. § 1.98(a)(1), Applicant has identified the prosecution record of U.S. and non-U.S. patent applications as the source for each document. The information provided mirrors the requirements for cited U.S. and non-U.S. patent applications as set forth by 37 C.F.R. § 1.98(b).

Applicant respectfully requests consideration of all documents submitted in the present Information Disclosure Statement and List and entry into the record for the present application (Application No. 16/588,026).

Applicant would like to bring to the Examiner's attention the existence of the following U.S patent applications.

INFORMATION DISCLOSURE STATEMENT for Application No. 16/588,026 (Attorney Docket No. 36362.0150U4) Disclosure of U.S. Patent Applications				
Examiner's Initials	**App. No. (Pub./Patent No.)**	**Filing Date (Pub./Issue Date)**	**1st Named Inventor (Applicant)**	**Attorney Docket No.**
	61/982,052	04/21/2014	Christopher L. Drenth	36362.0150U1-
	14/692,484 (10,047,581)	04/21/2015 (8/14/2018)	Christopher L. Drenth	36362.0150U2-
	16/017,334 (10,465,463)	06/25/2018 (11/5/2019)	Christopher L. Drenth	36362.0150U3

Applicants would like to bring to the Examiner's attention the existence of the following non-U.S. patent applications.

INFORMATION DISCLOSURE STATEMENT for Application No. 16/017,334 (Attorney Docket No. 36362.0150U3) Disclosure of Non-U.S. Patent Applications					
Examiner's Initials	**Country**	**Application No. (Publication No.)**	**Filing Date**	**1st Named Inventor (Applicant)**	**Attorney Docket No.**
	AU	2015249889	04/21/2015	Longyear TM, Inc.	36362.0150AU1

REFLEX EXHIBIT 1002 - 100/304

INFORMATION DISCLOSURE STATEMENT for Application No. 16/017,334 (Attorney Docket No. 36362.0150U3) Disclosure of Non-U.S. Patent Applications					
Examiner's Initials	**Country**	**Application No. (Publication No.)**	**Filing Date**	**1st Named Inventor (Applicant)**	**Attorney Docket No.**
	AU	2019257536 (AU 2015249889)	4/21/2015 (11/14/2019)	Longyear TM, Inc.	36362.0150AU2
	BR	BR112016024554.7	04/21/2015	Longyear TM, Inc.	36362.0150BR1
	CA	2946574	04/21/2015	Longyear TM, Inc.	36362.0150CA1
	CL	2016-002684	04/21/2015	Longyear TM, Inc.	36362.0150CL1
	CN	2015800211077	04/21/2015	Longyear TM, Inc.	36362.0150CN1
	EP	15782230.5 (EP 3134600)	04/21/2015 (9/4/2019)	Longyear TM, Inc.	36362.0150EP1
	EP	19188334.7	4/21/2015	Longyear TM, Inc.	36362.0150EP2
	PCT	PCT/US2015/026907 (WO2015/164394)	04/21/2015 (10/29/2015)	Longyear TM, Inc.	36362.0150P1-
	PE	2111-2016	04/21/2015	Longyear TM, Inc.	36362.0150PE1
	ZA	2016/07259	04/21/2015	Longyear TM, Inc.	36362.0150ZA1

Pursuant to 37 C.F.R. § 1.97(b)(3), Applicant submits that this document is timely filed in that the Patent and Trademark Office has not yet mailed to Applicant a first Office Action on the merits. Applicant submits that no fee is due; however, Applicant hereby authorizes the Commissioner to charge to Deposit Account No. 14-0629 any fee that may be required to effect the consideration and entry of this Information Disclosure Statement and List and the references contained therein.

Respectfully submitted,

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Electronic Acknowledgement Receipt

EFS ID:	38650840
Application Number:	16588026
International Application Number:	
Confirmation Number:	7130
Title of Invention:	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME
First Named Inventor/Applicant Name:	Christopher L. DRENTH
Customer Number:	23859
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	AU2015249889B2.pdf	2626500 0bd20f56fc61938d81e336c622c4669ba363758f	no	53

Warnings:

Information:					
2	Foreign Reference	CN101649727A.pdf	191139 5f712b60b203347fb8cafa12479099303e83bba1	no	6
Warnings:					
Information:					
3	Foreign Reference	Translation_of_CN101649727A.pdf	257035 0ea069a5d73d21d818fba9d3ee7255414a28b253	no	4
Warnings:					
Information:					
4	Foreign Reference	CN201396092Y.pdf	165828 a5900da1ada6db0f24cf94594324c17fdf63e952	no	5
Warnings:					
Information:					
5	Foreign Reference	Translation_of_CN201396092Y.pdf	251252 af4cca3e0805c28a090cba56b0d6a2c5a31fbd05	no	4
Warnings:					
Information:					
6	Foreign Reference	EP3134600_WO2015164394A1.pdf	2414182 ffab2e7def38d893b50dd5ac5df56a9ec7bf351d	no	49
Warnings:					
Information:					
7	Non Patent Literature	36362_0150AU1_NOA_7_23_2019.pdf	109754 74a30cfe380d795dea206619a62a5d6e9d652512	no	3
Warnings:					
Information:					
8	Non Patent Literature	36362_0150CN1_1stOA_9_10_2018.pdf	204324 bbe76861e47571ed4a5f196f5f8c48939b5cb041	no	5
Warnings:					
Information:					

9	Non Patent Literature	36362_0150CN1_2ndOA_1_19_2020.pdf	328588 f49edfeba169503570 4bfaefeab72b0d197ad9b3	no	6
Warnings:					
Information:					
10	Non Patent Literature	36362_0150U3_NonFinal_3_14_2019.pdf	433426 8de96d2b48952fddc8142580d90f14078ae9b83a	no	11
Warnings:					
Information:					
11	Non Patent Literature	36362_0150U3_ResponseNonFinal_6_12_2019.pdf	367906 c23abf449b9fc222b67c15544566cde90f1af017	no	9
Warnings:					
Information:					
12	Non Patent Literature	36362_0150U3_NOA_6_28_2019.pdf	355252 98ea9d0aa0b9d328020165894ece8dcc733dc096	no	5
Warnings:					
Information:					
13	Non Patent Literature	36362_0150U3_IssueNotification_10_16_2019.pdf	55007 31169873596bc1f057f384a104dfd0d6a44c5dfc	no	1
Warnings:					
Information:					
14	Information Disclosure Statement (IDS) Form (SB08)	36362_0150U4_IDS_SB08_2_21_2020.pdf	247347 005d73bbee0bcfc061f1365292a65a601d83185e	no	5
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
15	Transmittal Letter	36362_0150U4_IDS_Transmittal_2_21_2020.pdf	200621 0f74b4b1e55999329323bb4e40cebf6547aa6d2c	no	3
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Information:					
			Total Files Size (in bytes):	8208161	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

(12) STANDARD PATENT (11) Application No. **AU 2015249889 B2**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Core barrel head assembly with an integrated sample orientation tool and system for using same

(51) International Patent Classification(s)
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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

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(54) **Title**: CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

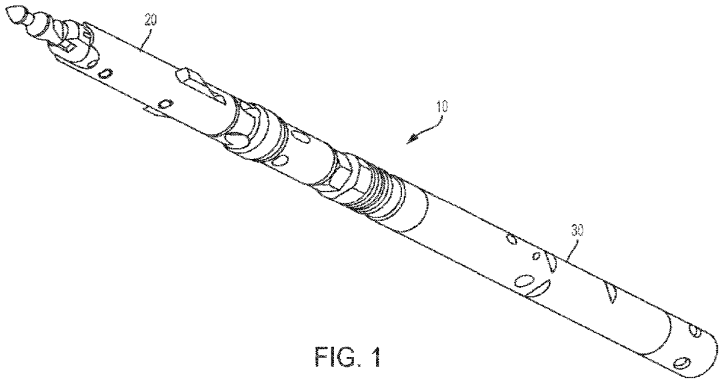


FIG. 1

(57) **Abstract**: A core barrel head assembly having at least one electronic instrument that is configured to obtain orientation data; a power source; and a communication means to receive and/or transmit orientation data for use in a core sample down hole surveying and sample orientation system that is configured to provide an indication of the orientation of a core sample relative to a body of material from which the core has been extracted, and also to a method of core sample orientation identification.

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CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

CROSS REFERENCE TO RELATED PATENT APPLICATION

[0001] This application claims priority to U.S. Provisional Application No. 61/982,052 filed April 21, 2014, which is herein incorporated by reference in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to down hole surveying in drilling operations. More particularly, to a core barrel assembly having at least one electronic instrument that is configured for use in a core sample down hole surveying and sample orientation system. In one example, the at least one electronic instrument is configured to provide an indication of the orientation of a core sample relative to a body of material from which the core has been extracted, and also to a method of core sample orientation identification.

BACKGROUND

[0003] Conventionally, core samples are obtained through the use of core drilling systems that comprise outer and inner tube assemblies. In operation, a cutting head is attached to the outer tube assembly so that rotational torque applied to the outer tube assembly can be transmitted to the cutting head. A core is generated during the drilling operation, with the core progressively extending along the elongate axis of the inner tube assembly as drilling progresses. Typically, when a core sample is acquired, the core within the inner tube assembly is fractured and the inner tube assembly and the fractured core sample contained therein are then retrieved from within the drill hole, typically by way of a retrieval cable lowered down the drill hole. Once the inner tube assembly has been brought to ground surface, the core sample can be removed and subjected to the desired analysis.

[0004] It is desirable for analysis purposes to have an indication of the orientation of the core sample relative to the ground from which it was extracted. This is complicated in that it is common to drill at an angle relative to the vertical. For efficiency and accuracy of the mineralogical record, it is desirable to determine the orientation and survey position of each core's position underground before being drilled out and extracted. Such orientation and survey positions allow for the

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subsequent production of a three dimensional map of underground mineral/rock content.

[0005] One common way of obtaining an indication of the orientation of a core sample is through use of an orientation spear comprising a marker (such as a crayon) projecting from one end of a thin steel shank, the other end of which is attached to a wire line. The orientation spear is lowered down the drill hole, prior to the inner tube assembly being introduced. The marker on the orientation spear strikes the facing surface of material from which the core is to be generated, leaving a mark thereon. Because of gravity, the mark is on the lower side of the drill hole. The inner tube assembly is then introduced into the outer tube assembly in the drill hole. As drilling proceeds, a core sample is generated within the inner tube assembly. The core sample so generated carries the mark which was previously applied. Upon completion of the core drilling run and retrieval of the core sample, the mark provides an indication of the orientation of the core sample at the time it was in the ground.

[0006] Other conventional technologies use core orientation units attached to core inner tubes and back-end assemblies to determine the correct orientation of the drilled out core sample after a preferred predetermined drilling distance intervals during drilling. These core orientation units typically measure rotational direction of the core sample before extraction. On retrieval at the surface of the hole, the rotational direction can be determined by electronic means and the upper or lower side of the core material physically 'marked' for later identification by geologists.

[0007] Coupled with the core orientation system, a survey instrument is conventionally used. In this technique, at periodic depths, the survey instrument is lowered down the drill hole to determine azimuth (angular measurement relative to a reference point or direction), dip (or inclination) and any other required survey parameters. These periodic depth survey readings are used to approximate the drill-path at different depths. Together with the rotational position of the extracted core (from the core orientation device), the three dimensional subsurface material content map can be determined.

[0008] It has been found desirable to provide an improved core barrel assembly having an integrated sample orientation subassembly and method for using same that is configured for use in a core sample down hole surveying and sample

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orientation that minimizes the need to add additional drill string elements, which allows for increased efficiency and speed of drilling.

OBJECT

[0008a] It is an object of the present invention to substantially overcome or at least ameliorate one or more of the above disadvantages, or to provide a useful alternative.

SUMMARY

[0008b] In a first aspect, the present invention provides a core barrel head assembly, comprising:

an elongate tube body defining a first interior cavity and a selectively sealed interior cavity spaced distally from the first interior cavity, wherein the elongate tube body has a threaded proximal end for coupling to a wire line retrieval portion of a head assembly, wherein the first interior cavity extends distally from the threaded proximal end to a base portion of the elongate tube body, and wherein the elongate tube body further defines a port positioned proximate the base portion and extending from the exterior surface of the elongate tube body into fluid communication with the first interior cavity;

a plurality of windows defined in the elongate tube body that extend from the exterior surface of the elongate tube body into optical communication with the sealed interior cavity proximate a closed proximal end of the sealed interior cavity;

at least one electronic instrument that is configured to obtain orientation data mounted therein the sealed interior cavity, wherein the at least one electronic instrument comprises at least one digital and/or electro-mechanical sensors in a core orientation data recording tool that can be configured to determine a core orientation of a sample core just prior to or after the core break;

a power source in operable communication with the at least one electronic instrument, wherein the power source is mounted therein the interior cavity; and

communication means to receive and/or transmit core orientation data,

wherein the sealed interior cavity is sized and shaped to hermetically enclose the at least one electronic instrument and the power source.

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[0008c] In a second aspect, the present invention provides a core barrel head comprising:

an elongate tube body defining a first interior cavity and a selectively sealed interior cavity spaced distally from the first interior cavity, wherein the elongate tube body has a threaded proximal end for coupling to a wire line retrieval portion of a head assembly, wherein the first interior cavity extends distally from the threaded proximal end to a base portion of the elongate tube body, and wherein the elongate tube body further defines a port positioned proximate the base portion and extending from the exterior surface of the elongate tube body into fluid communication with the first interior cavity;

at least one electronic instrument that is configured to obtain orientation data mounted therein the sealed interior cavity, wherein the at least one electronic instrument comprises at least one digital and/or electro-mechanical sensors in a core orientation data recording tool that can be configured to determine a core orientation of a sample core just prior to or after the core break;

a power source in operable communication with the at least one electronic instrument, wherein the power source is mounted therein the interior cavity; and

communication means to receive and/or transmit core orientation data,

wherein the sealed interior cavity is sized and shaped to hermetically enclose the at least one electronic instrument and the power source, and

wherein a pressure fitting is mounted in the port to allow for selective passage of fluid to and from the exterior surface of the barrel head assembly into communication with the first interior cavity.

[0008c] In a third aspect, the present disclosure provides a core barrel head assembly, comprising:

an elongate tube body defining a first interior cavity and a selectively sealed interior cavity spaced distally from the first interior cavity, wherein the elongate tube body has a threaded proximal end for coupling to a wire line retrieval portion of a head assembly, wherein the first interior cavity extends distally from the threaded proximal end to a base portion of the elongate tube body, and wherein the elongate tube body further defines a port positioned proximate the base portion and extending from the exterior surface of the

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elongate tube body into fluid communication with the first interior cavity, wherein the sealed interior cavity extends distally to an open threaded distal end of the elongate tube body;

a seal coupler that is configured to be sealingly received in the open threaded distal end of the elongate tube body;

at least one electronic instrument that is configured to obtain orientation data mounted therein the sealed interior cavity, wherein the at least one electronic instrument comprises at least one digital and/or electro-mechanical sensors in a core orientation data recording tool that can be configured to determine a core orientation of a sample core just prior to or after the core break;

a power source in operable communication with the at least one electronic instrument, wherein the power source is mounted therein the interior cavity; and

communication means to receive and/or transmit core orientation data,

wherein the sealed interior cavity is sized and shaped to hermetically enclose the at least one electronic instrument and the power source.

[0009] There is disclosed herein a core barrel head assembly having an elongate tube body that defines a selectively sealed interior cavity. The core barrel head assembly can have at least one electronic instrument positioned in the interior cavity that is configured to obtain core orientation data of a core sample and a power source positioned in the interior cavity and in electrical communication with the at least one electronic instrument. The core barrel head assembly can also have a communication means that is configured to receive and/or transmit orientation data for use in a core sample down hole surveying and/or sample orientation system. The derived core orientation data provides an indication of the orientation of the core sample relative to a body of material from which the core has been extracted, and also to a method of using same.

[0010] The core barrel head assembly is configured for connection to tube portions of a drill string via respective connection means. In another aspect, the at least one electronic instrument of the core barrel head assembly can be mounted, for example and without limitation, within the interior cavity defined the body, within an interior cavity that is defined therein a side wall of the body of the core barrel head assembly, or potted or in sealed contact with a portion of a side wall of the core barrel assembly (on either an exterior

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surface or an interior surface of a cavity defined therein the body). As one skilled in the art will contemplate, the core barrel head assembly can comprise at least one electronic instrument that is configured to obtain orientation data, an electrically coupled power source and communication means to receive and/or transmit orientation data.

[0011] The communication means can comprise a wireless communication means that is configured to wirelessly receive and/or transmit survey data. Optionally, the communication means can be configured to communicate one way or two ways with each other, when drilling has ceased or during drilling.

[0012] The at least one electronic instrument of the core barrel head assembly advantageously enables obtaining drill hole survey readings without the need to insert unwieldy extension drill rods and/or a survey probe to measure azimuth and inclination/dip of the drill hole path. This results in a reduction of

equipment handling and usage of equipment, a reduction of operations by not needing to periodically withdraw the drill bit a certain distance in order to advance a survey probe ahead of, and therefore distanced from, the drill bit, with a resultant increase in operational efficiency.

[0013] There is disclosed herein a method of conducting a down hole survey of drilling, the method including: a) drilling the core from a subsurface body of material; b) recording data relating to orientation of the core to be retrieved, the data recorded using the at least one electronic instrument of the core barrel head assembly, c) separating the core from the subsurface body, and d) obtaining an indication of the orientation of the core based on the recorded core orientation data obtained before the core was separated from the subsurface body.

[0014] Optionally, the method can comprise: determining that drilling has ceased for a period of time, using the at least one electronic instrument of the core barrel head assembly to record data relating to orientation of the core to be retrieved, separating the core from the subsurface body, retrieving the core to the surface, and obtaining an indication of the orientation of the core based on the recorded core orientation data obtained once the drilling had ceased and before the core was separated from the subsurface body.

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[0015] Advantages are that there is more time available for drilling due to less time required for surveying and manipulating additional pieces of equipment and mechanical extensions during the survey process.

BRIEF DESCRIPTION OF THE FIGURES

[0016] Figure 1 shows a perspective view of a core barrel head assembly being operatively coupled to a head assembly.

[0017] Figure 2 shows a longitudinal cross-sectional view of Figure 1.

[0018] Figure 3 shows an expanded view of a portion of Figure 2, showing the core barrel head assembly.

[0019] Figure 4 shows a perspective exploded view of the core barrel head assembly of Figure 1.

[0020] Figure 5 shows a longitudinal cross-sectional view of the core barrel head assembly, showing an at least one electronic instrument and an electrically coupled power source disposed therein an interior cavity of a body of the core barrel head assembly.

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[0021] Figure 6 shows a longitudinal cross-sectional view of another aspect of the core barrel head assembly, showing an at least one electronic instrument and an electrically coupled power source disposed therein an interior cavity of a body of the core barrel head assembly.

[0022] Figure 7 shows a longitudinal cross-sectional view of the body of the core barrel head assembly.

[0023] Figure 8 shows a longitudinal cross-sectional view of a core barrel head assembly being operatively coupled to a head assembly.

[0024] Figure 9 shows a schematic view of an exemplary at least one electronic instrument.

[0025] Figure 10 shows a schematic view of an exemplary at least one electronic instrument and an electrically coupled power source for disposition therein an interior cavity of a body of the core barrel head assembly.

[0026] Figure 11 shows an exemplary high level flowchart relating to a method of using the present invention.

[0027] Figure 12 shows an exemplary flowchart relating to an alternative embodiment of a method of using the present invention.

[0028] Figure 13 shows an exemplary flowchart relating to an alternative embodiment of a method of using the present invention.

[0029] Figure 14 shows an exemplary prior art hand held device for wirelessly interrogating the core barrel head assembly of the present invention.

DETAILED DESCRIPTION

[0030] The present invention can be understood more readily by reference to the following detailed description, examples, drawings, and claims, and their previous and following description. However, before the present devices, systems, and/or methods are disclosed and described, it is to be understood that this invention is not limited to the specific devices, systems, and/or methods disclosed unless otherwise specified, as such can, of course, vary. It is also to be understood that the terminology used herein is for the purpose of describing particular aspects only and is not intended to be limiting.

[0031] The following description of the invention is provided as an enabling teaching of the invention in its best, currently known embodiment. To this end, those skilled in the relevant art will recognize and appreciate that many changes can be

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made to the various aspects of the invention described herein, while still obtaining the beneficial results of the present invention. It will also be apparent that some of the desired benefits of the present invention can be obtained by selecting some of the features of the present invention without utilizing other features. Accordingly, those who work in the art will recognize that many modifications and adaptations to the present invention are possible and can even be desirable in certain circumstances and are a part of the present invention. Thus, the following description is provided as illustrative of the principles of the present invention and not in limitation thereof.

[0032] As used throughout, the singular forms "a," "an" and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a port" can include two or more such ports unless the context indicates otherwise.

[0033] Ranges can be expressed herein as from "about" one particular value, and/or to "about" another particular value. When such a range is expressed, another aspect includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent "about," it will be understood that the particular value forms another aspect. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint.

[0034] As used herein, the terms "optional" or "optionally" mean that the subsequently described event or circumstance may or may not occur, and that the description includes instances where said event or circumstance occurs and instances where it does not.

[0035] The word "or" as used herein means any one member of a particular list and also includes any combination of members of that list.

[0036] As will be appreciated by one skilled in the art, the methods and systems may take the form of an entirely hardware embodiment, an entirely software embodiment, or an embodiment combining software and hardware aspects. Furthermore, the methods and systems may take the form of a computer program product on a computer-readable storage medium having computer-readable program instructions (*e.g.*, computer software) embodied in the storage medium. More particularly, the present methods and systems may take the form of web-

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implemented computer software. Any suitable computer-readable storage medium may be utilized including, without limitation, hard disks, CD-ROMs, optical storage devices, magnetic storage devices, or solid-state electronic storage devices.

[0037] Embodiments of the methods and systems are described below with reference to block diagrams and flowchart illustrations of methods, systems, apparatuses and computer program products. It will be understood that each block of the block diagrams and flowchart illustrations, and combinations of blocks in the block diagrams and flowchart illustrations, respectively, can be implemented by computer program instructions. These computer program instructions may be loaded onto a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions which execute on the computer or other programmable data processing apparatus create a means for implementing the functions specified in the flowchart block or blocks.

[0038] These computer program instructions may also be stored in a computer-readable memory that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer-readable memory produce an article of manufacture including computer-readable instructions for implementing the function specified in the flowchart block or blocks. The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer-implemented process such that the instructions that execute on the computer or other programmable apparatus provide steps for implementing the functions specified in the flowchart block or blocks.

[0039] Accordingly, blocks of the block diagrams and flowchart illustrations support combinations of means for performing the specified functions, combinations of steps for performing the specified functions and program instruction means for performing the specified functions. It will also be understood that each block of the block diagrams and flowchart illustrations, and combinations of blocks in the block diagrams and flowchart illustrations, can be implemented by special purpose hardware-based computer systems that perform the specified functions or steps, or combinations of special purpose hardware and computer instructions.

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[0040] In one aspect, a drill assembly for drilling into a subsurface body of material can comprise a drill string 10 comprising a drill bit, an outer tube formed of linearly connected tube sections, and an inner tube for receiving the core drilled from the subsurface body. In one aspect, the core barrel head assembly 30 is integrated into the drill string 10 to form a portion of the drill string, such as shown in Figure 1, where the core barrel head assembly is operably coupled to a conventional head assembly 20.

[0041] The core barrel head assembly is configured for connection to tube portions of a drill string via respective connection means. In another aspect, the at least one electronic instrument of the core barrel head assembly can be mounted, for example and without limitation, within the interior cavity defined the body, within an interior cavity that is defined therein a side wall of the body of the core barrel head assembly, or potted or in sealed contact with a portion of a side wall of the core barrel assembly (on either an exterior surface or an interior surface of a cavity defined therein the body). As one skilled in the art will contemplate, the core barrel head assembly can comprise at least one electronic instrument that is configured to obtain orientation data, an electrically coupled power source and communication means to receive and/or transmit orientation data.

[0042] In one aspect, and referring to Figures 1-7, the core barrel head assembly 30 can comprise at least one electronic instrument 40 that is configured to obtain orientation data, a operatively electrically coupled power source 50 and communication means to receive and/or transmit orientation data. In one aspect, at least one electronic instrument 40 can comprise at least one digital and/or electro-mechanical sensors 42, and/or one or more physical data sensors 44 in a core orientation data recording tool that can be configured to determine the core orientation just prior to or after the core break, and, optionally, to detect the signal of the break of the core from the body of material. In various aspects, it is contemplated that the recorded data can optionally include “dip” angle and/or azimuth datum to increase the reliability of the core orientation results as described below.

[0043] In this aspect, the at least one digital and/or electro-mechanical sensor 42 in operative communication with the at least one electronic instrument 40 of the core barrel assembly can be configured to detect vibration and/or to detect tri-axial

gravitation loading acting on the electronic instrument. In one exemplary aspect, once a desired vibration state is detected and/or a desired G-loading state is detected , drilling can cease and the core barrel head assembly can record data relating to the orientation of the core, such as, for example and without limitation, gravitational field strength and direction, and/or magnetic field strength and direction.

[0044] The core barrel head assembly 30 has a proximal end 32 that is operatively oriented toward the drill bit end of the drill string and an opposed distal end 34. As shown in Figures 1 and 5-6, the core barrel head assembly 30 has an elongate tube body 60 that is conventionally joined to a conventional wire line retrieval portion of a head assembly 10. Thus, the head assembly of the drill string is complete without the necessity for the use of an unwieldy extension tube as required in the prior art designs.

[0045] The threaded proximal end 62 of the elongate tube body 60 is in communication with a first interior cavity 64 that extends distally to a base portion 65. Proximate the base portion of the second interior cavity, a port 66 is defined that extends from the exterior surface of the elongate tube body into fluid communication with the first interior cavity. Optionally, in this aspect, it is contemplated that a grease fitting 68 can be mounted in the port 66 to allow for selective passage of grease or lubricant into communication with the first interior cavity and vice versa.

[0046] A second interior cavity 70 is defined therein the elongate tube body 60 that is spaced from and extends distally from the first interior cavity. The second interior cavity 70 can be sized to hermetically enclose at least one of the least one electronic instrument 40 that is configured to obtain orientation data, the power source 50 and the communication means to receive and/or transmit orientation data. In another aspect, the second interior cavity 70 can be sized to hermetically enclose the least one electronic instrument 40 that is configured to obtain orientation data and the power source 50. In one aspect, the at least one electronic instrument 40 can comprise the electronic instrument discussed above and schematically shown in Figures 8 and 9. The at least one electronic instrument 40 is operatively electrically coupled to the power source 50, which can comprise any conventional power source, such as, for example and without limitation, a battery, a rechargeable battery, and the like.

[0047] In one aspect, as shown, a plurality of windows 74 can be defined in the elongate tube body that extend from the exterior surface 61 of the elongate tube body into the second interior chamber 70 proximate the closed proximal end 72 of the second interior chamber. In a further aspect, an orientation indicator module 80 can be provided that comprises a plurality of light emitters 82. The orientation indicator module 80 can be sized and shaped to sealingly close the second interior chamber from any intrusion of pressurized fluid into the second interior chamber 70 via the defined plurality of windows 74.

[0048] In another aspect, it is contemplated that the second interior cavity can comprise at least one orienting slot defined therein. In this aspect, the orientation indicator module can be oriented manually and the desired position can be maintained to the at least one O-ring seal 84 described below. Optionally, in a further aspect, the orientation indicator module 82 is configured to orient or otherwise position a plurality of light emitters 88 so that each light emitter underlies one window.

[0049] In one aspect, the orientation indicator module 80 can further comprise a sealing means for preventing any pressurized fluid from entering the second interior cavity 70 from the defined windows 74. In one aspect, the sealing means can comprise at least one O-ring seal 84 that is mounted on an exterior portion of the orientation indicator module and that is configured to seal between the exterior portion of the orientation indicator module and a portion of the interior surface of the second interior cavity.

[0050] In one exemplary aspect, light from the plurality of light emitters 88 (*e.g.* LEDs, and the like) passes through or can be observed through the plurality of windows 74. Reference arrow A refers to the drill bit end direction, and reference arrow B refers to the head assembly direction. Further, as described above, the process of obtaining core orientation is made easier by only requiring two color lights, such as, for example and without limitation, green and red, to indicate one or other direction of rotation to establish correct core orientation prior to marking. The indicators form part of the sealed device and can be low power consumption LED lights.

[0051] Alternatively, flashing lights may be used, such as, for example and without limitation, a certain frequency or number of flashes for one direction and

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another frequency or number of flashes for the other direction of rotation. A steady light could be given when correct orientation is achieved. Thus, advantageously, when the core barrel head assembly 30 and the core sample are recovered from down the hole, the core barrel head assembly 30 need not be separated from the drill string in order to determine a required orientation of the core sample. Wireless communication to a remote device, such as a hand held device, to transfer data between the core barrel head assembly and the remote device, can also be effected by transmitting through the at least one aperture.

[0052] In another aspect, the second interior cavity 70 extends distally to the open distal end 73 of the elongate tube body 60. To further effect a hermetical enclosure of the least one electronic instrument 40 that is configured to obtain orientation data, the power source 50 and, optionally, the communication means to receive and/or transmit orientation data, a seal coupler 90 can be provided that is configured to be sealingly received in the open threaded distal end 73 of the elongate tube body 60. As noted, a sealing means can be provided to prevent any pressurized fluid from entering the second interior cavity. In one aspect, the sealing means can comprise at least one O-ring seal 95 that is mounted on a portion of the seal coupler and that is configured to seal between a portion of the seal coupler and a portion of the interior surface of the open distal end of the elongate tube body.

[0053] In a further aspect, to further effect a hermetical seal of the second interior cavity and to provide fluid control for the wire line operation, a check valve assembly 100 is provided. In one aspect, the check valve assembly 100 comprises a coupled proximal end assembly and a distally tapered seat that defines an interior chamber 110 for operative receipt of a check ball 120.

[0054] In one aspect, the proximal end assembly102 of the check valve assembly can define a female threaded coupling that is configured to be threadably coupled to the male threads defined on the exterior surface of the distal end 73 of the elongate tube body 60. As one skilled in the art will appreciate, as the proximal end assembly of the check valve assembly 100 is threadably coupled to the distal end 73 of the elongate tube body, the seal coupler 90 is driven into a sealed position therein the second interior cavity 70 to affect complete hermeticity.

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[0055] Further, as one skilled in the art will appreciate, because the orientation indicator module 90 is sealingly disposed in the proximal end of the second interior chamber 70, the least one electronic instrument 40, the power source 50 and, optionally, the communication means to receive and/or transmit orientation data is disposed in operative contact with the orientation indicator module, and the seal coupler 90 is disposed in contact with the least one electronic instrument 40, the power source 50 and, optionally, the communication means to receive and/or transmit orientation data, as the proximal end assembly of the check valve assembly is threadably coupled to the distal 73 end of the elongate tube body, both the sealing means on the respective orientation indicator module 80 and the seal coupler 90 are driven into a sealed position therein the second interior cavity to affect complete hermeticity of the second interior cavity.

[0056] In another aspect, the interior chamber 110 of the check valve assembly extends to a distal end 104 of the check valve assembly. In this aspect, at least one port 106 is provided that extends from the exterior surface of the check valve assembly and is in fluid communication with the interior chamber of the check valve assembly. In one aspect, the at least one port 106 can comprise a plurality of ports. In this aspect, it is contemplated that the plurality of ports can be angularly spaced an equal or an unequal number of degrees apart.

[0057] In this aspect, the interior chamber 110 can have a distally tapered seat 112 that is adapted to selectively receive the ball 120 that is sized to selectively block the distally tapered seat. One skilled in the art will appreciate that the interior chamber 110 of the check valve assembly 100 can be sized and shaped to allow the ball to selectively move axially between an open position, in which the ball is spaced proximally away from the surface of the tapered seat so that pressurized fluid can move through the distal end of the check valve assembly and subsequently through the interior chamber to exit out of the at least one port, and a closed position, in which the ball is pressurized against the surface of the tapered seat so that pressurized fluid cannot move through the check valve assembly.

[0058] In a further aspect, the exterior surface 61 of the elongate tube body 60 can define a plurality of female planar stops 67 proximate the mid-body portion. These female planar stops aid in grasping and selectively orienting the orientation of the core barrel head assembly 30. Optionally, additional female planar stops 69 can

be defined proximate the indicator widows defined in the elongate tube body to aid in ease of selectively orienting the sample.

[0059] Referring now to Figure 8, an alternative embodiment of the core barrel head assembly 30 is shown that comprises at least one electronic instrument 40 that is configured to obtain orientation data, a operatively electrically coupled power source 50 and communication means to receive and/or transmit orientation data.

[0060] In this aspect the core barrel head assembly 130 has a proximal end 132 that is operatively oriented toward the drill bit end of the drill string and an opposed distal end 134. As shown in Figure 8, the core barrel head assembly 130 is conventionally joined to a conventional wire line retrieval portion of a head assembly 10. Thus, the head assembly of the drill string is complete without the necessity for the use of an unwieldy extension tube as required in the prior art designs.

[0061] The core barrel head assembly 130 has an elongate tube body 160 that is operably coupled to elongate hollow spindle 170 that is, in turn, operably coupled to a selectively open check valve assembly 180. The elongate tube body has a threaded proximal end 162 that defines an internal bushing mount 163. The open distal end 164 of the elongate tube body defines an internal shoulder 165 that is sized and shaped to receive at least one conventional cylindrical bearing 190.

[0062] A bushing 192 is mounted in the bushing mount and is sized and shaped to rotatably receive the proximal end 172 of the hollow spindle 170. As shown in the figures, a mid-portion of the hollow spindle is rotatably supported by the at least one bearing 190. In a further aspect, a nut 194 is coupled to a treaded portion 174 of the hollow spindle 170 adjacent to the proximal end of the hollow spindle 170.

[0063] The a portion of the interior wall 165 of the elongate tube body 160, a portion of the nut 194 and a portion of the exterior surface of the hollow spindle define a an interior cavity 166 into which a spring is mounted and the at least one electronic instrument 40 that is configured to obtain orientation data, a operatively electrically coupled power source 50 and communication means to receive and/or transmit orientation data are mounted. The least one electronic instrument 40 that is configured to obtain orientation data, a operatively electrically coupled power source 50 and communication means to receive and/or transmit orientation data can be integrated; potted or otherwise affixed to the elongate tube body within the interior

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cavity 166. As one skilled in the art will appreciate, as the hollow spindle turns, the elongate tube body will remain in the same position, *i.e.*, the elongate tube body does not turn when the hollow spindle is turned.

[0064] In an optional aspect, a port 167 is defined that extends from the exterior surface of the elongate tube body into fluid communication with the interior cavity. Optionally, in this aspect, it is contemplated that a grease fitting 168 can be mounted in the port 167 to allow for selective passage of grease or lubricant into communication with the interior cavity.

[0065] It is contemplated that the interior cavity 166 can be sized to hermetically enclose at least one of the least one electronic instrument 40 that is configured to obtain orientation data, the power source 50 and the communication means to receive and/or transmit orientation data. In another aspect, the interior cavity 166 can be sized to hermetically enclose the least one electronic instrument 40 that is configured to obtain orientation data and the power source 50. In one aspect, the at least one electronic instrument 40 can comprise the electronic instrument discussed above and schematically shown in Figures 9 and 10. The at least one electronic instrument 40 is operatively electrically coupled to the power source 50, which can comprise any conventional power source, such as, for example and without limitation, a battery, a rechargeable battery, and the like.

[0066] In a further aspect, to provide fluid control for the wire line operation, a selectively open check valve assembly 180 is provided. In one aspect, the check valve assembly 180 comprises a coupled end assembly 182 defining a proximally tapered seat 184 that defines an interior chamber 185 for operative receipt of a check ball 195.

[0067] In one aspect, the coupled end assembly 182 of the check valve assembly can define a female threaded coupling that is configured to be threadably coupled to the male threads defined on the exterior surface of the distal end 173 of the hollow spindle 170. Thus, as shown in the figures, the tapered seat 184 is operably coupled to the distal end 173 of the spindle 170 such that the hollow interior of the spindle 170 can be selectively placed in fluid communication with fluid governed by the check valve assembly 180.

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[0068] As one skilled in the art will appreciate, the end assembly 182 of the check valve assembly defines at least one port 186 that extends from the exterior surface of the check valve assembly and is in fluid communication with the interior chamber of the check valve assembly. In one aspect, the at least one port 186 can comprise a plurality of ports. In this aspect, it is contemplated that the plurality of ports can be angularly spaced an equal or an unequal number of degrees apart.

[0069] In this aspect, the interior chamber 185 can have a proximally tapered seat 184 that is adapted to selectively receive the ball 195 that is sized to selectively block the proximally tapered seat. One skilled in the art will appreciate that the interior chamber 185 of the check valve assembly 180 can be sized and shaped to allow the ball to selectively move axially between an open position, in which the ball is spaced proximally away from the surface of the tapered seat so that pressurized fluid can move out through the elongate spindle into the proximal end of the check valve assembly and subsequently through the interior chamber of the check valve assembly to exit out of the at least one port, and a closed position, in which the ball is pressurized against the surface of the tapered seat so that pressurized fluid cannot move through the check valve assembly to through the hollow spindle.

[0070] In operation, it is contemplated that, in one non-limiting example, the at least one electronic instrument 40 of the core barrel head assembly 30 does not take any orientation measurements while vibrations, such as from the drilling operation, are present. In this aspect, the combination of mechanical, electromechanical and/or electronic sensors and software algorithms programmed into the at least one electronic instrument of the core barrel head assembly are configured to determine that the core barrel head assembly is in motion while descending down the hole and during drilling and is therefore not yet needed to detect breaking of the core sample from the body of material. Similarly, in a further aspect, it is contemplated that the at least one electronic instrument of the core barrel head assembly can be configured to detect that the core barrel head assembly is ascending to the surface for core retrieval after core breaking and subsequently will not take any core orientation measurements during the ascending operation.

[0071] In one non-limiting example, in operation, when the driller is ready to break the core, the driller can selectively not rotate the drill string for a first predetermined delay time period that can range from between about 10 seconds to

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about 90 seconds. During the delay time period, it is contemplated that an orientation and dip measurement can be taken during this non-rotation, *i.e.*, minimal vibration, period. Subsequently, after breaking the core, the driller can wait a second predetermined delay time period that can range from between about 60 seconds to about 120 seconds, or at least 90 seconds before initiating further rotation.

[0072] Optionally, it is contemplated that pressure created within the borehole by drilling mud and/or water, which may be pumped down the borehole from the surface can be detected by the at least one electronic instrument 42, which can comprise at least one pressure sensor. In various non-limiting examples, the at least one pressure sensor can be mounted on the drill string, such as on the inner and/or outer drill tube or on the drill bit or on the core barrel head assembly. The detected pressure, such as, for example and without limitation, pressure within the inner tube receiving the core, or pressure differential, such as, for example and without limitation, pressure differential between/across the inner and outer tubes, can be indicative of the inner tube being nearly or totally full of core material. This can occur before the core is separated from the subsurface body of material (such as by breaking the core from the body by a sharp pull back on the core) and hence can provide an indicator that the core is about to be broken.

[0073] Optionally, it is contemplated that the least one electronic instrument 40, which is configured to obtain orientation data, the power source 50 and the communication means to receive and/or transmit orientation data can be sized and shaped to be integrally mounted therein conventional wire line assemblies. It this aspect, the least one electronic instrument 40 that is configured to obtain orientation data, the power source 50 and the communication means to receive and/or transmit orientation data can be miniaturized and/or flexible to be received within defined cavities therein the conventional wire line assemblies and can be subsequently hermetically sealed, such as with, for example and without limitation, an epoxy, therein the defined cavities.

[0074] One skilled in the art will appreciate that the core barrel head assembly 30 does not need to be separated from the head assembly 20 in order to determine core sample orientation and/or to gather data recorded by the tool means that there is less risk of equipment failure and drilling downtime, as well as reduced equipment handling time through not having to separate the sections in order to otherwise obtain core sample orientation. Known systems require an end-on interrogation of

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the tool. By providing a sealed apparatus and the facility to determine orientation of the core sample by observing the orientation indications through one or more windows 74 in the side of the elongate tube body 60, reliability and efficiency of core sample collection and orientating is improved. Consequently operational personnel risk injury, as well as additional downtime of the drilling operation. Without having to separate core barrel head assembly 30 from the head assembly, the orientation of the core sample can be determined and the gathered information retrieved with less drilling delay and risk of equipment damage/failure.

[0075] Further, unlike known systems, the core barrel head assembly 30 provides for the desired flow of pressurized fluid in the wire-line assemblies to conventionally operate the fluid control vales that are commonly used in wire-line operations. As noted, the check valve assembly 100 allows for the selectively passage of fluid therethrough that assembly and to the exterior surface of the core barrel head assembly 30 and subsequently through the pressure relief valve to exit out of the first interior cavity of the elongate tube body.

[0076] In one aspect, the one or more pressure sensors 42 can be provided to detect pressure data, which can comprise pressure readings; changes in pressure and/or pressure differentials. The pressure data can be operative communication with the core barrel head assembly 30 and/or an operator at the surface. In one exemplary aspect, once a desired pressure value is detected, drilling can cease and the at least one electronic instrument 40 of the core barrel head assembly 30 can record data relating to the orientation of the core, such as gravitational field strength and direction, and/or magnetic field strength and direction.

[0077] In various aspects, it is contemplated that the recorded data can optionally include "dip" angle or azimuth datum to increase the reliability of the core orientation results. Conventionally, dip is the angle of the inner core tube drill assembly with respect to the horizontal plane and can be the angle above or below the horizontal plane depending on drilling direction from above ground level or from underground drilling in any direction. This provides further confirmation that the progressive drilling of a hole follows a maximum progressive dip angle which may incrementally change as drilling progresses, but not to the extent which exceeds a dogleg severity, *i.e.,* a normalized estimate (*e.g.* degrees / 30 meters) of the overall

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curvature of an actual drill-hole path between two consecutive directional survey/orientation stations.

[0078] In operation, prior to obtaining an orientation and core sample, a remote external communication device can be set by an operator to a start time. The remote external communication device communicates with the at least one electronic instrument 40 of the core barrel head assembly 30 before it is tripped into the drill hole. Subsequently, after a predetermined timed interval has elapsed from the start time, the at least one electronic instrument 40 can be configured to begin normal operation to detect the signature of vibration indicating a core break.

[0079] Optionally, in another aspect, pressure changes or levels can be detected to indicate a pre-break condition or period, such as pressure of mud/water within the inner tube increasing due to the core filling or nearly filling the inner tube holding the core.

[0080] In one aspect, the at least one electronic instrument 40 of the core barrel head assembly 30 can be configured to not take any orientation measurements while vibrations, such as from the drilling operation, are present. In this aspect, the combination of mechanical, electromechanical and/or electronic sensors and software algorithms programmed into the at least one electronic instrument 40 of the core barrel head assembly 30 can be configured to determine that the core barrel head assembly is in motion while descending down the hole and during drilling and is therefore not yet needed to detect breaking of the core sample from the body of material. Similarly, in a further aspect, it is contemplated that the at least one electronic instrument 40 of the core barrel head assembly 30 can be configured to detect that the core barrel head assembly is ascending to the surface for core retrieval after core breaking and subsequently will not take any core orientation measurements during the ascending operation.

[0081] Optionally, dip angle can be included in determining orientation of the core. In one aspect, the dip angle of the drill hole can be used to determine whether or not to use the obtained orientation data. For example, a valid core orientation sample can be determined from the previously discussed validation steps being acceptable and, additionally, from the dip angle of the drill hole also being within acceptable limits. In one aspect, the dip can be sampled as a reference prior to the first run of a new drill hole. This particular reference is called a setup function. In this aspect, the setup function can be selected on the remote communications

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device, which then communicates to the core barrel head assembly. For clarity, the core sample orientation subassembly does not orientation the core, rather, it records signals indicative of the orientation of the core to be retrieved. The core barrel head assembly can then be lowered down the hole or aligned to the angle of the drill rods in the case of no hole yet to be drilled. Once the core barrel head assembly is down to a desired position or to the end of the hole the user can "mark" the "shot," preferably via use of the remote communications device.

[0082] Subsequently, the core barrel head assembly is retrieved and the remote communications device can be used to communicate the dip (angle) of the drill hole to the communication means of the core barrel head assembly. Optionally, the dip of the end of the hole can be manually entered into the remote communications device and this communicated back to the core barrel head assembly.

[0083] In one aspect, a compliant datum is obtained when one or more signals indicative of the orientation of the core is/are obtained by the core orientation device during a period of no drilling vibration prior to detecting vibration from breaking the core and that being prior to a subsequent period of no drilling vibration. It is contemplated that one or more embodiments can utilize the final compliant datum instead of the first obtained compliant datum.

[0084] In one aspect, it is contemplated that the at least one electronic instrument 40 can comprise an LCD display 41 at one end. This can allow for setting up of the orientation system prior to deployment and to indicate visually alignment of the core sample when retrieved to the surface. The core barrel head assembly 30 can be connected to the core barrel head assembly which can be operably is connected to a sample tube for receiving a core sample. In one aspect, and as exemplarily shown in Figures 8 and 9, the at least one electronic instrument 40 can comprise at least one vibration sensor, at least one accelerometer 43, a memory 45, a timer 47 and the aforementioned LCD display 41. Optionally, at least one electronic instrument 40 can further comprise one or more of at least one of a gravity sensor, magnetic field sensor, inclinometer, a direction measuring sensor, a gyro, and/or preferably a combination two or more of these devices.

[0085] In this aspect, the at least one electronic instrument 40 can be configured to record orientation data every few seconds during core sampling. The start time can be synchronized with actual time using a common stop watch. The

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operably coupled core barrel head assembly 30 and the core barrel head assembly can then be lowered into the drill string outer casing to commence core sampling. After drilling and capturing a core sample in the inner core sample tube, the operator, can stop the stop watch and retrieve the core sample tube back to the surface. At the surface, before removing the core sample from the inner tube, the operator can views the LCD display, if it is still working, which steps the operator through instructions to rotate the core tube until the core sample lower section is at the core tube lower end . The core sample is then marked and stored for future analysis.

[0086] Another aspect of the present invention provides a method of conducting a down hole survey of drilling, the method including: a) drilling the core from a subsurface body of material; b) recording data relating to orientation of the core to be retrieved, the data recorded using the at least one electronic instrument of the core barrel head assembly, c) separating the core from the subsurface body, and d) obtaining an indication of the orientation of the core based on the recorded core orientation data obtained before the core was separated from the subsurface body.

[0087] Optionally, the method can comprise: determining that drilling has ceased for a period of time, using the at least one electronic instrument of the core barrel head assembly to record data relating to orientation of the core to be retrieved, separating the core from the subsurface body, retrieving the core to the surface, and obtaining an indication of the orientation of the core based on the recorded core orientation data obtained once the drilling had ceased and before the core was separated from the subsurface body.

[0088] In one exemplary aspect, for the embodiment shown in the flowchart in Figure 11, the core orientation can be validated when the following events have occurred:

a) Step 200: detecting no vibration above a threshold by the core barrel head assembly, or is detected to be below a threshold, for the first predetermined delay time period;

b) Step 220: taking a core orientation measurement during the first predetermined delay time period;

c) Step 230: detecting noise from breaking the core from the subsurface body after the first predetermined delay time period and before the second predetermined delay time period;

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d) Step 240: detecting no vibration above a threshold by the core barrel head assembly, or is detected to be below a threshold, for the second predetermined delay time period;

e) Step 250: retaining the orientation measurement obtained in Step 220 only if Steps 200, 230 and 240 are present;

f) Step 260: disregarding detected signals or to not detect vibration or lack of vibration if only if Steps 200, 230 and 240 are obtained. If the detected signals are disregarded, a vibration silence signal in Step 280 must be detected before the core is broken.

[0089] Optionally, as shown in Step 270, a dip measurement can be obtained during the period of no drilling prior to breaking the core (period Y), preferably if dip is within the set limits.

[0090] In one aspect, once the required core orientation is obtained, the core barrel head assembly may be shut down or turned to low power standby mode in Step 290 in preparation to be subsequently placed into an orientation mode. Once the core barrel head assembly 30 is retrieved to the surface in Step 300, an operator can set the core barrel head assembly to the orientation mode in Step 310. In one example, and not meant to be limiting, this can be done via the remote communication means for communicating with the communication means of the core barrel head assembly in Step 320.

[0091] In a further aspect, it is contemplated that the core barrel head assembly can comprise an orientation indicator assembly that comprises one or more lights or other visual indicators, such as, for example and without limitation, one or more display panels to give an indication of orientation direction and required orientation for marking the core. In this aspect, once in orientation mode, visual indications, such as flashing of one or more LEDs, can indicate to the operator which direction to rotate the core to find the" correct down side" for marking. In this aspect, the "correct downside" is the part of the core that was lowermost prior to separating from the subsurface body.

[0092] Once the correct downside is identified in Step 330, the operator can again effect communication to the communication means of the core barrel head assembly via the remote communication device. In Step 340, and based on the orientation data recorded, the remote communication device can be configured to

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verify that the correct orientation was achieved. Subsequently, in Step 350, the operator can perform another orientation operation.

[0093] Optional and exemplary methods of using the present invention are shown in Figures 12 and 13. In one aspect, as shown in Figure 12, the at least one electronic instrument 40 of the core barrel head assembly 30 can be programmed to be used in a running mode, a hibernation mode and an orientating mode. In this aspect, the at least one electronic instrument 40 of the core barrel head assembly 30 is configured to actuate and take sequential provisional data readings (POD1, POD2, POD3, etc.) when the at least one electronic instrument senses that vibrations have stopped. These provisional data readings are taken as desired time intervals that can be between about 0.1 to about 1.0 seconds. In this aspect, the core barrel head assembly 30 is configured to actuate or power up when the at least one electronic instrument is taken out hibernation. Further, it is contemplated that the time clock starts operation whenever the at least one electronic instrument 40. For example, this could happen on the surface prior to insertion into the hole. The programming can also optionally disregard any acquired provisional data (POD1, POD2, POD3, etc.) if vibrations are sensed during any portion of the acquisition of the sequential provisional data readings. In this case, the programming would automatically go to the step "Turn Off G-Sensor" in the running mode.

[0094] In one aspect, as shown in Figure 13, the at least one electronic instrument 40 of the core barrel head assembly 30 can be similarly programmed to be used in a running mode, a hibernation mode and an orientating mode. In this aspect, the at least one electronic instrument 40 of the core barrel head assembly 30 is configured to actuate in accord with a time interval scheme in which a signal is sent to the tri-axial g-sensors to take readings in accord with the predetermined time interval scheme.

[0095] In one aspect, it is contemplated that the core barrel head assembly 30 can be utilized in asynchronous time operation for core sampling. In this aspect, the data recording events taken by the core barrel head assembly 30 are not synchronized in time with the communication device. That is, the core barrel head assembly can be programmed to not commence timing from a reference time, and can optionally be programmed such that the at least one electronic instrument 40 of the core barrel head assembly 30 does not take samples (shots) at specific predetermined time intervals. For example, and not meant to be limiting, the at least

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one electronic instrument 40 of the core barrel head assembly 30 can be programmed to not take a three second sample every one minute with that one minute interval synchronized to the remote, which would therefore know when each sample is about to take place. In this aspect, the communication means or device is not synchronized to the core orientation unit, *i.e.* asynchronous operation, and therefore the communication device does not know if or when a sample is being taken. Thus, obtaining an indication of core sample orientation is simplified over known arrangements.

[0096] In one aspect, while the core barred head assembly is on the surface, the external communication device can signal to the at least one electronic instrument 40 to activate or come out of a standby mode prior to deployment down hole. Optionally, the at least one electronic instrument 40 can already be activated such that it is not necessary to have the at least one electronic instrument 40 switch on from a deactivated ('turned off') state.

[0097] Alternatively, the at least one electronic instrument 40 can be configured to activate and commence taking data samples after a predetermined period from deployment from the surface or after elapse of an activation delay timer or other delay mechanism. For example, the data gathering device may be configured at the surface to only 'wake-up' from a standby mode to an activated mode after at least a predetermined period of time has elapsed or a counter has completed a predetermined count relating to a time period delay.

[0098] In one aspect, it is contemplated that the at least one electronic instrument 40 can be programmed to take measurements/record orientation data based on the time intervals and/or randomly generated time intervals. In this aspect, the programmed instructions to record data generated as a result of the regular or randomly generated time intervals can remain on-going while the at least one electronic instrument 40 activated. However, because at least one of the sensor(s) in the at least one electronic instrument 40 may be shut down/deactivated during sensed vibrations, no orientation data gets acquired during time period in which vibrations are sensed. When the vibrations stop, the sensors are turned on and the time intervals instructions would then resume execution as per the time regular or random intervals. In this aspect, orientation data is being measured/obtained per the time intervals being used, as preferably initiated at the beginning of the run or after a delay timer. But, data will not be recorded during the

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time intervals due to the fact that the sensor(s) will be off/deactivated, *e.g.* during a time period in which vibrations are sensed. In this aspect, when drilling ceases, which results in vibrations ceasing, data will be taken, and may preferably continue to be taken, in accordance with the time intervals scheme initiated at the surface, and preferably may always running in the background even when the sensor(s) is/are off or deactivated (*e.g.*, asleep).

[0099] In a further aspect, the at least one electronic instrument 40 can log and/or record orientation related data down hole at intervals (regular or randomly generated intervals within minimum and maximum interval time limits) and can also measures total lapsed survey time T.

[00100] In a further aspect, the at least one electronic instrument 40 can be started by an external communication device at the surface but a second, different, communication device can be used to 'mark' (to set) the point in time, *i.e.*, to commence the elapsed period of time t relating to breaking the core sample from the underlying rock and thereby be used for identifying the data set recorded immediately before that break.

[00101] In one aspect, to compensate for taking regular or random time period orientation measurements, which uses up battery power as the at least one electronic instrument 40 advances down hole, a start delay can be provided. For example, when the external communication device at the surface is operated, *e.g.*, turned on, an option to set a delay time in the at least one electronic instrument 40 may be displayed. For example, a delay in minutes between 0 to 99 minutes might be displayed. In this aspect, when the at least one electronic instrument 40 is started-up and the communication device communicates the delay period to the at least one electronic instrument 40, the timer in the at least one electronic instrument 40 will allow the delay period to elapse before any orientation measurements are recorded.

[00102] In one aspect, orientation data can be recorded while drilling is ceased and closest to time Tx, where Tx is preferably less than or equal to T-t, and where T is the time recorded by the at least one electronic instrument 40 (survey time) and t is the elapsed time recorded by the external communication device that was commenced once drilling ceased and the orientation data was recorded. In this exemplary aspect, it will be appreciated that the required recorded data may be at a

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time Tx greater than T-t, *i.e.*, if the drilling remained ceased after commencing the elapsed time and separating (breaking) the core sample from the rock was delayed while the at least one electronic instrument 40 recorded orientation data. Thus, Tx can be greater than T-t providing no drilling activity takes place after drilling ceases and before the core is broken from the underlying rock. In this aspect, in operation, when the core barrel head assembly 30 is retrieved back at the surface with the core sample), the external communication device interrogates the at least one electronic instrument 40 to identify the recorded core orientation data closest to T-t, *i.e.*, the timer of the external communication device is not synchronised to the timer of the at least one electronic instrument 40, and both timers are not commenced at a reference time.

[00103] For example and without limitation, orientation data may be recorded by the at least one electronic instrument 40 at regular irregular intervals of time within a known range of allowed time intervals, such as one or more of 10s, 15s, 20s or 30s intervals within a range of 1s to 1 minute. It is contemplated that the time intervals can be generated by a random (time) number generator operating within the minimum and maximum allowed range. Thus, the time intervals for obtaining orientation data may be repeated (e.g. 10s, 10s, 10s, 20s, 20s, 10s…). In this exemplary aspect, data recording events ('shots') are therefore not constantly taken on a set time period. However, it is contemplated that predetermined set time intervals may be used. That is, the at least one electronic instrument 40 may record orientation data every time interval, preferably up until the core is broken form the underlying rock, though recording may also continue afterwards.

[00104] In operation, the at least one electronic instrument 40 can be deployed down hole. Optionally, the at least one electronic instrument 40 can be started at the surface and its timer commence the survey time timing at the surface, or the timer can have a delay to save power until the at least one electronic instrument 40 is all or partway down the borehole. Subsequently, when the core sample has been captured sufficiently in the core tube, drilling ceases and during this period of non-drilling, the at least one electronic instrument 40 records orientation data relating to its own orientation in the borehole, and therefore, of the associated core sample that is captured in the core barrel head assembly 30, which cannot rotate unless the at least one electronic instrument 40 also rotates. Next, the core sample is broken

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away from the underlying rock and the core barrel head assembly 30 is retrieved to the surface.

[00105] In one aspect, an external communication device can record the elapsed time t by a user, *i.e.*, commencing the timer in the handheld external communication device at the surface. This is preferably either when drilling has ceased or immediately before breaking the core from the rock while drilling has ceased, or immediately after the core is broken. However, it will be appreciated that the elapsed time can be commenced after the core is broken away from the underlying rock because the at least one electronic instrument 40 can be programmed to identify the nearest recorded data older than the commencement of the elapsed time that occurred during no drilling. In this aspect, the external communication device retains a record of the elapsing time.

[00106] When the at least one electronic instrument 40 and core barrel head assembly 30 containing the core sample are retrieved to the surface, the user can interrogate the at least one electronic instrument 40. In this aspect, once the at least one electronic instrument 40 confirms receiving the interrogation command, the communication device can command halting of the survey time T (stopping the at least one electronic instrument 40's timer) and elapsed time t (stopping the external communication device's timer). In this aspect, the external communication device can instruct the at least one electronic instrument 40 to identify the recorded orientation data from immediately before or after the commencement of the elapsed period of time going back from the end of the survey time, *i.e.*, the at least one electronic instrument 40 has to 'look back' in time for the data recorded at or around the elapsed ago. In this aspect, the at least one electronic instrument 40 subtracts the elapsed time t from its survey time T to provide a time Tx associated with the required recorded data obtained when drilling was ceased.

[00107] In this aspect, once the correct recorded orientation data is identified in its memory, the at least one electronic instrument can go into orientation mode so that the core sample can be orientated and that orientation recorded. In one exemplary aspect, recording of orientation data by the at least one electronic instrument 40 is triggered on a time interval basis; this may be by the regular or random time intervals mentioned above. Recording the orientation data may only commence once the time delay has ended. For example, the timer within the at

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least one electronic instrument 40 may be running from deployment (or before) of the device into the borehole. However, the delay may prevent the device from recording orientation data until the delay has ended. Once the delay has ended, orientation data is recorded according to the prevailing time interval sequence, *i.e.*, randomly generated time intervals or regular time intervals.

[00108] Optionally, when vibration or other motion of the at least one electronic instrument 40 stops down hole sufficiently, the at least one electronic instrument 40 may resume recording orientation data according to the prevailing time interval regime or may switch to another time interval regime for sensing and recording orientation.

[00109] Optionally, the at least one electronic instrument 40 can be programmed to identify core orientation data recorded before breaking of the core sample but based on an elapsed time period commenced after breaking the core sample. The at least one electronic instrument 40 can be programmed to identify the recorded orientation data that that was recorded before commencement of the elapsed time. In a further aspect, the recorded data can be recorded after breaking of the core sample because of the time interval recording regime. In this aspect, if that data set was recorded while nothing was moving down hole (and has not moved since breaking the core), the data set can be trusted to be sufficiently accurate. It can be compared with one or more previous data sets, and if they concur, then can be deemed sufficiently accurate for orientation purposes. Only one of those data sets is needed and any other of them may be discarded or disregarded.

[00110] In a further aspect, it is contemplated that operation of the at least one electronic instrument 40 to commence recording orientation data can be initiated at the surface and device then deployed into the borehole. Commencement of recording orientation data can also be delayed, so as to save battery power by avoiding taking unnecessary or unusable orientation measurements whilst the device is progressing down the borehole. Orientation measurement immediately before or after breaking the core sample from the underlying rock is/are required. In one exemplary aspect, the at least one electronic instrument 40 can have a delay preventing recording of orientation data until the delay ends.

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[00111] In another aspect, the at least one electronic instrument 40 can take orientation measurements periodically, such as at random or regular periods of time, and record one or more of those measurements. Preferably the at least one electronic instrument 40 can be in a sleep mode, change to a power-up (wake-up) mode and then take a measurement, and re-enter sleep each interval. In one aspect, if two or more consecutive orientation measurements are the same, the at least one electronic instrument 40 can ignore, not record or delete from memory unnecessary repeat measurements and only retain one of the repeat measurements, preferably being the first of the identical measurements. In this aspect, each recorded measurement of orientation can be tagged or 'time stamped', preferably relative to the timer running in the at least one electronic instrument 40, *i.e.*, the recorded orientation data is given a time stamp Tx, where x is the particular time within the survey timeframe running in the device. Thus, Tx is the time since the survey time T commenced that that orientation data set was recorded. It is contemplated that Tx can be a real time or cumulative time since commencement of the survey time T. Thus, in this aspect, the at least one electronic instrument 40 can have a real time clock type timer or a 'start-stop' (counter or stopwatch) type timer. When drilling ceases and the core is to be broken from the underlying rock (because there is sufficient core sample in the core barrel), a 'mark' is taken, which commences an elapsed time t at the surface. In this aspect, it is contemplated that this mark can be taken before or after the break at either regular or irregular time intervals.

[00112] Referring now to Figure 14, an exemplary known hand held device 400 which receives wirelessly receives data or signals from the communication means of the core barrel head assembly. In this aspect, communication means of the core barrel head assembly comprises a transmitter which can use line of sight data transfer through the window, such as by infra-red data transfer, or a wireless radio transmission. The communication device 400 can store the signals or data received from the communication means of the core barrel head assembly. In one aspect, the communication device 400 can comprise a display 402, navigation buttons 404, 406, and a data accept confirmation button 408.

[00113] In one aspect, setting up of the core barrel head assembly 30 can be carried out before insertion into the drill hole. Data retrieval can be carried out by

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infrared communication between the communication means of the core barrel head assembly and a core orientation data receiver or communication device 400. In this aspect, after recovering the core sample inner tube back at the surface, and before removing the core sample from the tube, the operator can optionally remove the head assembly. The operator can use the remote communication device to obtain orientation data from the communication means of the core barrel head assembly using a line of sight wireless infrared communication between the remote device and communication means of the core barrel head assembly. However, it will be appreciated that communication of data between the communication means of the core barrel head assembly and the communication device 400 can be by other wireless means, such as by radio transmission.

[00114] In this prior art aspect, the whole inner tube, core sample, and core barrel head assembly can be rotated as necessary to determine a required orientation of the core sample. The indicators on the proximal end of the core barrel head assembly indicate to the operator which direction, clockwise or anti-clockwise, to rotate the core sample. One color of indicator can be used to indicate clockwise rotation and another color can be used to indicate anticlockwise rotation is required. This is carried out until the core sample is oriented with its lower section at the lower end of the tube. The core sample is then marked for correct orientation and then used for analysis.

[00115] In one aspect, it is contemplated that the visual and/or audible orientation indicators, under certain site and/or environmental conditions, may not be sufficiently visible or audible. Thus, an additional or alternative means and/or method may be utilized to ensure that the core sample has been correctly oriented. In this embodiment, the exterior surface 61 of the body of the core barrel head assembly 30 can have angular degree marks that optionally are scribed/ etched, machined, molded or otherwise provided, such as by printing or painting, on the exterior surface 61. For example, dashes can be equally spaced around the outside parameter represent one or more angular degrees of the full circle or perimeter. Further scribing of a number every five dashes starting with the number 0 then 5, 10, 15 etc. until 355.

[00116] When the core is retrieved and the communication means of the core barrel head assembly communicates with the hand held communicator 400, additional information can be transmitted from the core barrel head assembly to the

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communicator 400, such as a number between zero 0 and 359 (inclusive) denoting an angular degree of rotation of core barrel head assembly and the core sample. When the core is oriented during one or more embodiments of the method of the present invention, the numerical scribing the core barrel head assembly should be the same as the number transmitted, to the communicator 400, which re-confirms correct orientation. Thus, if the visual or audible means for indicating core orientation are not useful or available, then the core can be oriented using the angular degree arrangement to match the transmitted number, and then can be audited using the communicator 400.

[00117] Embodiments of the present invention provide the advantage of a fully operating down hole core barrel head assembly without having to disconnect or disassemble any part of the tool/device from the inner tube and/or from the head assembly or any other part of the drilling assembly that the core barrel head assembly would need to be assembled within for its normal operation. Disconnecting or disassembling the core barrel head assembly from the head assembly and/or inner tube risks failure of seals at those connections and/or risks cross threading of the joining thread. Also, because those sections are threaded together with high force, it takes substantial manual force and large equipment to separate the sections. High surrounding pressure in the drill hole means that the connecting seals between sections function to prevent water and dirt from ingressing into and damaging the device.

[00118] Although several embodiments of the invention have been disclosed in the foregoing specification, it is understood by those skilled in the art that many modifications and other embodiments of the invention will come to mind to which the invention pertains, having the benefit of the teaching presented in the foregoing description and associated drawings. It is thus understood that the invention is not limited to the specific embodiments disclosed hereinabove, and that many modifications and other embodiments are intended to be included within the scope of the appended claims. Moreover, although specific terms are employed herein, as well as in the claims which follow, they are used only in a generic and descriptive sense, and not for the purposes of limiting the described invention, nor the claims which follow.

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Claims:

1. A core barrel head assembly, comprising:

an elongate tube body defining a first interior cavity and a selectively sealed interior cavity spaced distally from the first interior cavity, wherein the elongate tube body has a threaded proximal end for coupling to a wire line retrieval portion of a head assembly, wherein the first interior cavity extends distally from the threaded proximal end to a base portion of the elongate tube body, and wherein the elongate tube body further defines a port positioned proximate the base portion and extending from the exterior surface of the elongate tube body into fluid communication with the first interior cavity;

a plurality of windows defined in the elongate tube body that extend from the exterior surface of the elongate tube body into optical communication with the sealed interior cavity proximate a closed proximal end of the sealed interior cavity;

at least one electronic instrument that is configured to obtain orientation data mounted therein the sealed interior cavity, wherein the at least one electronic instrument comprises at least one digital and/or electro-mechanical sensors in a core orientation data recording tool that can be configured to determine a core orientation of a sample core just prior to or after the core break;

a power source in operable communication with the at least one electronic instrument, wherein the power source is mounted therein the interior cavity; and

communication means to receive and/or transmit core orientation data,

wherein the sealed interior cavity is sized and shaped to hermetically enclose the at least one electronic instrument and the power source.

2. The core barrel head assembly of Claim 1, wherein a pressure fitting is mounted in the port to allow for selective passage of fluid to and from the exterior surface of the barrel head assembly into communication with the first interior cavity.

3. The core barrel head assembly of Claim 1, wherein the sealed interior cavity is sized and shaped to hermetically enclose the communication means to receive and/or transmit orientation data.

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4. The core barrel head assembly of Claim 1, further comprising an orientation indicator module comprising a plurality of light emitters.

5. The core barrel head assembly of Claim 4, wherein the orientation indicator module is sized and shaped to sealingly close the sealed interior cavity from any intrusion of pressurized fluid into the sealed interior cavity via the plurality of windows.

6. The core barrel head assembly of Claim 4, wherein the orientation indicator module is configured to orient or otherwise position the plurality of light emitters so that each light emitter underlies one window.

7. The core barrel head assembly of Claim 4, wherein the orientation indicator module further comprises a first sealing means for preventing any pressurized fluid from entering the sealed interior cavity from the plurality of windows defined in the elongate tube body.

8. The core barrel head assembly of Claim 7, wherein the first sealing means comprises at least one O-ring seal that is mounted on an exterior portion of the orientation indicator module and that is configured to seal between an exterior portion of the orientation indicator module and a portion of an interior surface of the sealed interior cavity.

9. The core barrel head assembly of Claim 8, wherein the sealed interior cavity comprises at least one orienting slot defined therein.

10. The core barrel head assembly of Claim 8, wherein a desired position of the orientation indicator module is maintained relative to at least one O-ring seal.

11. The core barrel head assembly of Claim 1, wherein the sealed interior cavity extends distally to an open threaded distal end of the elongate tube body.

12. The core barrel head assembly of Claim 11, further comprising a seal coupler that is configured to be sealingly received in the open threaded distal end of the elongate tube body.

13. The core barrel head assembly of Claim 12, further comprising a second sealing means for preventing any pressurized fluid from entering the sealed interior cavity.

14. The core barrel head assembly of Claim 13, wherein the second sealing means comprises at least one O-ring seal that is mounted on a portion of the seal coupler and that

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is configured to seal between a portion of the seal coupler and a portion of an interior surface of the open distal end of the elongate tube body.

15. The core barrel head assembly of Claim 12, further comprising a check valve assembly configured to affect a hermetical seal of the sealed interior cavity and to provide fluid control for wire line operation.

16. The core barrel head assembly of Claim 15, wherein the check valve assembly comprises a coupled proximal end assembly and a distally tapered seat that defines an interior chamber for operative receipt of a check ball.

17. The core barrel head assembly of Claim 16, wherein the proximal end assembly defines a female threaded coupling that is configured to be threadably coupled to male threads defined on an exterior surface of a distal end of the elongate tube body.

18. The core barrel head assembly of Claim 17, wherein, when the proximal end assembly is threadably coupled to the distal end of the elongate tube body, the seal coupler is driven into a sealed position therein the sealed interior cavity to affect complete hermeticity.

19. The core barrel head assembly of Claim 16, wherein the interior chamber of the check valve assembly extends to a distal end of the check valve assembly, and wherein the check valve assembly further defines at least one port that extends from an exterior surface of the check valve assembly and is in fluid communication with the interior chamber of the check valve assembly.

20. The core barrel head assembly of Claim 19, wherein the interior chamber has a distally tapered seat that is adapted to selectively receive the check ball that is sized to selectively block the distally tapered seat.

21. The core barrel head assembly of Claim 20, wherein the interior chamber is sized and shaped to allow the check ball to selectively move axially between an open position, in which the check ball is spaced proximally away from the surface of the tapered seat so that pressurized fluid can move through the distal end of the check valve assembly and subsequently through the interior chamber to exit out of the at least one port, and a closed position, in which the check ball is pressurized against the surface of the tapered seat so that pressurized fluid cannot move through the check valve assembly.

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22. The core barrel head assembly of Claim 1, wherein an exterior surface of the elongate tube body defines a plurality of female planar stops proximate the mid-body portion.

23. The core barrel head assembly of Claim 1, wherein the at least one electronic instrument is programmed to obtain orientation data when the at least one electronic instrument senses no relative movement of the at least one electronic instrument.

24. The core barrel head assembly of Claim 23, wherein the at least one electronic instrument is programmed to obtain orientation data when the at least one electronic instrument senses no vibrations.

25. The core barrel head assembly of Claim 24, wherein the at least one electronic instrument does not take any orientation measurements if vibrations are sensed by the at least one electronic instrument.

26. The core barrel head assembly of Claim 23, wherein the at least one electronic instrument is programmed to not obtain orientation data when the at least one electronic instrument determines that the core barrel head assembly is in motion while descending down or ascending up the hole and during drilling.

27. The core barrel head assembly of Claim 1, wherein the at least one electronic instrument is programmed to obtain orientation data based on a predetermined time interval scheme.

28. A core barrel head assembly, comprising:

an elongate tube body defining a first interior cavity and a selectively sealed interior cavity spaced distally from the first interior cavity, wherein the elongate tube body has a threaded proximal end for coupling to a wire line retrieval portion of a head assembly, wherein the first interior cavity extends distally from the threaded proximal end to a base portion of the elongate tube body, and wherein the elongate tube body further defines a port positioned proximate the base portion and extending from the exterior surface of the elongate tube body into fluid communication with the first interior cavity;

at least one electronic instrument that is configured to obtain orientation data mounted therein the sealed interior cavity, wherein the at least one electronic instrument comprises at least one digital and/or electro-mechanical sensors in a core orientation data

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recording tool that can be configured to determine a core orientation of a sample core just prior to or after the core break;

a power source in operable communication with the at least one electronic instrument, wherein the power source is mounted therein the interior cavity; and

communication means to receive and/or transmit core orientation data,

wherein the sealed interior cavity is sized and shaped to hermetically enclose the at least one electronic instrument and the power source, and

wherein a pressure fitting is mounted in the port to allow for selective passage of fluid to and from the exterior surface of the barrel head assembly into communication with the first interior cavity.

29. The core barrel head assembly of Claim 28, further comprising a plurality of windows defined in the elongate tube body that extend from the exterior surface of the elongate tube body into optical communication with the sealed interior cavity proximate a closed proximal end of the sealed interior cavity

30. The core barrel head assembly of Claim 28, wherein the sealed interior cavity extends distally to an open threaded distal end of the elongate tube body.

31. The core barrel head assembly of Claim 30, further comprising a seal coupler that is configured to be sealingly received in the open threaded distal end of the elongate tube body.

32. The core barrel head assembly of Claim 28, wherein the at least one electronic instrument is programmed to obtain orientation data when the at least one electronic instrument senses no relative movement of the at least one electronic instrument.

33. A core barrel head assembly, comprising:

an elongate tube body defining a first interior cavity and a selectively sealed interior cavity spaced distally from the first interior cavity, wherein the elongate tube body has a threaded proximal end for coupling to a wire line retrieval portion of a head assembly, wherein the first interior cavity extends distally from the threaded proximal end to a base portion of the elongate tube body, and wherein the elongate tube body further defines a port positioned proximate the base portion and extending from the exterior surface of the

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elongate tube body into fluid communication with the first interior cavity, wherein the sealed interior cavity extends distally to an open threaded distal end of the elongate tube body;

a seal coupler that is configured to be sealingly received in the open threaded distal end of the elongate tube body;

at least one electronic instrument that is configured to obtain orientation data mounted therein the sealed interior cavity, wherein the at least one electronic instrument comprises at least one digital and/or electro-mechanical sensors in a core orientation data recording tool that can be configured to determine a core orientation of a sample core just prior to or after the core break;

a power source in operable communication with the at least one electronic instrument, wherein the power source is mounted therein the interior cavity; and

communication means to receive and/or transmit core orientation data,

wherein the sealed interior cavity is sized and shaped to hermetically enclose the at least one electronic instrument and the power source.

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Patent & Trade Mark Attorneys

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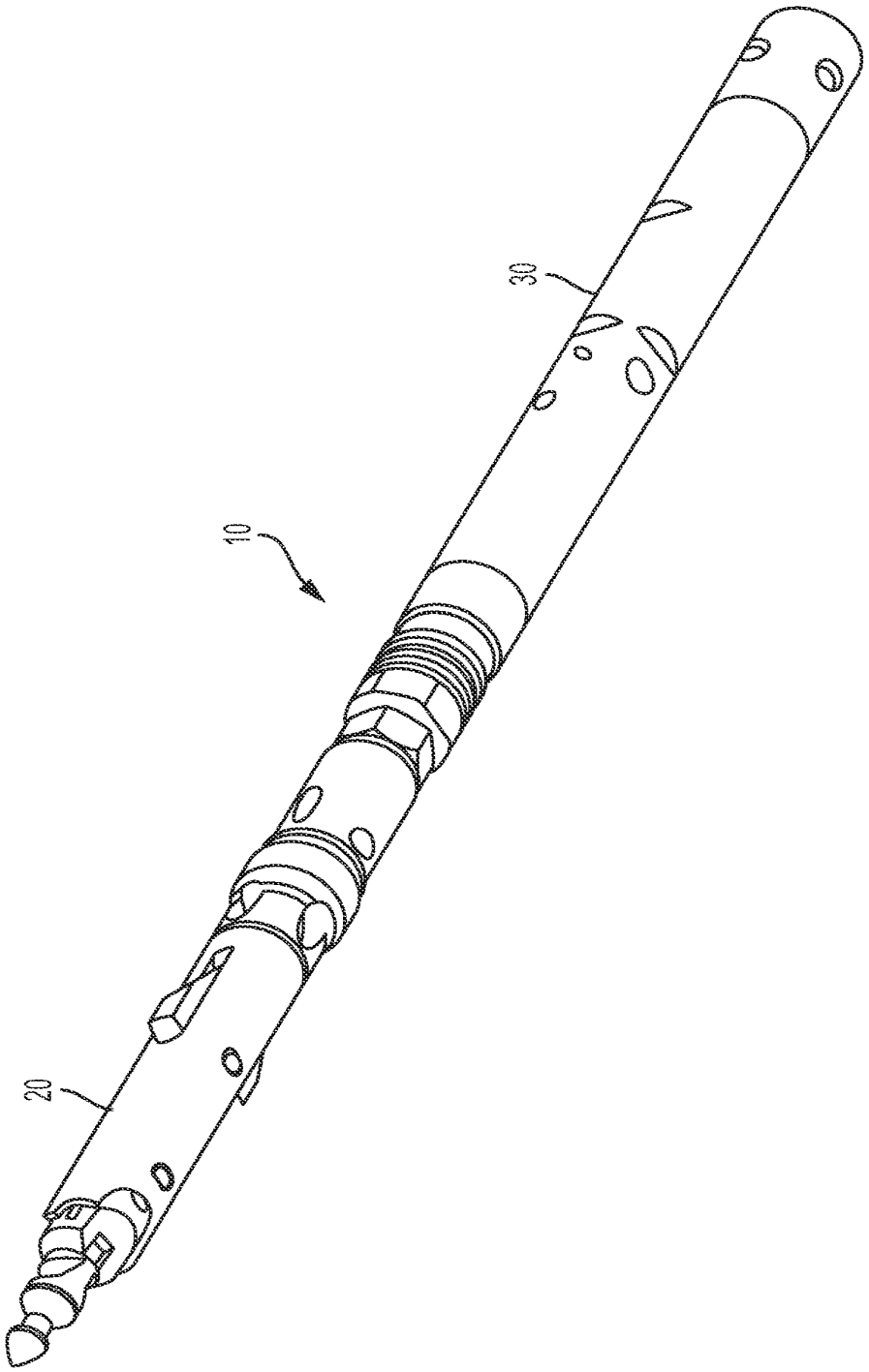


FIG. 1

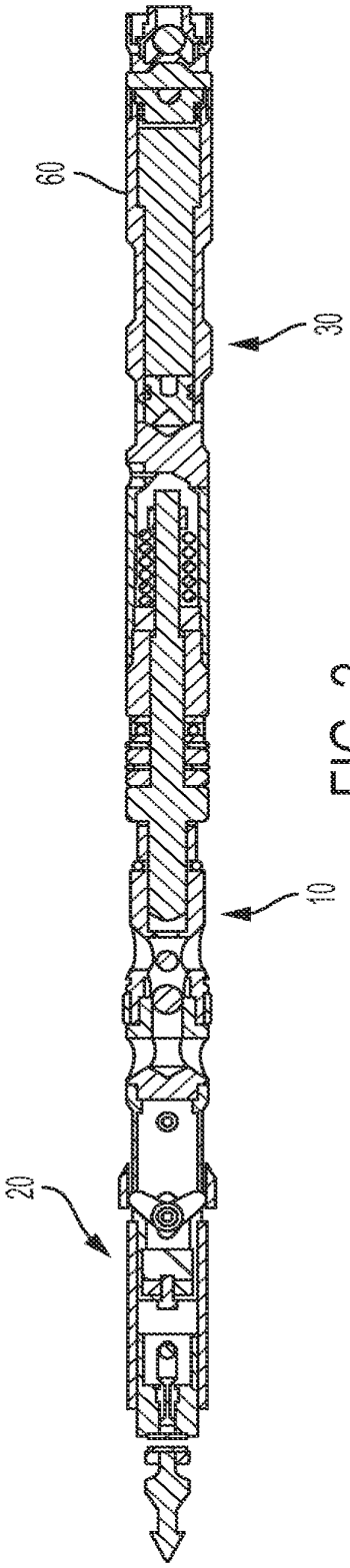

60
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10
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FIG. 2

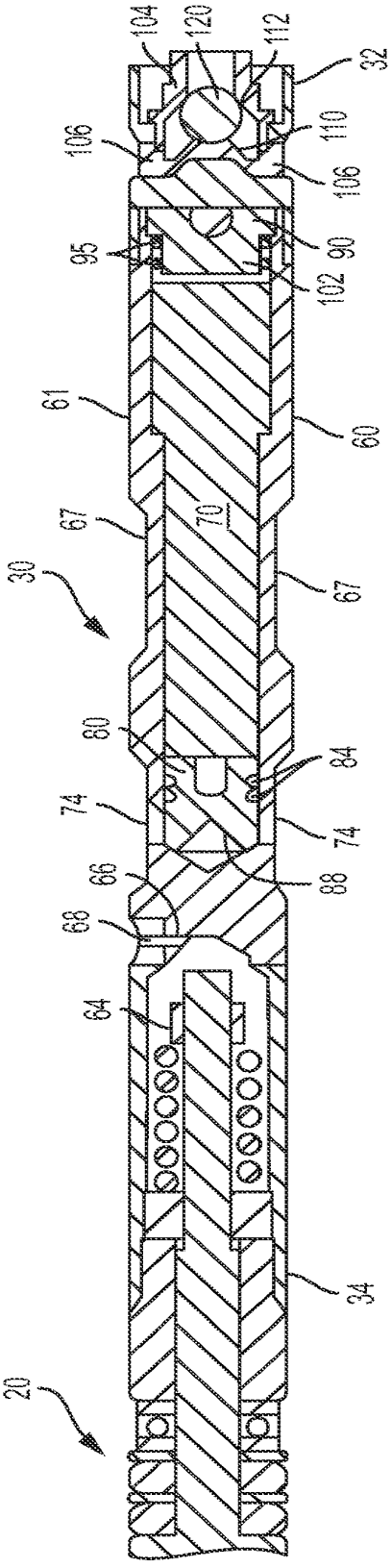

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32
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34
20

FIG. 3

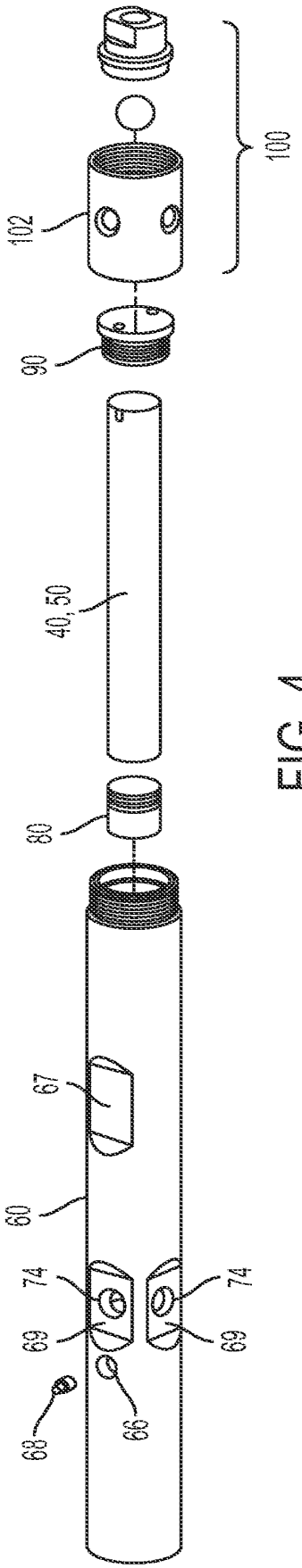

100
102
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40, 50
80
67
60
74
74
69
69
68
66

FIG. 4

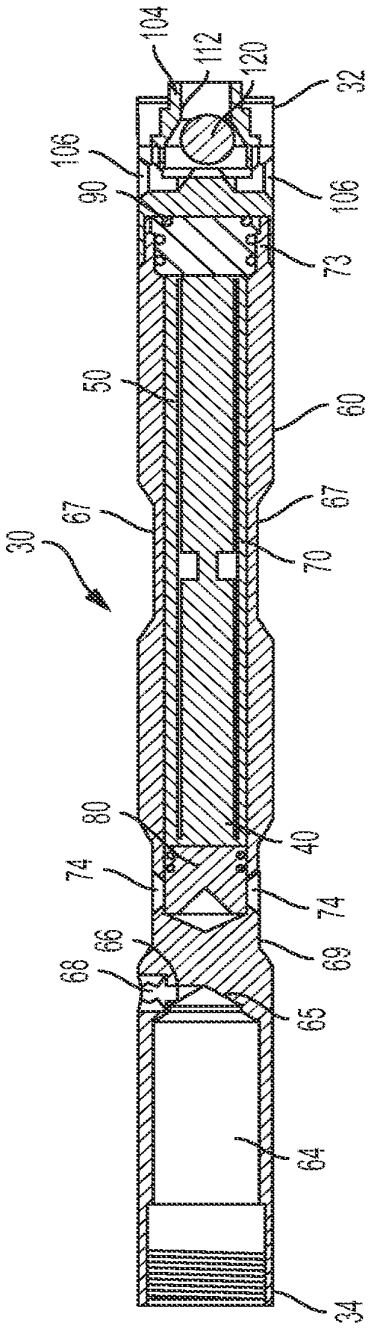

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FIG. 5

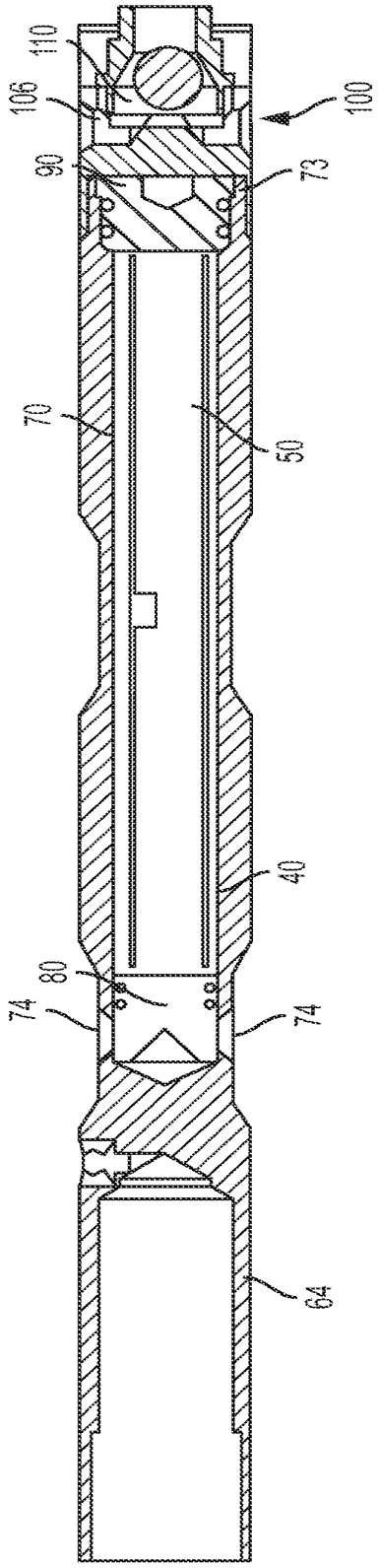


FIG. 6

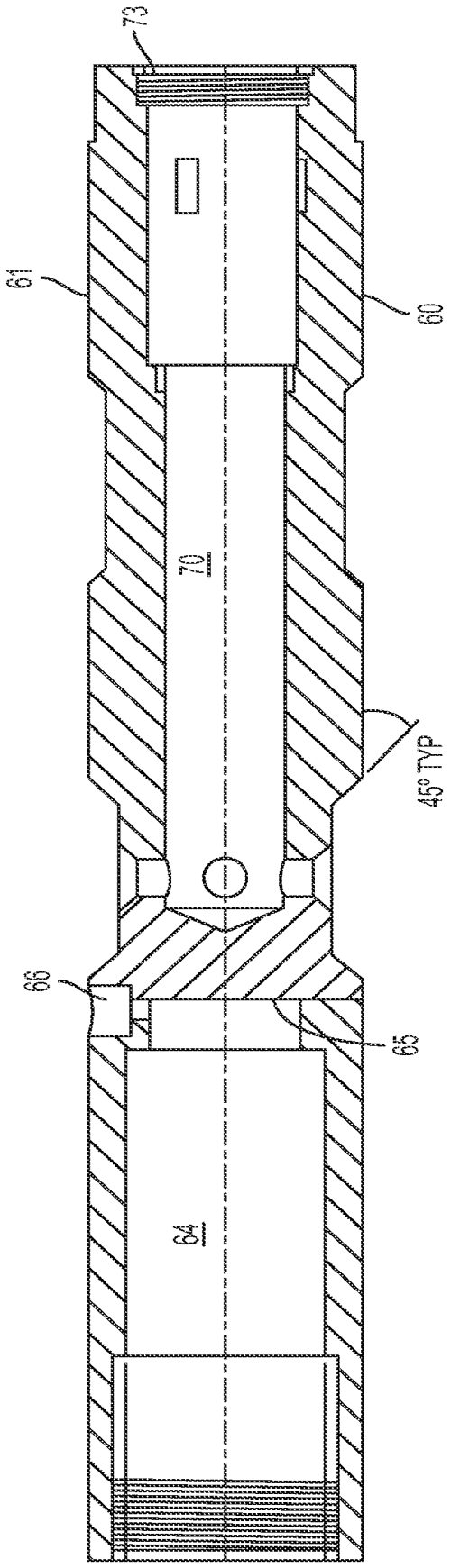


FIG. 7

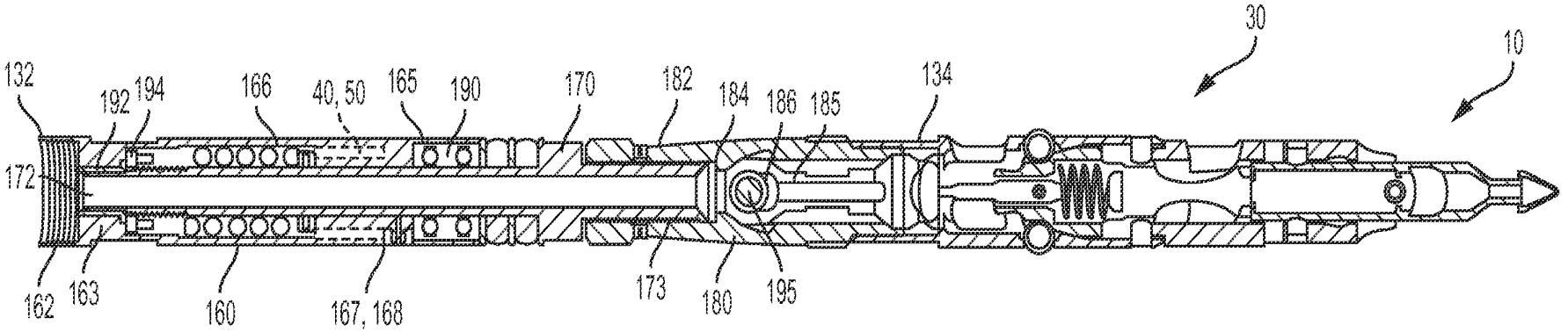

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FIG. 8

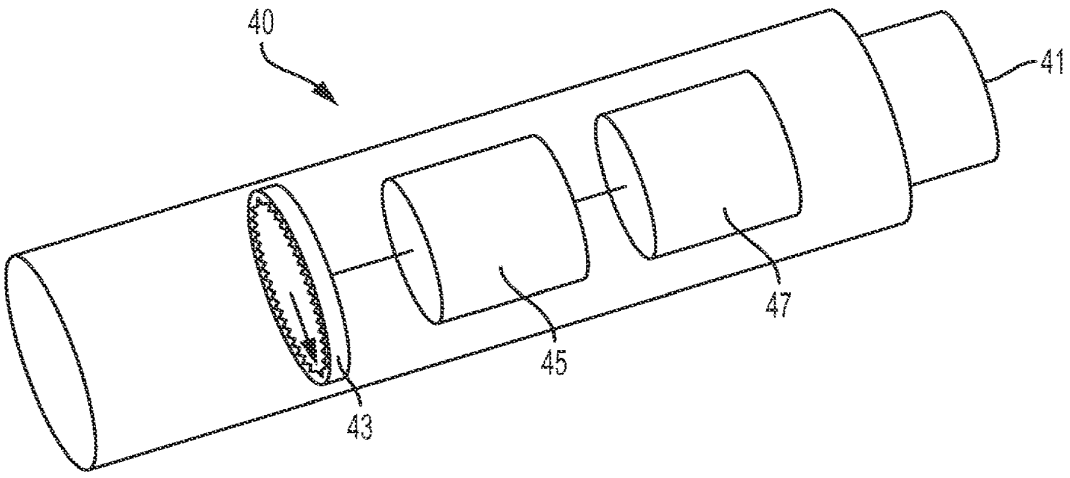


FIG. 9

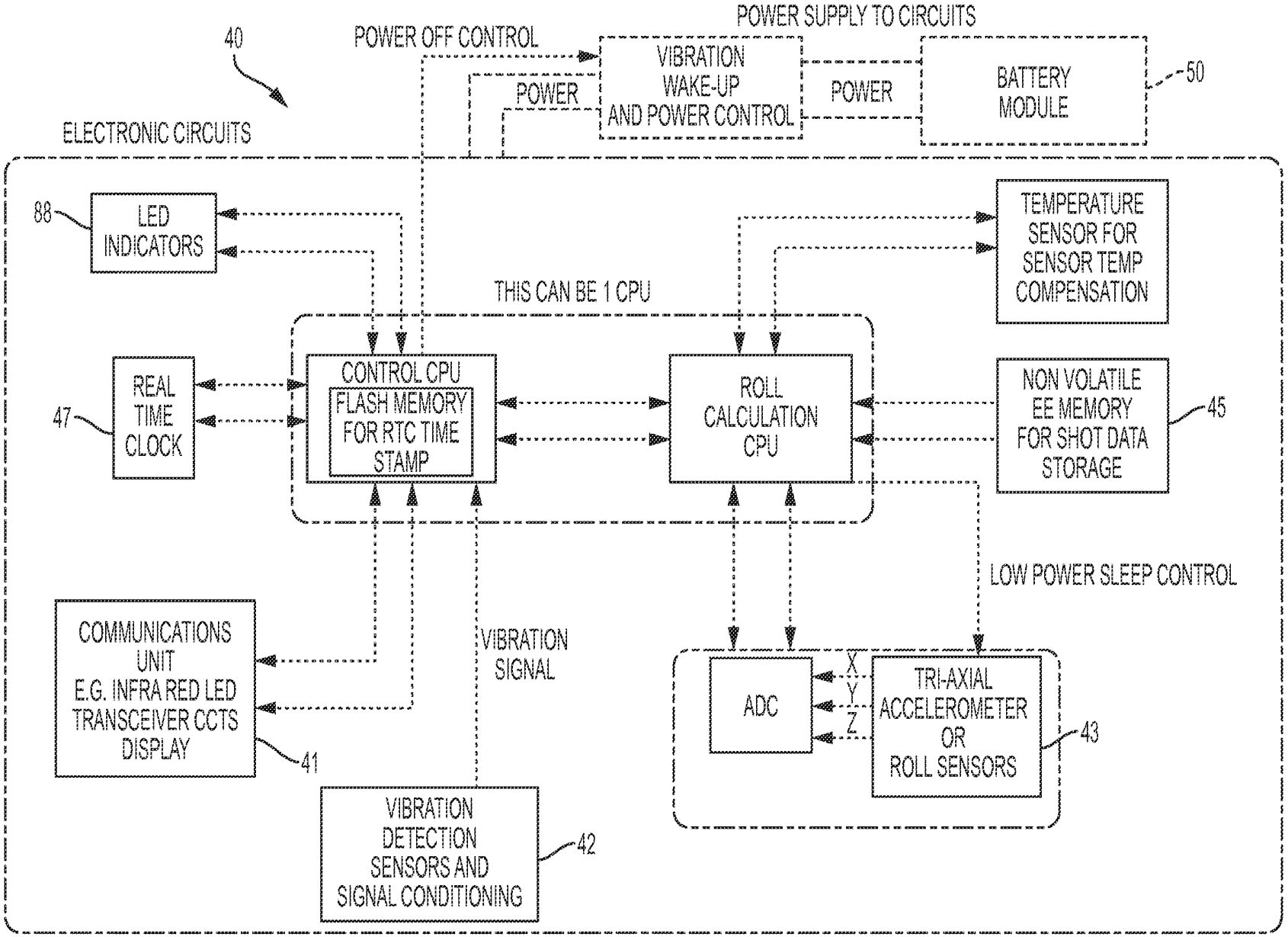

40
POWER OFF CONTROL
POWER SUPPLY TO CIRCUITS
POWER
VIBRATION WAKE-UP AND POWER CONTROL
POWER
BATTERY MODULE
50
ELECTRONIC CIRCUITS
88
LED INDICATORS
TEMPERATURE SENSOR FOR SENSOR TEMP COMPENSATION
THIS CAN BE 1 CPU
47
REAL TIME CLOCK
CONTROL CPU
FLASH MEMORY FOR RTC TIME STAMP
ROLL CALCULATION CPU
NON VOLATILE EE MEMORY FOR SHOT DATA STORAGE
45
LOW POWER SLEEP CONTROL
COMMUNICATIONS UNIT E.G. INFRA RED LED TRANSCEIVER CCTS DISPLAY
41
VIBRATION SIGNAL
ADC
X
Y
Z
TRI-AXIAL ACCELEROMETER OR ROLL SENSORS
43
VIBRATION DETECTION SENSORS AND SIGNAL CONDITIONING
42

FIG. 10

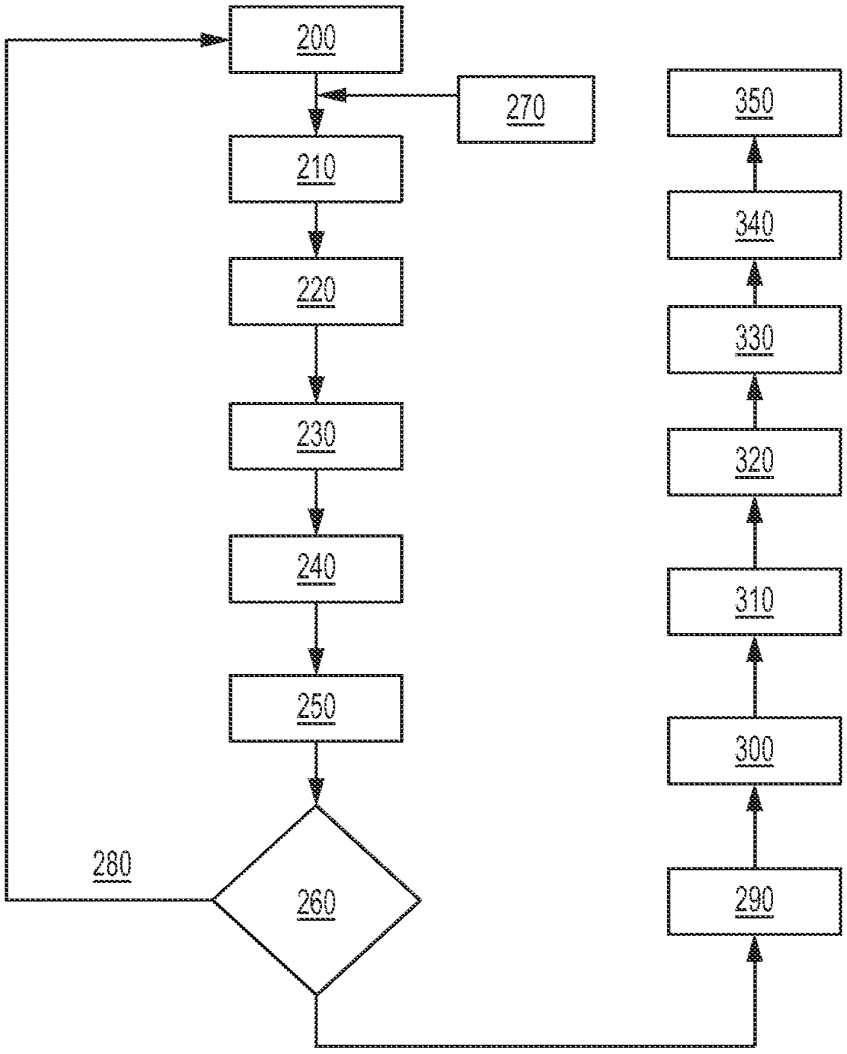


FIG. 11

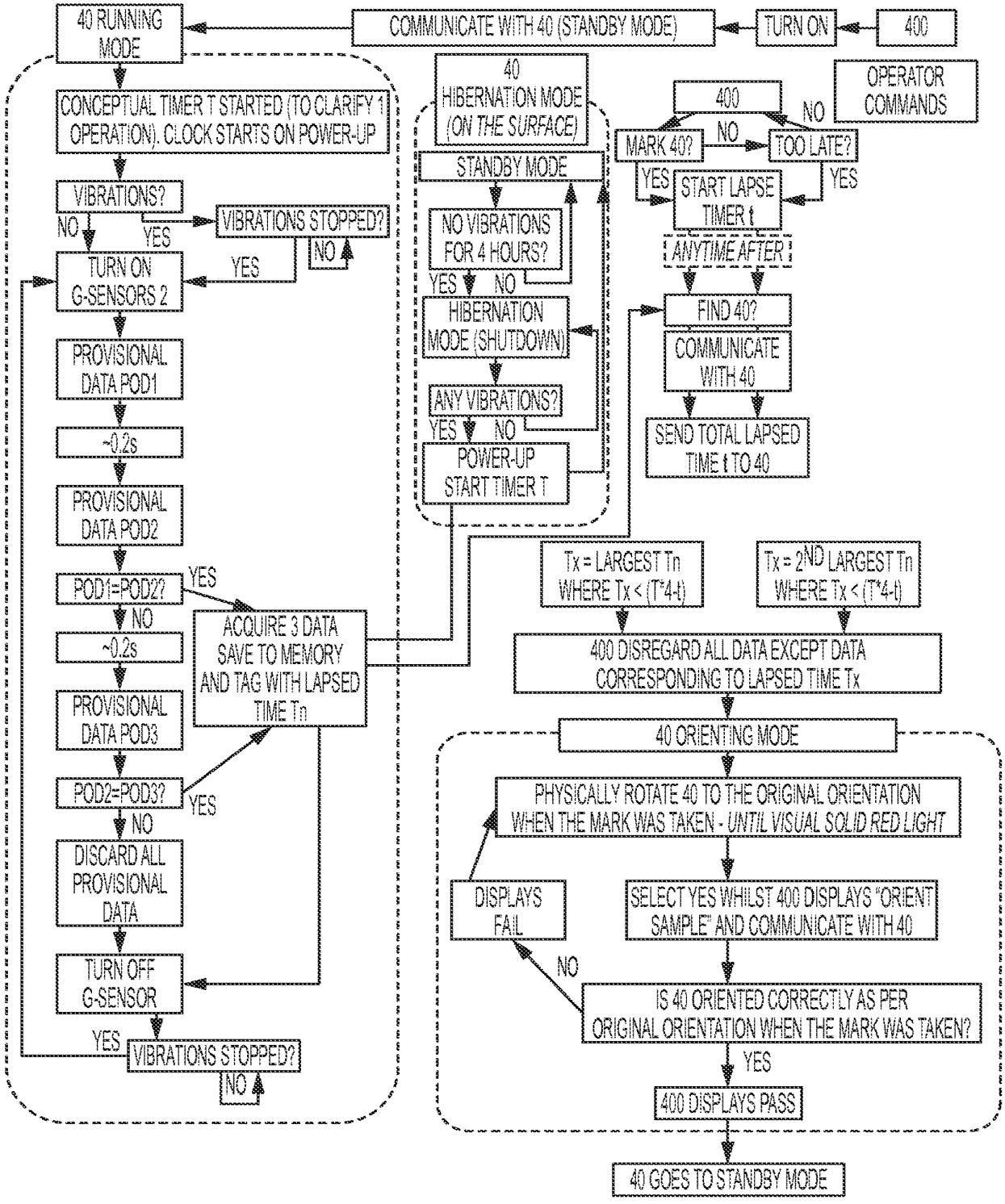

400
TURN ON
COMMUNICATE WITH 40 (STANDBY MODE)
40 RUNNING MODE
CONCEPTUAL TIMER T STARTED (TO CLARIFY 1 OPERATION). CLOCK STARTS ON POWER-UP
VIBRATIONS?
NO
YES
VIBRATIONS STOPPED?
NO
YES
TURN ON G-SENSORS 2
PROVISIONAL DATA POD1
~0.2s
PROVISIONAL DATA POD2
POD1=POD2?
YES
NO
~0.2s
PROVISIONAL DATA POD3
POD2=POD3?
YES
NO
DISCARD ALL PROVISIONAL DATA
TURN OFF G-SENSOR
YES
VIBRATIONS STOPPED?
NO
ACQUIRE 3 DATA SAVE TO MEMORY AND TAG WITH LAPSED TIME Tn
40 HIBERNATION MODE (ON THE SURFACE)
STANDBY MODE
NO VIBRATIONS FOR 4 HOURS?
YES
NO
HIBERNATION MODE (SHUTDOWN)
ANY VIBRATIONS?
YES
NO
POWER-UP START TIMER T
400
OPERATOR COMMANDS
NO
MARK 40?
NO
TOO LATE?
YES
YES
START LAPSE TIMER t
ANYTIME AFTER
FIND 40?
COMMUNICATE WITH 40
SEND TOTAL LAPSED TIME t TO 40
Tx = LARGEST Tn WHERE Tx < (T*4-t)
Tx = 2ND LARGEST Tn WHERE Tx < (T*4-t)
400 DISREGARD ALL DATA EXCEPT DATA CORRESPONDING TO LAPSED TIME Tx
40 ORIENTING MODE
PHYSICALLY ROTATE 40 TO THE ORIGINAL ORIENTATION WHEN THE MARK WAS TAKEN - UNTIL VISUAL SOLID RED LIGHT
DISPLAYS FAIL
SELECT YES WHILST 400 DISPLAYS "ORIENT SAMPLE" AND COMMUNICATE WITH 40
NO
IS 40 ORIENTED CORRECTLY AS PER ORIGINAL ORIENTATION WHEN THE MARK WAS TAKEN?
YES
400 DISPLAYS PASS
40 GOES TO STANDBY MODE

FIG. 12

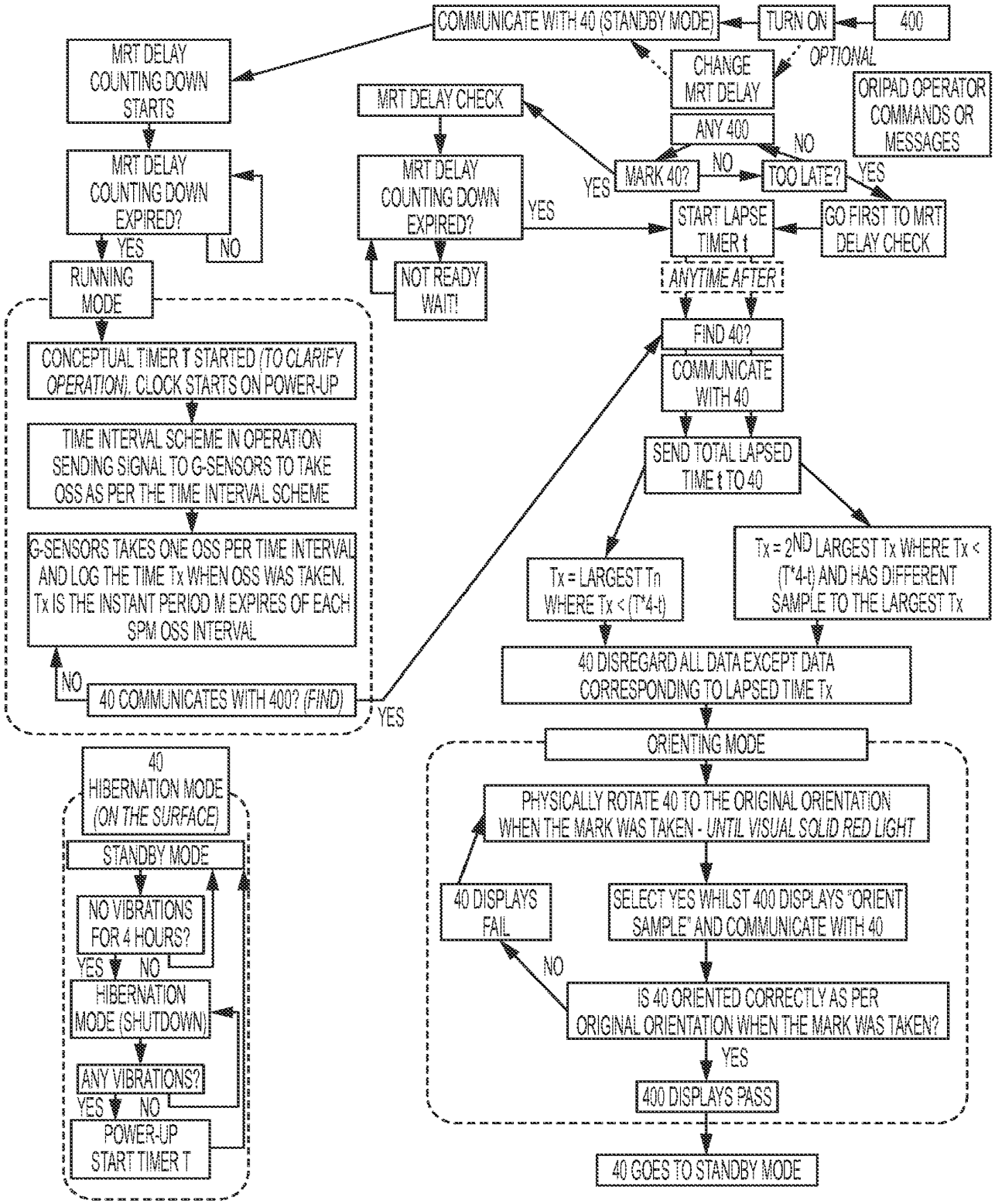

COMMUNICATE WITH 40 (STANDBY MODE)
TURN ON
400
OPTIONAL
CHANGE MRT DELAY
ORIPAD OPERATOR COMMANDS OR MESSAGES
MRT DELAY COUNTING DOWN STARTS
MRT DELAY CHECK
ANY 400
NO
MRT DELAY COUNTING DOWN EXPIRED?
MRT DELAY COUNTING DOWN EXPIRED?
YES
MARK 40?
NO
TOO LATE?
YES
YES
START LAPSE TIMER t
GO FIRST TO MRT DELAY CHECK
NO
YES
RUNNING MODE
NOT READY WAIT!
ANYTIME AFTER t
FIND 40?
COMMUNICATE WITH 40
CONCEPTUAL TIMER T STARTED (TO CLARIFY OPERATION). CLOCK STARTS ON POWER-UP
TIME INTERVAL SCHEME IN OPERATION SENDING SIGNAL TO G-SENSORS TO TAKE OSS AS PER THE TIME INTERVAL SCHEME
SEND TOTAL LAPSED TIME t TO 40
G-SENSORS TAKES ONE OSS PER TIME INTERVAL AND LOG THE TIME Tx WHEN OSS WAS TAKEN. Tx IS THE INSTANT PERIOD M EXPIRES OF EACH SPM OSS INTERVAL
Tx = LARGEST Tn WHERE Tx < (T*4-t)
Tx = 2ND LARGEST Tx WHERE Tx < (T*4-t) AND HAS DIFFERENT SAMPLE TO THE LARGEST Tx
NO
40 COMMUNICATES WITH 400? (FIND)
YES
40 DISREGARD ALL DATA EXCEPT DATA CORRESPONDING TO LAPSED TIME Tx
ORIENTING MODE
40 HIBERNATION MODE (ON THE SURFACE)
PHYSICALLY ROTATE 40 TO THE ORIGINAL ORIENTATION WHEN THE MARK WAS TAKEN - UNTIL VISUAL SOLID RED LIGHT
STANDBY MODE
40 DISPLAYS FAIL
SELECT YES WHILST 400 DISPLAYS "ORIENT SAMPLE" AND COMMUNICATE WITH 40
NO VIBRATIONS FOR 4 HOURS?
YES
NO
NO
HIBERNATION MODE (SHUTDOWN)
IS 40 ORIENTED CORRECTLY AS PER ORIGINAL ORIENTATION WHEN THE MARK WAS TAKEN?
ANY VIBRATIONS?
YES
NO
YES
POWER-UP START TIMER T
400 DISPLAYS PASS
40 GOES TO STANDBY MODE

FIG. 13

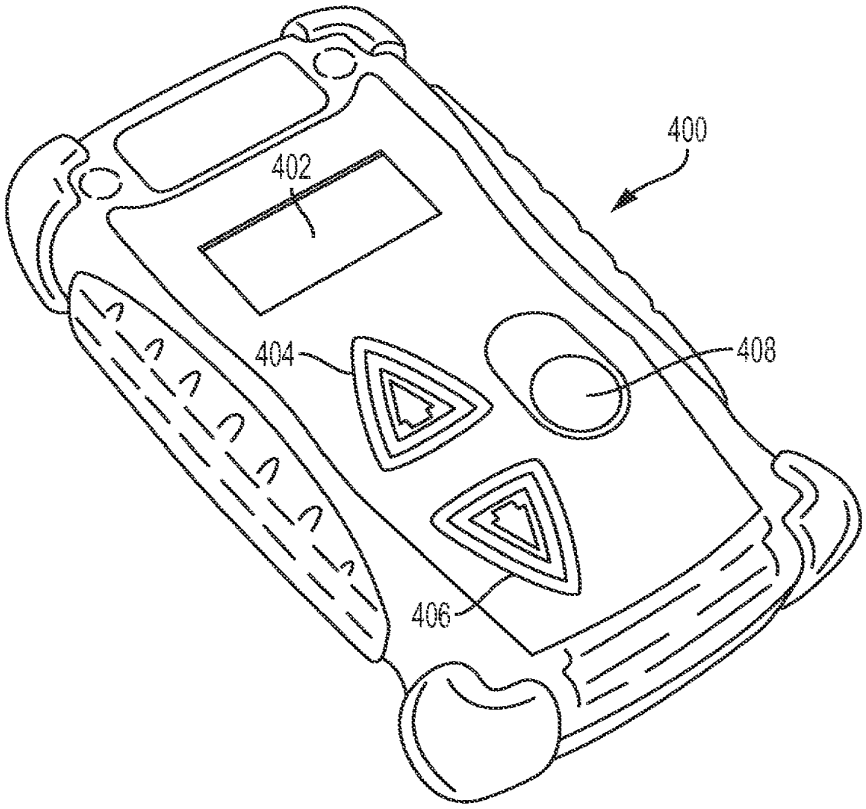


FIG. 14

[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
E21B 25/16 (2006.01)

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[21] 申请号 200910004486.5

[43] 公开日 2010 年 2 月 17 日

[11] 公开号 CN 101649727A

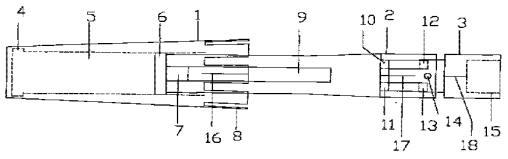
[22] 申请日 2009.3.13
[21] 申请号 200910004486.5
[71] 申请人 中国矿业大学
地址 221116 江苏省徐州市中国矿业大学南湖校区
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权利要求书 1 页 说明书 2 页 附图 2 页

[54] 发明名称

岩心定向器

[57] 摘要

一种岩心定向器。它是将化学膨胀管和推力锥组装为一体，推力锥受化学膨胀管内部空腔凸键和推力锥凹槽的限制无法旋转，推力锥通过异径接头与测斜仪连接，化学膨胀管置于小钻孔中，通过常规钻杆施加压力，压力传递到推力锥，推力锥迫使化学膨胀管发生膨胀破坏并挤压空腔内的速凝胶流出，使化学膨胀管挤压胶结在小钻孔中，测取标记痕的方位即得到岩心方位。



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1．一种岩心定向器，利用测斜仪测量岩心标记的方位，其特征是：化学膨胀管在下端，推力锥连接在化学膨胀管空腔中并可拉伸运动，推力锥通过异径接头与测斜仪连接。

2.根据权力要求 1 所述岩心定向器，其特征是:化学膨胀管与推力锥为一体，空腔内装满速凝胶，推力锥头部装有活塞。

3. 根据权力要求 1 所述岩心定向器，其特征是：空腔内有凸键，推力锥上有凹槽，键与凹槽对应，限制推力锥旋转。

4. 根据权力要求 1 所述岩心定向器，其特征是：化学膨胀管、推力锥和和异径接头上均有标记痕。

5．根据权力要求 1 所述岩心定向器，其特征是：推力锥后部内壁有两个凸键，异径接头上有两个凹槽，凹槽卡在凸键上，限制推力锥与异径接头旋转，销钉通过小圆孔连接推力锥与异径接头。

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岩心定向器

所属技术领域

本发明涉及一种岩心定向器。

背景技术

目前，常规钻探难以对岩心进行原位产状定向，带刻刀的钻进定向设备在定向过程中定向标志在实际操作中可能发生扭转，与岩心真实方位产生偏角，不利于实际应用。

发明内容

为了克服现有钻孔定向设备在钻进过程中定向标志易扭转偏差、定向精度低等不足，本发明提供一种岩心定向器，该岩心定向器在已有小钻孔中安装，在安装过程中岩心定向器不产生扭动，与岩石凝结固定为一体，准确测量岩心方位。

本发明解决其技术问题所采用的技术方案是：化学膨胀管与推力锥组装为一体，推力锥通过销钉、凸键和凹槽连接异径接头，异径接头与测斜仪连接。将化学膨胀管置于小钻孔中，给推力锥施加压力，推力锥通过活塞将空腔中的速凝胶挤出，速凝胶将化学膨胀管与周围岩石凝结为一体，同时推力锥使膨胀管变形固定在小钻孔中，测得测斜仪数据后使异径接头与推力锥分离，再换用大口径常规钻头，将推力锥与岩心钻出。通过推力锥和膨胀管上标记痕确定岩心方位。

本发明的有益效果是，岩心定向器与岩石固定为一体，岩心定向器的方位对应岩心方位，精度高，结构简单，拆卸方便。

附图说明

下面结合附图和实施例对本实用新型进一步说明。

图 1 是本发明的初始结构原理图；

图 2 是本发明的作业完成后结构原理图；

图 3 是本发明图 1 的化学膨胀管主视图；

图 4 是本发明图 1 的化学膨胀管俯视图；

图 5 是本发明图 1 的推力锥主视图；

图 6 是本发明图 1 的推力锥俯视图；

图 7 是本发明图 1 的异径接头主视图；

图 8 是本发明图 1 的异径接头俯视图；

图中 1.化学膨胀管，2.推力锥，3.异径接头，4.凝胶出口，5.空腔，6.活塞，7.凸键，8.膨胀头，9.凹槽，10.凸键，11.凸键，12.凹槽，13.凹槽，14 销钉，15.内螺纹，16.标记痕，17.标记痕，18.标记痕，19.小圆孔，20.小圆孔。

具体实施方式

在图 1、图 2 中，化学膨胀管（1）与推力锥（2）组装为一体，推力锥（2）通过销钉（14）、凸键（10）、凸键（11）和凹槽（12）、凹槽（13）与异径接头（3）连接，异径接头（3）通过内螺纹（15）与上部测斜仪连接，化学膨胀管（1）内部的空腔（5）装满速凝胶，空腔（5）上铸有凸键（7），空腔（5）底部有两个封闭的凝胶出口（4），凝胶出口（4）较薄弱、受压后会导通；推力锥（2）头部有活塞（6），推力锥（2）上的凹槽（9）与凸键（7）对应，后部有小圆孔（19）、内壁铸有凸键（10）、凸键（11）；异径接头（3）头部有小圆孔（20）与小圆孔（19）对应放置销钉（14），凹槽（12）、凹槽（13）分别与凸键（10）、凸键（11）对应，后部内壁有内螺纹（15）；化学膨胀管（1）铸有标记痕（16），推力锥（2）铸有标记痕（17），异径接头（3）铸有标记痕（18）。

在图 1 所示实施例中，图 3、图 4 所示的化学膨胀管（1），图 5、图 6 所示的推力锥（2），图 7、图 8 所示的异径接头（3）组装成本发明的初始结构，将化学膨胀管（1）置于小钻孔中，通过常规钻杆施加压力，压力传递到异径接头（3），销钉（14）被挤压断，在凸键（10）、凸键（11）和凹槽（12）、凹槽（13）的作用下压力传递到推力锥（2），推力锥（2）

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通过活塞（6）挤压空腔（5）内的速凝胶从凝胶出口（4）流出并迫使化学膨胀头（8）发生膨胀破坏，使化学膨胀管（1）挤压胶结在小钻孔中,；如图 2 所示，凹槽（9）卡在凸键（7）上，保证推力锥（2）在空腔（5）内只能垂直运动、无法旋转，销钉（14）被压断后小圆孔（19）和小圆孔（20）错开，凸键（10）卡在凹槽（12）上、凸键（11）卡在凹槽（13）上，保证异径接头（3）与推力锥（2）不发生旋转；测斜仪测取数据后上提钻具，将推力锥（2）与异径接头（3）分离。最后用常规大口径钻头将化学膨胀管（1）和推力锥（2）以及大口径岩心钻取出来，通过化学膨胀管（1）上的标记痕（16）、推力锥（2）上标记痕（17）和异径接头（3）上标记痕（18）确定岩心方位。

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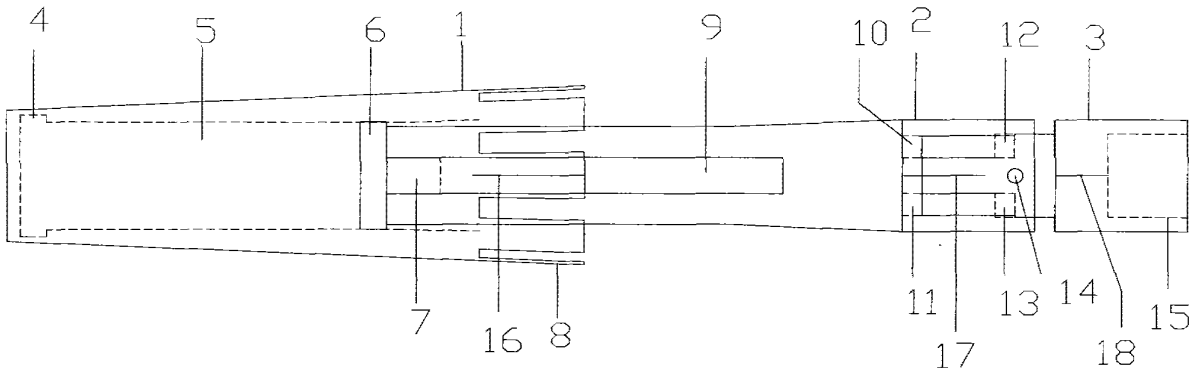


图 1

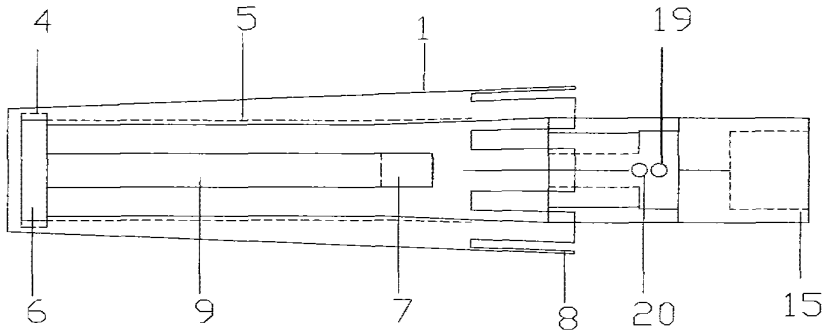


图 2

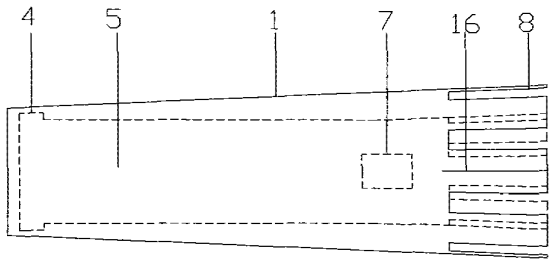


图 3

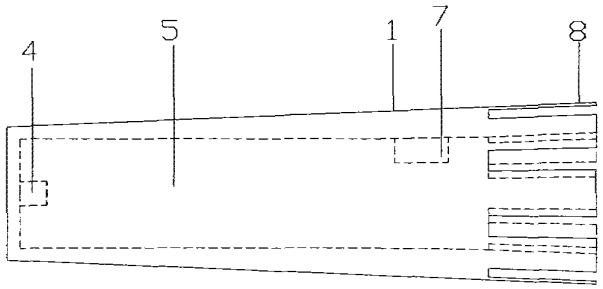


图 4

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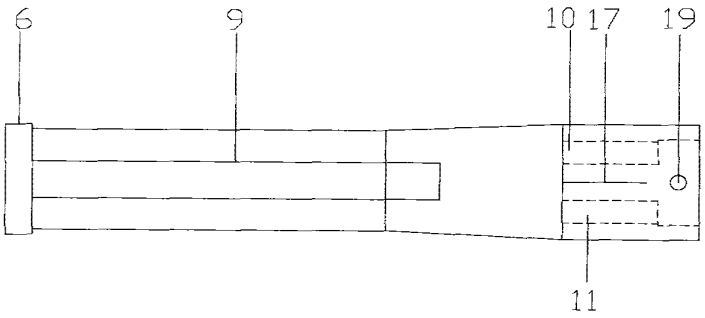


图 5

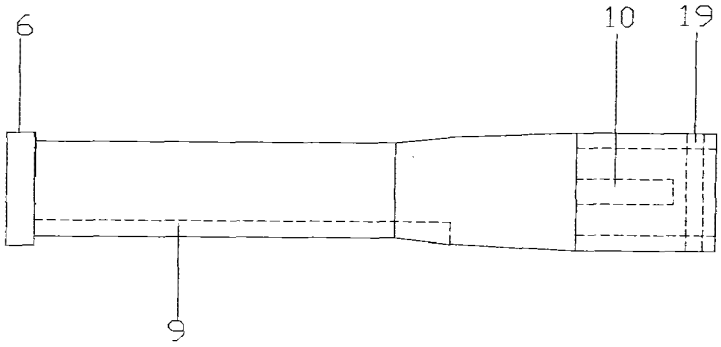


图 6

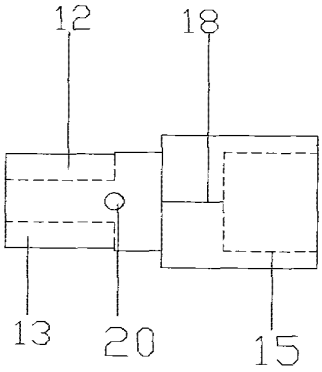


图 7

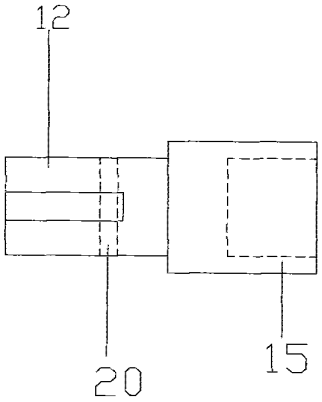


图 8

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Espacenet

Bibliographic data: CN101649727 (A) — 2010-02-17

Core orientator

Inventor(s): QINGHONG DONG; HAI WANG; HONGLIANG WANG; QINGZHONG SUN; HUILEI WU ± (DONG QINGHONG, ; WANG HAI, ; WANG HONGLIANG, ; SUN QINGZHONG, ; WU HUILEI)

Applicant(s): UNIV CHINA MINING ± (CHINA UNIVERSITY OF MINING & TECHNOLOGY)

Classification: **- international:** ***E21B25/16***
- cooperative:

Application number: CN20091004486 20090313

Priority number (s): CN20091004486 20090313

Also published as: CN101649727 (B)

Abstract of CN101649727 (A)

The invention provides a core orientator which assembles a chemical expansion pipe with a thrust cone together; the thrust cone can not rotate due to limitation of sharps of a cavity in the chemical expansion pipe and grooves in the thrust cone; the thrust cone is connected with a clinoretee through a reducing joint; the chemical expansion pipe is mounted in a small drill hole; a general drill stem exerts pressure which is transmitted to the thrust cone, then the thrust cone forces the chemical expansion pipe to generate expanding damage and extrude instant adhesive in the cavity to flow out so as to lead the chemical expansion pipe to be extruded and glued into the small drill hole; the orientation of a mark trace is measured to obtain the core orientation.

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DESCRIPTION CN101649727

A core directional device. It is a combination of a chemical expansion tube and a thrust cone. The thrust cone cannot be rotated due to the constraints of the cavity convex key and the thrust cone groove in the chemical expansion tube. The thrust cone is connected to the inclinometer through a reducer joint. In small holes, pressure is applied through a conventional drill pipe, and the pressure is transmitted to the thrust cone. The thrust cone forces the chemical expansion tube to expand and break and squeezes out the rapid gel in the cavity. The chemical expansion tube is squeezed and cemented in the small drill. In the hole, the orientation of the core is obtained by measuring the orientation of the mark.

Core Orienter

Technical field

The invention relates to a core directional device.

Background technique

At present, it is difficult for conventional drilling to orient the core in situ. During the directional process of the drilling directional equipment with a cutter, the directional mark may be twisted in actual operation, which may deviate from the true azimuth of the core, which is not conducive to practical application.

Summary of the Invention

In order to overcome the shortcomings of the existing drilling directional equipment during the drilling process, such as easy torsional deviation of the directional mark and low directional accuracy, the present invention provides a core directional device. The core directional device is installed in an existing small hole during the installation process The core core directional device does not produce twisting, and is integrated with the rock condensation to accurately measure the core orientation.

The technical solution adopted by the present invention to solve its technical problem is that the chemical expansion tube and the thrust cone are assembled into one body. The thrust cone is connected to the reducer through a pin, a convex key and a groove, and the reducer is connected to the inclinometer. The chemical expansion tube is placed in a small borehole to apply pressure to the thrust cone. The thrust cone squeezes out the quick gel in the cavity through the piston. The quick gel coagulates the chemical expansion tube with the surrounding rocks into one body. The expansion tube is deformed and fixed in a small borehole. After measuring the inclinometer data, the reducer joint is separated from the thrust cone, and then a large-diameter conventional drill is used to drill the thrust cone and the core. The core orientation is determined by the markings on the thrust cone and the expansion tube.

The beneficial effects of the present invention are that the core orienter is fixed with the rock as a whole, the orientation of the core orienter corresponds to the core position, the precision is high, the structure is simple, and the disassembly is convenient.

BRIEF DESCRIPTION OF THE DRAWINGS

The following further describes the utility model with reference to the drawings and embodiments.

FIG. 1 is a schematic diagram of an initial structure of the present invention;

2 is a schematic diagram of the structure after the operation of the present invention is completed;

3 is a front view of the chemical expansion tube of FIG. 1 according to the present invention;

4 is a top view of the chemical expansion tube of FIG. 1 according to the present invention;

Figure 5 is a front view of the thrust cone of Figure 1 of the present invention;

Figure 6 is a top view of the thrust cone of Figure 1 of the present invention;

7 is a front view of the reducer joint of FIG. 1 according to the present invention;

8 is a plan view of the reducer joint of FIG. 1 according to the present invention;

In the picture 1. Chemical expansion tube, 2. Thrust cone, 3. Reducer, 4. Gel exit, 5. Cavity, 6. Piston, 7. Convex key, 8. Inflated head, 9. Groove, 10. Convex key, 11. Convex key, 12. Groove, 13. Groove, 14 pin, 15. Internal thread, 16. Marking marks, 17. Marking marks, 18. Marking marks, 19. Small round holes, 20 small round holes.

detailed description

In Figures 1 and 2, the chemical expansion tube (1) and the thrust cone (2) are assembled into one body, and the thrust cone (2) passes through the pin (14), the convex key (10), the convex key (11) and the groove (12) The groove (13) is connected with the reducer joint (3), the reducer joint (3) is connected with the upper inclinometer through the internal thread (15), and the cavity (5) inside the chemical expansion tube (1) is installed Full speed gel, convex key (7) is cast on cavity (5), there are two closed gel outlets (4) at the bottom of cavity (5), the gel outlet (4) is weak, and it will Conduction; the thrust cone (2) has a piston (6) on the head, a groove (9) on the thrust cone (2) corresponding to the convex key (7), a small circular hole (19) on the rear, and a convex cast on the inner wall Key (10), convex key (11); reducer joint (3), the head has small round holes (20) and small round holes (19) corresponding to the pins (14), grooves (12), grooves (13)) Corresponding to convex keys (10) and convex keys (11), the inner wall of the rear part has internal threads (15); the chemical expansion tube (1) is cast with marking marks (16), and the thrust cone (2) is cast with marking marks (17), the reducing joint (3) is cast with a mark (18).

In the embodiment shown in FIG. 1, the chemical expansion tube (1) shown in FIGS. 3 and 4, the thrust cone (2) shown in FIGS. 5 and 6, and the reducer joint shown in FIGS. 7 and 8 (3) The initial structure of the invention is assembled. The chemical expansion tube (1) is placed in a small hole, and pressure is applied through a conventional drill pipe. The pressure is transmitted to the reducer joint (3), and the pin (14) is squeezed and broken. The pressure of the convex key (10), the convex key (11), the groove (12), and the groove (13) is transmitted to the thrust cone (2), and the thrust cone (2) squeezes the cavity through the piston (6) (5) The rapid gel inside flows from the gel outlet (4) and forces the chemical expansion head (8) to expand and break, so that the chemical expansion tube (1) is squeezed and cemented in a small hole; as shown in Figure 2, The groove (9) is clamped on the convex key (7) to ensure that the thrust cone (2) can only move vertically and cannot rotate in the cavity (5). After the pin (14) is broken, the small circular hole (19) and small The circular hole (20) is staggered, the convex key (10) is stuck on the groove (12), and the convex key (11) is stuck on the groove (13), so that the reducer joint (3) and the thrust cone (2) do not occur Rotate; lift the drill after the data is measured by the inclinometer, and separate the thrust cone (2) from the reducer (3). Finally, take out the chemical expansion tube (1) and thrust cone (2) and the large-diameter core drill with a conventional large-caliber drill bit, and pass the marking marks (16) on the chemical expansion tube (1) and the marking marks on the thrust cone (2). (17) and mark (18) on the reducing joint (3) to determine the core orientation.

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CLAIMS CN101649727

1.

A core directional device uses an inclinometer to measure the azimuth of a core mark, which is characterized in that a chemical expansion tube is at the lower end, and a thrust cone is connected to the cavity of the chemical expansion tube and can be stretched and moved. Inclinometer connection.

2.

The core directional device according to claim 1, characterized in that the chemical expansion tube and the thrust cone are integrated, the cavity is filled with quick gel, and the thrust cone head is provided with a piston.

3.

The core directional device according to claim 1, characterized in that there are convex keys in the cavity and grooves in the thrust cone, and the keys correspond to the grooves, limiting the rotation of the thrust cone.

4.

The core directional device according to claim 1, characterized in that the chemical expansion pipe, the thrust cone and the reducer are marked with marks.

5.

The core directional device according to claim 1, characterized in that there are two convex keys on the inner wall of the rear of the thrust cone, two grooves on the reducer joint, and the grooves are clamped on the convex keys, limiting the thrust cone and reducer joint Rotate, the pin connects the thrust cone and reducer through a small circular hole.

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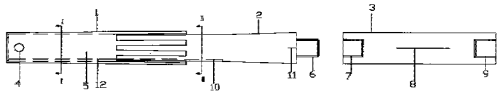
权利要求书 1 页 说明书 2 页 附图 1 页

[54] 实用新型名称

岩心定向装置

[57] 摘要

一种岩心定向装置。它是将化学膨胀管与推力锥连接为一体，推力锥受化学膨胀管内部空腔上键和推力锥上槽的限制无法旋转，推力锥通过反向螺纹与测斜仪连接，测斜仪上部接常规钻杆，化学膨胀管置于小钻孔中，通过常规钻杆施加压力，压力传递到推力锥迫使化学膨胀管发生纵向膨胀破坏并挤压空腔内的速凝胶流出，使化学膨胀管挤压胶结在小钻孔中，测取标记痕的方位即得到岩心方位。



REFLEX EXHIBIT 1002 - 169/304

1．一种岩心定向装置，其特征是：化学膨胀管在下端，推力锥连接在化学膨胀管空腔中并可拉伸运动，推力锥与测斜仪连接。

2.根据权利要求1所述岩心定向装置，其特征是:化学膨胀管与推力锥为一体，空腔内装满速凝胶。

3．根据权利要求1所述岩心定向装置，其特征是：空腔内突出键，推力锥上有凹槽，键与凹槽对应，限制推力锥旋转。

4．根据权利要求1所述岩心定向装置，其特征是：推力锥和和测斜仪外管均有刻痕标志。

5．根据权利要求1所述岩心定向装置，其特征是：化学膨胀管空腔底部的两个孔为圆形孔。

REFLEX EXHIBIT 1002 - 170/304

岩心定向装置

所属技术领域

本实用新型涉及一种岩心定向装置。

背景技术

目前，常规钻探难以对岩心进行原位产状定向，带刻刀的钻进定向设备在定向过程中定向标志在实际操作中可能发生扭转，与岩心真实方位产生偏角，不利于实际应用。

发明内容

为了克服现有钻孔定向设备在钻进过程中定向标志易扭转偏差、定向精度低等不足，本实用新型提供一种在小钻孔中安装定向测量设备，该定向测量设备在已有小钻孔中安装，在安装过程中定向设备不产生扭动，方便快捷。

本实用新型解决其技术问题所采用的技术方案是：化学膨胀管与推力锥固定为一体，推力锥通过反向螺纹连接测斜仪。将化学膨胀管置于小钻孔中，给推力锥施加压力，推力锥将空腔中的速凝胶挤出，速凝胶将化学膨胀管与周围岩石凝结为一体，同时推力锥使膨胀管变形固定在小钻孔中，测得测斜仪数据后然后正向旋转钻具使测斜仪管与推力锥分离，再换用大口径常规钻头，将推力锥与岩心钻出。通过推力锥上标记确定岩心方位。

本实用新型的有益效果是，标记装置与岩石固定为一体，标记装置的方位对应岩心方位，结构简单，拆卸方便。

附图说明

下面结合附图和实施例对本实用新型进一步说明。

图 1 是本实用新型的结构原理图；

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图 2 是本实用新型图 1 的Ⅰ-Ⅰ剖面图；

图 3 是本实用新型图 1 的Ⅱ-Ⅱ剖面图；

图中 1.化学膨胀管，2.推力锥，3.测斜仪，4.圆孔，5.空腔，6.反向外螺纹，7.反向内螺纹，8.标记痕，9.正向内螺纹，10.凹槽，11.标记痕，12.键。

具体实施方式

在图 1 中，化学膨胀管（1）与推力锥（2）为一体，推力锥（2）通过反向外螺纹（6）与测斜仪（3）连接，测斜仪上部接常规钻杆，化学膨胀管（1）内部的空腔（5）装满速凝胶，空腔（5）上凸出键（12），空腔（5）底部有两个封闭的圆孔（4），圆孔（4）较薄弱、受压后会导通，推力锥（2）上有凹槽（10）与键（12）对应，推力锥（2）铸有标记痕（8），测斜仪（3）铸有标记痕（11）。

将化学膨胀管（1）置于小钻孔中，通过常规钻杆施加压力，压力传递到推力锥（2），推力锥（2）迫使化学膨胀管（1）发生纵向膨胀破坏并挤压空腔（5）内的速凝胶从圆孔（4）流出，使化学膨胀管（1）挤压胶结在小钻孔中；如图 2、图 3 所示，凹槽（10）卡在键（12）上，保证推力锥（2）在空腔（5）内只能垂直运动、无法旋转；测取测斜仪（3）数据后旋转钻具，将推力锥（2）与测斜仪分离。最后用常规大口径钻头将化学膨胀管（1）和推力锥（2）以及大口径岩心钻取出来，通过推力锥上标记痕（8）和测斜仪上标记痕（11）确定岩心方位。

REFLEX EXHIBIT 1002 - 172/304

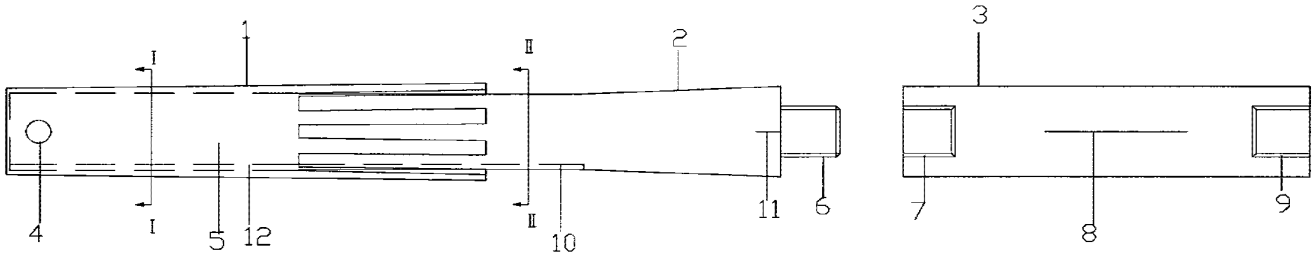


图 1

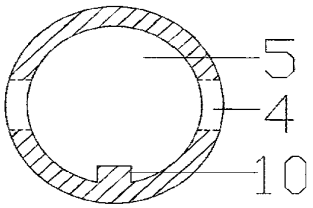


图 2

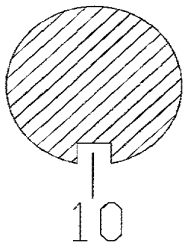


图 3

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Espacenet

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Core orienting device

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Applicant(s): UNIV CHINA MINING ± (CHINA UNIVERSITY OF MINING & TECHNOLOGY)

Classification: **- international:** ***E21B25/16***
- cooperative:

Application number: CN20092009213U 20090314

Priority number (s): CN20092009213U 20090314

Abstract of CN201396092 (Y)

The utility model relates to a core orienting device. A chemical expansion pipe is connected with a thrust cone to form a whole body. The thrust cone cannot rotate under the restriction of the upper key of the internal cavity of the chemical expansion pipe and the upper groove of the thrust cone. The thrust cone is connected with a gradiograph through reverse thread. The upper part of the gradiograph is connected with a conventional drill stem. The chemical expansion pipe is placed in a small borehole and applies pressure through the conventional drill stem. The pressure is transferred to thethrust cone to force the chemical expansion pipe to longitudinally expand and be damaged, to squeeze out the instant adhesive in the cavity and to enable the chemical expansion pipe to be glued in thesmall borehole. Thereby, the orientation of marks is measured and the orientation of the core is obtained.

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DESCRIPTION CN201396092

A core directional device. It connects the chemical expansion tube with the thrust cone as a whole. The thrust cone cannot be rotated by the upper key of the cavity inside the chemical expansion tube and the upper groove of the thrust cone. The thrust cone is connected to the inclinometer through the reverse thread. The upper part of the inclinometer Connected with a conventional drill pipe, the chemical expansion tube is placed in a small borehole. The pressure is transmitted through the conventional drill pipe, and the pressure is transmitted to the thrust cone to force the chemical expansion tube to undergo longitudinal expansion and damage and squeeze the rapid gel in the cavity to flow out, making the chemical expansion The tube was squeezed and cemented in a small borehole, and the orientation of the mark was measured to obtain the core orientation.

Core Orientation Device

Technical field

The utility model relates to a core directional device.

Background technique

At present, it is difficult for conventional drilling to orient the core in situ. In the process of orientation, the directional markers of the drilling directional equipment may be twisted in actual operation, which may deviate from the true orientation of the core, which is not conducive to practical application.

Summary of the Invention

In order to overcome the shortcomings of the conventional drilling directional equipment during the drilling process, such as easy torsional deviation of the directional mark and low directional accuracy, the utility model provides a directional measurement device installed in a small borehole. Installation in the hole, the orientation device does not twist during the installation process, convenient and quick.

The technical solution adopted by the utility model to solve its technical problems is that the chemical expansion tube and the thrust cone are fixed as a whole, and the thrust cone is connected to the inclinometer through a reverse thread. The chemical expansion tube is placed in a small drill hole to apply pressure to the thrust cone. The thrust cone squeezes out the rapid gel in the cavity. The rapid gel condenses the chemical expansion tube with the surrounding rocks, and the thrust cone makes the expansion tube. The deformation is fixed in a small borehole. After measuring the inclinometer data, the drill is rotated in a forward direction to separate the inclinometer tube from the thrust cone, and then a large-diameter conventional drill is used to drill the thrust cone and the core. The core orientation is determined by the mark on the thrust cone.

The beneficial effect of the utility model is that the marking device is fixed integrally with the rock, the position of the marking device corresponds to the core orientation, the structure is simple, and the disassembly is convenient.

BRIEF DESCRIPTION OF THE DRAWINGS

The following further describes the utility model with reference to the drawings and embodiments.

FIG. 1 is a structural schematic diagram of the present invention;

Figure 2 is a sectional view taken along the line I-I of Figure 1 of the present invention;

3 is a sectional view taken along the line II-II of FIG. 1 of the present invention;

In the picture 1. Chemical expansion tube, 2. Thrust cone, 3. Inclinometer, 4. Round hole, 5. Cavity, 6. Reverse male thread, 7. Reverse female thread, 8. Marking marks, 9. Positive female thread, 10. Groove, 11. Marking marks, 12. key.

detailed description

In Figure 1, the chemical expansion tube (1) is integrated with the thrust cone (2). The thrust cone (2) is connected to the inclinometer (3) through a reverse external thread (6). The upper part of the inclinometer is connected to a conventional drill pipe The cavity (5) inside the chemical expansion tube (1) is filled with speed gel, the key (12) is protruding on the cavity (5), and the bottom of the cavity (5) has two closed circular holes (4), The circular hole (4) is weak and will conduct after being pressed. The groove (10) on the thrust cone (2) corresponds to the key (12). The thrust cone (2) is cast with a mark (8). The inclinometer (3) Cast marks (11).

The chemical expansion tube (1) is placed in a small borehole, and pressure is applied through a conventional drill pipe. The pressure is transmitted to the thrust cone (2). The thrust cone (2) forces the chemical expansion tube (1) to undergo longitudinal expansion failure and squeeze the air. The quick gel in the cavity (5) flows out from the circular hole (4), so that the chemical expansion tube (1) is squeezed and cemented in a small hole; as shown in Figs. 2 and 3, the groove (10) is stuck on the key (12), ensure that the thrust cone (2) can only move vertically and cannot rotate in the cavity (5); measure the data of the inclinometer (3) and rotate the drilling tool to connect the thrust cone (2) and the inclinometer Separation. Finally, the chemical expansion tube (1) and thrust cone (2) and the large-diameter core drill were taken out with a conventional large-caliber drill bit, and the core orientation was determined by the mark (8) on the thrust cone and the mark (11) on the inclinometer.

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CLAIMS CN201396092

1.

A core directional device is characterized in that a chemical expansion tube is at the lower end, a thrust cone is connected to the cavity of the chemical expansion tube and can be stretched and moved, and the thrust cone is connected to the inclinometer.

2.

The core orientation device according to claim 1, characterized in that the chemical expansion tube and the thrust cone are integrated, and the cavity is filled with a speed gel.

3.

The core directional device according to claim 1, characterized in that: a key is protruded in the cavity, and a groove is formed in the thrust cone, and the key corresponds to the groove and restricts the rotation of the thrust cone.

4.

The core directional device according to claim 1, wherein the thrust cone and the outer tube of the inclinometer have score marks.

5.

The core orientation device according to claim 1, wherein the two holes at the bottom of the cavity of the chemical expansion tube are circular holes.

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

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(54) **Title**: CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

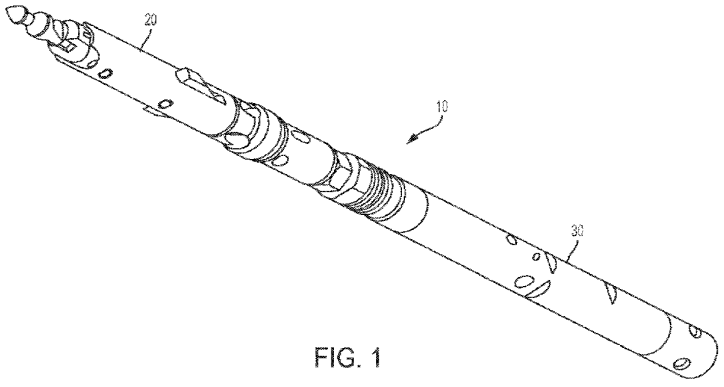


FIG. 1

(57) **Abstract**: A core barrel head assembly having at least one electronic instrument that is configured to obtain orientation data; a power source; and a communication means to receive and/or transmit orientation data for use in a core sample down hole surveying and sample orientation system that is configured to provide an indication of the orientation of a core sample relative to a body of material from which the core has been extracted, and also to a method of core sample orientation identification.

REFLEX EXHIBIT 1002 - 178/304

CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

CROSS REFERENCE TO RELATED PATENT APPLICATION

[0001] This application claims priority to U.S. Provisional Application No. 61/982,052 filed April 21, 2014, which is herein incorporated by reference in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to down hole surveying in drilling operations. More particularly, to a core barrel assembly having at least one electronic instrument that is configured for use in a core sample down hole surveying and sample orientation system. In one example, the at least one electronic instrument is configured to provide an indication of the orientation of a core sample relative to a body of material from which the core has been extracted, and also to a method of core sample orientation identification.

BACKGROUND

[0003] Conventionally, core samples are obtained through the use of core drilling systems that comprise outer and inner tube assemblies. In operation, a cutting head is attached to the outer tube assembly so that rotational torque applied to the outer tube assembly can be transmitted to the cutting head. A core is generated during the drilling operation, with the core progressively extending along the elongate axis of the inner tube assembly as drilling progresses. Typically, when a core sample is acquired, the core within the inner tube assembly is fractured and the inner tube assembly and the fractured core sample contained therein are then retrieved from within the drill hole, typically by way of a retrieval cable lowered down the drill hole. Once the inner tube assembly has been brought to ground surface, the core sample can be removed and subjected to the desired analysis.

[0004] It is desirable for analysis purposes to have an indication of the orientation of the core sample relative to the ground from which it was extracted. This is complicated in that it is common to drill at an angle relative to the vertical. For efficiency and accuracy of the mineralogical record, it is desirable to determine the orientation and survey position of each core's position underground before being drilled out and extracted. Such orientation and survey positions allow for the

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subsequent production of a three dimensional map of underground mineral/rock content.

[0005] One common way of obtaining an indication of the orientation of a core sample is through use of an orientation spear comprising a marker (such as a crayon) projecting from one end of a thin steel shank, the other end of which is attached to a wire line. The orientation spear is lowered down the drill hole, prior to the inner tube assembly being introduced. The marker on the orientation spear strikes the facing surface of material from which the core is to be generated, leaving a mark thereon. Because of gravity, the mark is on the lower side of the drill hole. The inner tube assembly is then introduced into the outer tube assembly in the drill hole. As drilling proceeds, a core sample is generated within the inner tube assembly. The core sample so generated carries the mark which was previously applied. Upon completion of the core drilling run and retrieval of the core sample, the mark provides an indication of the orientation of the core sample at the time it was in the ground.

[0006] Other conventional technologies use core orientation units attached to core inner tubes and back-end assemblies to determine the correct orientation of the drilled out core sample after a preferred predetermined drilling distance intervals during drilling. These core orientation units typically measure rotational direction of the core sample before extraction. On retrieval at the surface of the hole, the rotational direction can be determined by electronic means and the upper or lower side of the core material physically 'marked' for later identification by geologists.

[0007] Coupled with the core orientation system, a survey instrument is conventionally used. In this technique, at periodic depths, the survey instrument is lowered down the drill hole to determine azimuth (angular measurement relative to a reference point or direction), dip (or inclination) and any other required survey parameters. These periodic depth survey readings are used to approximate the drill-path at different depths. Together with the rotational position of the extracted core (from the core orientation device), the three dimensional subsurface material content map can be determined.

[0008] It has been found desirable to provide an improved core barrel assembly having an integrated sample orientation subassembly and method for using same that is configured for use in a core sample down hole surveying and sample

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orientation that minimizes the need to add additional drill string elements, which allows for increased efficiency and speed of drilling.

SUMMARY

[0009] In one aspect, the present invention provides a core barrel head assembly having an elongate tube body that defines a selectively sealed interior cavity. The core barrel head assembly can have at least one electronic instrument positioned in the interior cavity that is configured to obtain core orientation data of a core sample and a power source positioned in the interior cavity and in electrical communication with the at least one electronic instrument. The core barrel head assembly can also have a communication means that is configured to receive and/or transmit orientation data for use in a core sample down hole surveying and/or sample orientation system. The derived core orientation data provides an indication of the orientation of the core sample relative to a body of material from which the core has been extracted, and also to a method of using same.

[0010] The core barrel head assembly is configured for connection to tube portions of a drill string via respective connection means. In another aspect, the at least one electronic instrument of the core barrel head assembly can be mounted, for example and without limitation, within the interior cavity defined the body, within an interior cavity that is defined therein a side wall of the body of the core barrel head assembly, or potted or in sealed contact with a portion of a side wall of the core barrel assembly (on either an exterior surface or an interior surface of a cavity defined therein the body). As one skilled in the art will contemplate, the core barrel head assembly can comprise at least one electronic instrument that is configured to obtain orientation data, an electrically coupled power source and communication means to receive and/or transmit orientation data.

[0011] In another aspect, the communication means can comprise a wireless communication means that is configured to wirelessly receive and/or transmit survey data. Optionally, the communication means can be configured to communicate one way or two ways with each other, when drilling has ceased or during drilling.

[0012] In one aspect, the at least one electronic instrument of the core barrel head assembly advantageously enables obtaining drill hole survey readings without the need to insert unwieldy extension drill rods and/or a survey probe to measure azimuth and inclination/dip of the drill hole path. This results in a reduction of

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equipment handling and usage of equipment, a reduction of operations by not needing to periodically withdraw the drill bit a certain distance in order to advance a survey probe ahead of, and therefore distanced from, the drill bit, with a resultant increase in operational efficiency.

[0013] Another aspect of the present invention provides a method of conducting a down hole survey of drilling, the method including: a) drilling the core from a subsurface body of material; b) recording data relating to orientation of the core to be retrieved, the data recorded using the at least one electronic instrument of the core barrel head assembly, c) separating the core from the subsurface body, and d) obtaining an indication of the orientation of the core based on the recorded core orientation data obtained before the core was separated from the subsurface body.

[0014] Optionally, the method can comprise: determining that drilling has ceased for a period of time, using the at least one electronic instrument of the core barrel head assembly to record data relating to orientation of the core to be retrieved, separating the core from the subsurface body, retrieving the core to the surface, and obtaining an indication of the orientation of the core based on the recorded core orientation data obtained once the drilling had ceased and before the core was separated from the subsurface body.

[0015] Advantages are that there is more time available for drilling due to less time required for surveying and manipulating additional pieces of equipment and mechanical extensions during the survey process.

BRIEF DESCRIPTION OF THE FIGURES

[0016] Figure 1 shows a perspective view of a core barrel head assembly being operatively coupled to a head assembly.

[0017] Figure 2 shows a longitudinal cross-sectional view of Figure 1.

[0018] Figure 3 shows an expanded view of a portion of Figure 2, showing the core barrel head assembly.

[0019] Figure 4 shows a perspective exploded view of the core barrel head assembly of Figure 1.

[0020] Figure 5 shows a longitudinal cross-sectional view of the core barrel head assembly, showing an at least one electronic instrument and an electrically coupled power source disposed therein an interior cavity of a body of the core barrel head assembly.

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[0021] Figure 6 shows a longitudinal cross-sectional view of another aspect of the core barrel head assembly, showing an at least one electronic instrument and an electrically coupled power source disposed therein an interior cavity of a body of the core barrel head assembly.

[0022] Figure 7 shows a longitudinal cross-sectional view of the body of the core barrel head assembly.

[0023] Figure 8 shows a longitudinal cross-sectional view of a core barrel head assembly being operatively coupled to a head assembly.

[0024] Figure 9 shows a schematic view of an exemplary at least one electronic instrument.

[0025] Figure 10 shows a schematic view of an exemplary at least one electronic instrument and an electrically coupled power source for disposition therein an interior cavity of a body of the core barrel head assembly.

[0026] Figure 11 shows an exemplary high level flowchart relating to a method of using the present invention.

[0027] Figure 12 shows an exemplary flowchart relating to an alternative embodiment of a method of using the present invention.

[0028] Figure 13 shows an exemplary flowchart relating to an alternative embodiment of a method of using the present invention.

[0029] Figure 14 shows an exemplary prior art hand held device for wirelessly interrogating the core barrel head assembly of the present invention.

DETAILED DESCRIPTION

[0030] The present invention can be understood more readily by reference to the following detailed description, examples, drawings, and claims, and their previous and following description. However, before the present devices, systems, and/or methods are disclosed and described, it is to be understood that this invention is not limited to the specific devices, systems, and/or methods disclosed unless otherwise specified, as such can, of course, vary. It is also to be understood that the terminology used herein is for the purpose of describing particular aspects only and is not intended to be limiting.

[0031] The following description of the invention is provided as an enabling teaching of the invention in its best, currently known embodiment. To this end, those skilled in the relevant art will recognize and appreciate that many changes can be

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made to the various aspects of the invention described herein, while still obtaining the beneficial results of the present invention. It will also be apparent that some of the desired benefits of the present invention can be obtained by selecting some of the features of the present invention without utilizing other features. Accordingly, those who work in the art will recognize that many modifications and adaptations to the present invention are possible and can even be desirable in certain circumstances and are a part of the present invention. Thus, the following description is provided as illustrative of the principles of the present invention and not in limitation thereof.

[0032] As used throughout, the singular forms "a," "an" and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a port" can include two or more such ports unless the context indicates otherwise.

[0033] Ranges can be expressed herein as from "about" one particular value, and/or to "about" another particular value. When such a range is expressed, another aspect includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent "about," it will be understood that the particular value forms another aspect. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint.

[0034] As used herein, the terms "optional" or "optionally" mean that the subsequently described event or circumstance may or may not occur, and that the description includes instances where said event or circumstance occurs and instances where it does not.

[0035] The word "or" as used herein means any one member of a particular list and also includes any combination of members of that list.

[0036] As will be appreciated by one skilled in the art, the methods and systems may take the form of an entirely hardware embodiment, an entirely software embodiment, or an embodiment combining software and hardware aspects. Furthermore, the methods and systems may take the form of a computer program product on a computer-readable storage medium having computer-readable program instructions (*e.g.*, computer software) embodied in the storage medium. More particularly, the present methods and systems may take the form of web-

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implemented computer software. Any suitable computer-readable storage medium may be utilized including, without limitation, hard disks, CD-ROMs, optical storage devices, magnetic storage devices, or solid-state electronic storage devices.

[0037] Embodiments of the methods and systems are described below with reference to block diagrams and flowchart illustrations of methods, systems, apparatuses and computer program products. It will be understood that each block of the block diagrams and flowchart illustrations, and combinations of blocks in the block diagrams and flowchart illustrations, respectively, can be implemented by computer program instructions. These computer program instructions may be loaded onto a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions which execute on the computer or other programmable data processing apparatus create a means for implementing the functions specified in the flowchart block or blocks.

[0038] These computer program instructions may also be stored in a computer-readable memory that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer-readable memory produce an article of manufacture including computer-readable instructions for implementing the function specified in the flowchart block or blocks. The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer-implemented process such that the instructions that execute on the computer or other programmable apparatus provide steps for implementing the functions specified in the flowchart block or blocks.

[0039] Accordingly, blocks of the block diagrams and flowchart illustrations support combinations of means for performing the specified functions, combinations of steps for performing the specified functions and program instruction means for performing the specified functions. It will also be understood that each block of the block diagrams and flowchart illustrations, and combinations of blocks in the block diagrams and flowchart illustrations, can be implemented by special purpose hardware-based computer systems that perform the specified functions or steps, or combinations of special purpose hardware and computer instructions.

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[0040] In one aspect, a drill assembly for drilling into a subsurface body of material can comprise a drill string 10 comprising a drill bit, an outer tube formed of linearly connected tube sections, and an inner tube for receiving the core drilled from the subsurface body. In one aspect, the core barrel head assembly 30 is integrated into the drill string 10 to form a portion of the drill string, such as shown in Figure 1, where the core barrel head assembly is operably coupled to a conventional head assembly 20.

[0041] The core barrel head assembly is configured for connection to tube portions of a drill string via respective connection means. In another aspect, the at least one electronic instrument of the core barrel head assembly can be mounted, for example and without limitation, within the interior cavity defined the body, within an interior cavity that is defined therein a side wall of the body of the core barrel head assembly, or potted or in sealed contact with a portion of a side wall of the core barrel assembly (on either an exterior surface or an interior surface of a cavity defined therein the body). As one skilled in the art will contemplate, the core barrel head assembly can comprise at least one electronic instrument that is configured to obtain orientation data, an electrically coupled power source and communication means to receive and/or transmit orientation data.

[0042] In one aspect, and referring to Figures 1-7, the core barrel head assembly 30 can comprise at least one electronic instrument 40 that is configured to obtain orientation data, a operatively electrically coupled power source 50 and communication means to receive and/or transmit orientation data. In one aspect, at least one electronic instrument 40 can comprise at least one digital and/or electro-mechanical sensors 42, and/or one or more physical data sensors 44 in a core orientation data recording tool that can be configured to determine the core orientation just prior to or after the core break, and, optionally, to detect the signal of the break of the core from the body of material. In various aspects, it is contemplated that the recorded data can optionally include “dip” angle and/or azimuth datum to increase the reliability of the core orientation results as described below.

[0043] In this aspect, the at least one digital and/or electro-mechanical sensor 42 in operative communication with the at least one electronic instrument 40 of the core barrel assembly can be configured to detect vibration and/or to detect tri-axial

gravitation loading acting on the electronic instrument. In one exemplary aspect, once a desired vibration state is detected and/or a desired G-loading state is detected , drilling can cease and the core barrel head assembly can record data relating to the orientation of the core, such as, for example and without limitation, gravitational field strength and direction, and/or magnetic field strength and direction.

[0044] The core barrel head assembly 30 has a proximal end 32 that is operatively oriented toward the drill bit end of the drill string and an opposed distal end 34. As shown in Figures 1 and 5-6, the core barrel head assembly 30 has an elongate tube body 60 that is conventionally joined to a conventional wire line retrieval portion of a head assembly 10. Thus, the head assembly of the drill string is complete without the necessity for the use of an unwieldy extension tube as required in the prior art designs.

[0045] The threaded proximal end 62 of the elongate tube body 60 is in communication with a first interior cavity 64 that extends distally to a base portion 65. Proximate the base portion of the second interior cavity, a port 66 is defined that extends from the exterior surface of the elongate tube body into fluid communication with the first interior cavity. Optionally, in this aspect, it is contemplated that a grease fitting 68 can be mounted in the port 66 to allow for selective passage of grease or lubricant into communication with the first interior cavity and vice versa.

[0046] A second interior cavity 70 is defined therein the elongate tube body 60 that is spaced from and extends distally from the first interior cavity. The second interior cavity 70 can be sized to hermetically enclose at least one of the least one electronic instrument 40 that is configured to obtain orientation data, the power source 50 and the communication means to receive and/or transmit orientation data. In another aspect, the second interior cavity 70 can be sized to hermetically enclose the least one electronic instrument 40 that is configured to obtain orientation data and the power source 50. In one aspect, the at least one electronic instrument 40 can comprise the electronic instrument discussed above and schematically shown in Figures 8 and 9. The at least one electronic instrument 40 is operatively electrically coupled to the power source 50, which can comprise any conventional power source, such as, for example and without limitation, a battery, a rechargeable battery, and the like.

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[0047] In one aspect, as shown, a plurality of windows 74 can be defined in the elongate tube body that extend from the exterior surface 61 of the elongate tube body into the second interior chamber 70 proximate the closed proximal end 72 of the second interior chamber. In a further aspect, an orientation indicator module 80 can be provided that comprises a plurality of light emitters 82. The orientation indicator module 80 can be sized and shaped to sealingly close the second interior chamber from any intrusion of pressurized fluid into the second interior chamber 70 via the defined plurality of windows 74.

[0048] In another aspect, it is contemplated that the second interior cavity can comprise at least one orienting slot defined therein. In this aspect, the orientation indicator module can be oriented manually and the desired position can be maintained to the at least one O-ring seal 84 described below. Optionally, in a further aspect, the orientation indicator module 82 is configured to orient or otherwise position a plurality of light emitters 88 so that each light emitter underlies one window.

[0049] In one aspect, the orientation indicator module 80 can further comprise a sealing means for preventing any pressurized fluid from entering the second interior cavity 70 from the defined windows 74. In one aspect, the sealing means can comprise at least one O-ring seal 84 that is mounted on an exterior portion of the orientation indicator module and that is configured to seal between the exterior portion of the orientation indicator module and a portion of the interior surface of the second interior cavity.

[0050] In one exemplary aspect, light from the plurality of light emitters 88 (*e.g.* LEDs, and the like) passes through or can be observed through the plurality of windows 74. Reference arrow A refers to the drill bit end direction, and reference arrow B refers to the head assembly direction. Further, as described above, the process of obtaining core orientation is made easier by only requiring two color lights, such as, for example and without limitation, green and red, to indicate one or other direction of rotation to establish correct core orientation prior to marking. The indicators form part of the sealed device and can be low power consumption LED lights.

[0051] Alternatively, flashing lights may be used, such as, for example and without limitation, a certain frequency or number of flashes for one direction and

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another frequency or number of flashes for the other direction of rotation. A steady light could be given when correct orientation is achieved. Thus, advantageously, when the core barrel head assembly 30 and the core sample are recovered from down the hole, the core barrel head assembly 30 need not be separated from the drill string in order to determine a required orientation of the core sample. Wireless communication to a remote device, such as a hand held device, to transfer data between the core barrel head assembly and the remote device, can also be effected by transmitting through the at least one aperture.

[0052] In another aspect, the second interior cavity 70 extends distally to the open distal end 73 of the elongate tube body 60. To further effect a hermetical enclosure of the least one electronic instrument 40 that is configured to obtain orientation data, the power source 50 and, optionally, the communication means to receive and/or transmit orientation data, a seal coupler 90 can be provided that is configured to be sealingly received in the open threaded distal end 73 of the elongate tube body 60. As noted, a sealing means can be provided to prevent any pressurized fluid from entering the second interior cavity. In one aspect, the sealing means can comprise at least one O-ring seal 95 that is mounted on a portion of the seal coupler and that is configured to seal between a portion of the seal coupler and a portion of the interior surface of the open distal end of the elongate tube body.

[0053] In a further aspect, to further effect a hermetical seal of the second interior cavity and to provide fluid control for the wire line operation, a check valve assembly 100 is provided. In one aspect, the check valve assembly 100 comprises a coupled proximal end assembly and a distally tapered seat that defines an interior chamber 110 for operative receipt of a check ball 120.

[0054] In one aspect, the proximal end assembly102 of the check valve assembly can define a female threaded coupling that is configured to be threadably coupled to the male threads defined on the exterior surface of the distal end 73 of the elongate tube body 60. As one skilled in the art will appreciate, as the proximal end assembly of the check valve assembly 100 is threadably coupled to the distal end 73 of the elongate tube body, the seal coupler 90 is driven into a sealed position therein the second interior cavity 70 to affect complete hermeticity.

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[0055] Further, as one skilled in the art will appreciate, because the orientation indicator module 90 is sealingly disposed in the proximal end of the second interior chamber 70, the least one electronic instrument 40, the power source 50 and, optionally, the communication means to receive and/or transmit orientation data is disposed in operative contact with the orientation indicator module, and the seal coupler 90 is disposed in contact with the least one electronic instrument 40, the power source 50 and, optionally, the communication means to receive and/or transmit orientation data, as the proximal end assembly of the check valve assembly is threadably coupled to the distal 73 end of the elongate tube body, both the sealing means on the respective orientation indicator module 80 and the seal coupler 90 are driven into a sealed position therein the second interior cavity to affect complete hermeticity of the second interior cavity.

[0056] In another aspect, the interior chamber 110 of the check valve assembly extends to a distal end 104 of the check valve assembly. In this aspect, at least one port 106 is provided that extends from the exterior surface of the check valve assembly and is in fluid communication with the interior chamber of the check valve assembly. In one aspect, the at least one port 106 can comprise a plurality of ports. In this aspect, it is contemplated that the plurality of ports can be angularly spaced an equal or an unequal number of degrees apart.

[0057] In this aspect, the interior chamber 110 can have a distally tapered seat 112 that is adapted to selectively receive the ball 120 that is sized to selectively block the distally tapered seat. One skilled in the art will appreciate that the interior chamber 110 of the check valve assembly 100 can be sized and shaped to allow the ball to selectively move axially between an open position, in which the ball is spaced proximally away from the surface of the tapered seat so that pressurized fluid can move through the distal end of the check valve assembly and subsequently through the interior chamber to exit out of the at least one port, and a closed position, in which the ball is pressurized against the surface of the tapered seat so that pressurized fluid cannot move through the check valve assembly.

[0058] In a further aspect, the exterior surface 61 of the elongate tube body 60 can define a plurality of female planar stops 67 proximate the mid-body portion. These female planar stops aid in grasping and selectively orienting the orientation of the core barrel head assembly 30. Optionally, additional female planar stops 69 can

be defined proximate the indicator widows defined in the elongate tube body to aid in ease of selectively orienting the sample.

[0059] Referring now to Figure 8, an alternative embodiment of the core barrel head assembly 30 is shown that comprises at least one electronic instrument 40 that is configured to obtain orientation data, a operatively electrically coupled power source 50 and communication means to receive and/or transmit orientation data.

[0060] In this aspect the core barrel head assembly 130 has a proximal end 132 that is operatively oriented toward the drill bit end of the drill string and an opposed distal end 134. As shown in Figure 8, the core barrel head assembly 130 is conventionally joined to a conventional wire line retrieval portion of a head assembly 10. Thus, the head assembly of the drill string is complete without the necessity for the use of an unwieldy extension tube as required in the prior art designs.

[0061] The core barrel head assembly 130 has an elongate tube body 160 that is operably coupled to elongate hollow spindle 170 that is, in turn, operably coupled to a selectively open check valve assembly 180. The elongate tube body has a threaded proximal end 162 that defines an internal bushing mount 163. The open distal end 164 of the elongate tube body defines an internal shoulder 165 that is sized and shaped to receive at least one conventional cylindrical bearing 190.

[0062] A bushing 192 is mounted in the bushing mount and is sized and shaped to rotatably receive the proximal end 172 of the hollow spindle 170. As shown in the figures, a mid-portion of the hollow spindle is rotatably supported by the at least one bearing 190. In a further aspect, a nut 194 is coupled to a treaded portion 174 of the hollow spindle 170 adjacent to the proximal end of the hollow spindle 170.

[0063] The a portion of the interior wall 165 of the elongate tube body 160, a portion of the nut 194 and a portion of the exterior surface of the hollow spindle define a an interior cavity 166 into which a spring is mounted and the at least one electronic instrument 40 that is configured to obtain orientation data, a operatively electrically coupled power source 50 and communication means to receive and/or transmit orientation data are mounted. The least one electronic instrument 40 that is configured to obtain orientation data, a operatively electrically coupled power source 50 and communication means to receive and/or transmit orientation data can be integrated; potted or otherwise affixed to the elongate tube body within the interior

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cavity 166. As one skilled in the art will appreciate, as the hollow spindle turns, the elongate tube body will remain in the same position, *i.e.*, the elongate tube body does not turn when the hollow spindle is turned.

[0064] In an optional aspect, a port 167 is defined that extends from the exterior surface of the elongate tube body into fluid communication with the interior cavity. Optionally, in this aspect, it is contemplated that a grease fitting 168 can be mounted in the port 167 to allow for selective passage of grease or lubricant into communication with the interior cavity.

[0065] It is contemplated that the interior cavity 166 can be sized to hermetically enclose at least one of the least one electronic instrument 40 that is configured to obtain orientation data, the power source 50 and the communication means to receive and/or transmit orientation data. In another aspect, the interior cavity 166 can be sized to hermetically enclose the least one electronic instrument 40 that is configured to obtain orientation data and the power source 50. In one aspect, the at least one electronic instrument 40 can comprise the electronic instrument discussed above and schematically shown in Figures 9 and 10. The at least one electronic instrument 40 is operatively electrically coupled to the power source 50, which can comprise any conventional power source, such as, for example and without limitation, a battery, a rechargeable battery, and the like.

[0066] In a further aspect, to provide fluid control for the wire line operation, a selectively open check valve assembly 180 is provided. In one aspect, the check valve assembly 180 comprises a coupled end assembly 182 defining a proximally tapered seat 184 that defines an interior chamber 185 for operative receipt of a check ball 195.

[0067] In one aspect, the coupled end assembly 182 of the check valve assembly can define a female threaded coupling that is configured to be threadably coupled to the male threads defined on the exterior surface of the distal end 173 of the hollow spindle 170. Thus, as shown in the figures, the tapered seat 184 is operably coupled to the distal end 173 of the spindle 170 such that the hollow interior of the spindle 170 can be selectively placed in fluid communication with fluid governed by the check valve assembly 180.

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[0068] As one skilled in the art will appreciate, the end assembly 182 of the check valve assembly defines at least one port 186 that extends from the exterior surface of the check valve assembly and is in fluid communication with the interior chamber of the check valve assembly. In one aspect, the at least one port 186 can comprise a plurality of ports. In this aspect, it is contemplated that the plurality of ports can be angularly spaced an equal or an unequal number of degrees apart.

[0069] In this aspect, the interior chamber 185 can have a proximally tapered seat 184 that is adapted to selectively receive the ball 195 that is sized to selectively block the proximally tapered seat. One skilled in the art will appreciate that the interior chamber 185 of the check valve assembly 180 can be sized and shaped to allow the ball to selectively move axially between an open position, in which the ball is spaced proximally away from the surface of the tapered seat so that pressurized fluid can move out through the elongate spindle into the proximal end of the check valve assembly and subsequently through the interior chamber of the check valve assembly to exit out of the at least one port, and a closed position, in which the ball is pressurized against the surface of the tapered seat so that pressurized fluid cannot move through the check valve assembly to through the hollow spindle.

[0070] In operation, it is contemplated that, in one non-limiting example, the at least one electronic instrument 40 of the core barrel head assembly 30 does not take any orientation measurements while vibrations, such as from the drilling operation, are present. In this aspect, the combination of mechanical, electromechanical and/or electronic sensors and software algorithms programmed into the at least one electronic instrument of the core barrel head assembly are configured to determine that the core barrel head assembly is in motion while descending down the hole and during drilling and is therefore not yet needed to detect breaking of the core sample from the body of material. Similarly, in a further aspect, it is contemplated that the at least one electronic instrument of the core barrel head assembly can be configured to detect that the core barrel head assembly is ascending to the surface for core retrieval after core breaking and subsequently will not take any core orientation measurements during the ascending operation.

[0071] In one non-limiting example, in operation, when the driller is ready to break the core, the driller can selectively not rotate the drill string for a first predetermined delay time period that can range from between about 10 seconds to

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about 90 seconds. During the delay time period, it is contemplated that an orientation and dip measurement can be taken during this non-rotation, *i.e.*, minimal vibration, period. Subsequently, after breaking the core, the driller can wait a second predetermined delay time period that can range from between about 60 seconds to about 120 seconds, or at least 90 seconds before initiating further rotation.

[0072] Optionally, it is contemplated that pressure created within the borehole by drilling mud and/or water, which may be pumped down the borehole from the surface can be detected by the at least one electronic instrument 42, which can comprise at least one pressure sensor. In various non-limiting examples, the at least one pressure sensor can be mounted on the drill string, such as on the inner and/or outer drill tube or on the drill bit or on the core barrel head assembly. The detected pressure, such as, for example and without limitation, pressure within the inner tube receiving the core, or pressure differential, such as, for example and without limitation, pressure differential between/across the inner and outer tubes, can be indicative of the inner tube being nearly or totally full of core material. This can occur before the core is separated from the subsurface body of material (such as by breaking the core from the body by a sharp pull back on the core) and hence can provide an indicator that the core is about to be broken.

[0073] Optionally, it is contemplated that the least one electronic instrument 40, which is configured to obtain orientation data, the power source 50 and the communication means to receive and/or transmit orientation data can be sized and shaped to be integrally mounted therein conventional wire line assemblies. It this aspect, the least one electronic instrument 40 that is configured to obtain orientation data, the power source 50 and the communication means to receive and/or transmit orientation data can be miniaturized and/or flexible to be received within defined cavities therein the conventional wire line assemblies and can be subsequently hermetically sealed, such as with, for example and without limitation, an epoxy, therein the defined cavities.

[0074] One skilled in the art will appreciate that the core barrel head assembly 30 does not need to be separated from the head assembly 20 in order to determine core sample orientation and/or to gather data recorded by the tool means that there is less risk of equipment failure and drilling downtime, as well as reduced equipment handling time through not having to separate the sections in order to otherwise obtain core sample orientation. Known systems require an end-on interrogation of

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the tool. By providing a sealed apparatus and the facility to determine orientation of the core sample by observing the orientation indications through one or more windows 74 in the side of the elongate tube body 60, reliability and efficiency of core sample collection and orientating is improved. Consequently operational personnel risk injury, as well as additional downtime of the drilling operation. Without having to separate core barrel head assembly 30 from the head assembly, the orientation of the core sample can be determined and the gathered information retrieved with less drilling delay and risk of equipment damage/failure.

[0075] Further, unlike known systems, the core barrel head assembly 30 provides for the desired flow of pressurized fluid in the wire-line assemblies to conventionally operate the fluid control vales that are commonly used in wire-line operations. As noted, the check valve assembly 100 allows for the selectively passage of fluid therethrough that assembly and to the exterior surface of the core barrel head assembly 30 and subsequently through the pressure relief valve to exit out of the first interior cavity of the elongate tube body.

[0076] In one aspect, the one or more pressure sensors 42 can be provided to detect pressure data, which can comprise pressure readings; changes in pressure and/or pressure differentials. The pressure data can be operative communication with the core barrel head assembly 30 and/or an operator at the surface. In one exemplary aspect, once a desired pressure value is detected, drilling can cease and the at least one electronic instrument 40 of the core barrel head assembly 30 can record data relating to the orientation of the core, such as gravitational field strength and direction, and/or magnetic field strength and direction.

[0077] In various aspects, it is contemplated that the recorded data can optionally include "dip" angle or azimuth datum to increase the reliability of the core orientation results. Conventionally, dip is the angle of the inner core tube drill assembly with respect to the horizontal plane and can be the angle above or below the horizontal plane depending on drilling direction from above ground level or from underground drilling in any direction. This provides further confirmation that the progressive drilling of a hole follows a maximum progressive dip angle which may incrementally change as drilling progresses, but not to the extent which exceeds a dogleg severity, *i.e.,* a normalized estimate (*e.g.* degrees / 30 meters) of the overall

curvature of an actual drill-hole path between two consecutive directional survey/orientation stations.

[0078] In operation, prior to obtaining an orientation and core sample, a remote external communication device can be set by an operator to a start time. The remote external communication device communicates with the at least one electronic instrument 40 of the core barrel head assembly 30 before it is tripped into the drill hole. Subsequently, after a predetermined timed interval has elapsed from the start time, the at least one electronic instrument 40 can be configured to begin normal operation to detect the signature of vibration indicating a core break.

[0079] Optionally, in another aspect, pressure changes or levels can be detected to indicate a pre-break condition or period, such as pressure of mud/water within the inner tube increasing due to the core filling or nearly filling the inner tube holding the core.

[0080] In one aspect, the at least one electronic instrument 40 of the core barrel head assembly 30 can be configured to not take any orientation measurements while vibrations, such as from the drilling operation, are present. In this aspect, the combination of mechanical, electromechanical and/or electronic sensors and software algorithms programmed into the at least one electronic instrument 40 of the core barrel head assembly 30 can be configured to determine that the core barrel head assembly is in motion while descending down the hole and during drilling and is therefore not yet needed to detect breaking of the core sample from the body of material. Similarly, in a further aspect, it is contemplated that the at least one electronic instrument 40 of the core barrel head assembly 30 can be configured to detect that the core barrel head assembly is ascending to the surface for core retrieval after core breaking and subsequently will not take any core orientation measurements during the ascending operation.

[0081] Optionally, dip angle can be included in determining orientation of the core. In one aspect, the dip angle of the drill hole can be used to determine whether or not to use the obtained orientation data. For example, a valid core orientation sample can be determined from the previously discussed validation steps being acceptable and, additionally, from the dip angle of the drill hole also being within acceptable limits. In one aspect, the dip can be sampled as a reference prior to the first run of a new drill hole. This particular reference is called a setup function. In this aspect, the setup function can be selected on the remote communications

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device, which then communicates to the core barrel head assembly. For clarity, the core sample orientation subassembly does not orientation the core, rather, it records signals indicative of the orientation of the core to be retrieved. The core barrel head assembly can then be lowered down the hole or aligned to the angle of the drill rods in the case of no hole yet to be drilled. Once the core barrel head assembly is down to a desired position or to the end of the hole the user can "mark" the "shot," preferably via use of the remote communications device.

[0082] Subsequently, the core barrel head assembly is retrieved and the remote communications device can be used to communicate the dip (angle) of the drill hole to the communication means of the core barrel head assembly. Optionally, the dip of the end of the hole can be manually entered into the remote communications device and this communicated back to the core barrel head assembly.

[0083] In one aspect, a compliant datum is obtained when one or more signals indicative of the orientation of the core is/are obtained by the core orientation device during a period of no drilling vibration prior to detecting vibration from breaking the core and that being prior to a subsequent period of no drilling vibration. It is contemplated that one or more embodiments can utilize the final compliant datum instead of the first obtained compliant datum.

[0084] In one aspect, it is contemplated that the at least one electronic instrument 40 can comprise an LCD display 41 at one end. This can allow for setting up of the orientation system prior to deployment and to indicate visually alignment of the core sample when retrieved to the surface. The core barrel head assembly 30 can be connected to the core barrel head assembly which can be operably is connected to a sample tube for receiving a core sample. In one aspect, and as exemplarily shown in Figures 8 and 9, the at least one electronic instrument 40 can comprise at least one vibration sensor, at least one accelerometer 43, a memory 45, a timer 47 and the aforementioned LCD display 41. Optionally, at least one electronic instrument 40 can further comprise one or more of at least one of a gravity sensor, magnetic field sensor, inclinometer, a direction measuring sensor, a gyro, and/or preferably a combination two or more of these devices.

[0085] In this aspect, the at least one electronic instrument 40 can be configured to record orientation data every few seconds during core sampling. The start time can be synchronized with actual time using a common stop watch. The

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operably coupled core barrel head assembly 30 and the core barrel head assembly can then be lowered into the drill string outer casing to commence core sampling. After drilling and capturing a core sample in the inner core sample tube, the operator, can stop the stop watch and retrieve the core sample tube back to the surface. At the surface, before removing the core sample from the inner tube, the operator can views the LCD display, if it is still working, which steps the operator through instructions to rotate the core tube until the core sample lower section is at the core tube lower end . The core sample is then marked and stored for future analysis.

[0086] Another aspect of the present invention provides a method of conducting a down hole survey of drilling, the method including: a) drilling the core from a subsurface body of material; b) recording data relating to orientation of the core to be retrieved, the data recorded using the at least one electronic instrument of the core barrel head assembly, c) separating the core from the subsurface body, and d) obtaining an indication of the orientation of the core based on the recorded core orientation data obtained before the core was separated from the subsurface body.

[0087] Optionally, the method can comprise: determining that drilling has ceased for a period of time, using the at least one electronic instrument of the core barrel head assembly to record data relating to orientation of the core to be retrieved, separating the core from the subsurface body, retrieving the core to the surface, and obtaining an indication of the orientation of the core based on the recorded core orientation data obtained once the drilling had ceased and before the core was separated from the subsurface body.

[0088] In one exemplary aspect, for the embodiment shown in the flowchart in Figure 11, the core orientation can be validated when the following events have occurred:

a) Step 200: detecting no vibration above a threshold by the core barrel head assembly, or is detected to be below a threshold, for the first predetermined delay time period;

b) Step 220: taking a core orientation measurement during the first predetermined delay time period;

c) Step 230: detecting noise from breaking the core from the subsurface body after the first predetermined delay time period and before the second predetermined delay time period;

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d) Step 240: detecting no vibration above a threshold by the core barrel head assembly, or is detected to be below a threshold, for the second predetermined delay time period;

e) Step 250: retaining the orientation measurement obtained in Step 220 only if Steps 200, 230 and 240 are present;

f) Step 260: disregarding detected signals or to not detect vibration or lack of vibration if only if Steps 200, 230 and 240 are obtained. If the detected signals are disregarded, a vibration silence signal in Step 280 must be detected before the core is broken.

[0089] Optionally, as shown in Step 270, a dip measurement can be obtained during the period of no drilling prior to breaking the core (period Y), preferably if dip is within the set limits.

[0090] In one aspect, once the required core orientation is obtained, the core barrel head assembly may be shut down or turned to low power standby mode in Step 290 in preparation to be subsequently placed into an orientation mode. Once the core barrel head assembly 30 is retrieved to the surface in Step 300, an operator can set the core barrel head assembly to the orientation mode in Step 310. In one example, and not meant to be limiting, this can be done via the remote communication means for communicating with the communication means of the core barrel head assembly in Step 320.

[0091] In a further aspect, it is contemplated that the core barrel head assembly can comprise an orientation indicator assembly that comprises one or more lights or other visual indicators, such as, for example and without limitation, one or more display panels to give an indication of orientation direction and required orientation for marking the core. In this aspect, once in orientation mode, visual indications, such as flashing of one or more LEDs, can indicate to the operator which direction to rotate the core to find the" correct down side" for marking. In this aspect, the "correct downside" is the part of the core that was lowermost prior to separating from the subsurface body.

[0092] Once the correct downside is identified in Step 330, the operator can again effect communication to the communication means of the core barrel head assembly via the remote communication device. In Step 340, and based on the orientation data recorded, the remote communication device can be configured to

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verify that the correct orientation was achieved. Subsequently, in Step 350, the operator can perform another orientation operation.

[0093] Optional and exemplary methods of using the present invention are shown in Figures 12 and 13. In one aspect, as shown in Figure 12, the at least one electronic instrument 40 of the core barrel head assembly 30 can be programmed to be used in a running mode, a hibernation mode and an orientating mode. In this aspect, the at least one electronic instrument 40 of the core barrel head assembly 30 is configured to actuate and take sequential provisional data readings (POD1, POD2, POD3, etc.) when the at least one electronic instrument senses that vibrations have stopped. These provisional data readings are taken as desired time intervals that can be between about 0.1 to about 1.0 seconds. In this aspect, the core barrel head assembly 30 is configured to actuate or power up when the at least one electronic instrument is taken out hibernation. Further, it is contemplated that the time clock starts operation whenever the at least one electronic instrument 40. For example, this could happen on the surface prior to insertion into the hole. The programming can also optionally disregard any acquired provisional data (POD1, POD2, POD3, etc.) if vibrations are sensed during any portion of the acquisition of the sequential provisional data readings. In this case, the programming would automatically go to the step "Turn Off G-Sensor" in the running mode.

[0094] In one aspect, as shown in Figure 13, the at least one electronic instrument 40 of the core barrel head assembly 30 can be similarly programmed to be used in a running mode, a hibernation mode and an orientating mode. In this aspect, the at least one electronic instrument 40 of the core barrel head assembly 30 is configured to actuate in accord with a time interval scheme in which a signal is sent to the tri-axial g-sensors to take readings in accord with the predetermined time interval scheme.

[0095] In one aspect, it is contemplated that the core barrel head assembly 30 can be utilized in asynchronous time operation for core sampling. In this aspect, the data recording events taken by the core barrel head assembly 30 are not synchronized in time with the communication device. That is, the core barrel head assembly can be programmed to not commence timing from a reference time, and can optionally be programmed such that the at least one electronic instrument 40 of the core barrel head assembly 30 does not take samples (shots) at specific predetermined time intervals. For example, and not meant to be limiting, the at least

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one electronic instrument 40 of the core barrel head assembly 30 can be programmed to not take a three second sample every one minute with that one minute interval synchronized to the remote, which would therefore know when each sample is about to take place. In this aspect, the communication means or device is not synchronized to the core orientation unit, *i.e.* asynchronous operation, and therefore the communication device does not know if or when a sample is being taken. Thus, obtaining an indication of core sample orientation is simplified over known arrangements.

[0096] In one aspect, while the core barred head assembly is on the surface, the external communication device can signal to the at least one electronic instrument 40 to activate or come out of a standby mode prior to deployment down hole. Optionally, the at least one electronic instrument 40 can already be activated such that it is not necessary to have the at least one electronic instrument 40 switch on from a deactivated ('turned off') state.

[0097] Alternatively, the at least one electronic instrument 40 can be configured to activate and commence taking data samples after a predetermined period from deployment from the surface or after elapse of an activation delay timer or other delay mechanism. For example, the data gathering device may be configured at the surface to only 'wake-up' from a standby mode to an activated mode after at least a predetermined period of time has elapsed or a counter has completed a predetermined count relating to a time period delay.

[0098] In one aspect, it is contemplated that the at least one electronic instrument 40 can be programmed to take measurements/record orientation data based on the time intervals and/or randomly generated time intervals. In this aspect, the programmed instructions to record data generated as a result of the regular or randomly generated time intervals can remain on-going while the at least one electronic instrument 40 activated. However, because at least one of the sensor(s) in the at least one electronic instrument 40 may be shut down/deactivated during sensed vibrations, no orientation data gets acquired during time period in which vibrations are sensed. When the vibrations stop, the sensors are turned on and the time intervals instructions would then resume execution as per the time regular or random intervals. In this aspect, orientation data is being measured/obtained per the time intervals being used, as preferably initiated at the beginning of the run or after a delay timer. But, data will not be recorded during the

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time intervals due to the fact that the sensor(s) will be off/deactivated, *e.g.* during a time period in which vibrations are sensed. In this aspect, when drilling ceases, which results in vibrations ceasing, data will be taken, and may preferably continue to be taken, in accordance with the time intervals scheme initiated at the surface, and preferably may always running in the background even when the sensor(s) is/are off or deactivated (*e.g.*, asleep).

[0099] In a further aspect, the at least one electronic instrument 40 can log and/or record orientation related data down hole at intervals (regular or randomly generated intervals within minimum and maximum interval time limits) and can also measures total lapsed survey time T.

[00100] In a further aspect, the at least one electronic instrument 40 can be started by an external communication device at the surface but a second, different, communication device can be used to 'mark' (to set) the point in time, *i.e.*, to commence the elapsed period of time t relating to breaking the core sample from the underlying rock and thereby be used for identifying the data set recorded immediately before that break.

[00101] In one aspect, to compensate for taking regular or random time period orientation measurements, which uses up battery power as the at least one electronic instrument 40 advances down hole, a start delay can be provided. For example, when the external communication device at the surface is operated, *e.g.*, turned on, an option to set a delay time in the at least one electronic instrument 40 may be displayed. For example, a delay in minutes between 0 to 99 minutes might be displayed. In this aspect, when the at least one electronic instrument 40 is started-up and the communication device communicates the delay period to the at least one electronic instrument 40, the timer in the at least one electronic instrument 40 will allow the delay period to elapse before any orientation measurements are recorded.

[00102] In one aspect, orientation data can be recorded while drilling is ceased and closest to time Tx, where Tx is preferably less than or equal to T-t, and where T is the time recorded by the at least one electronic instrument 40 (survey time) and t is the elapsed time recorded by the external communication device that was commenced once drilling ceased and the orientation data was recorded. In this exemplary aspect, it will be appreciated that the required recorded data may be at a

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time Tx greater than T-t, *i.e.*, if the drilling remained ceased after commencing the elapsed time and separating (breaking) the core sample from the rock was delayed while the at least one electronic instrument 40 recorded orientation data. Thus, Tx can be greater than T-t providing no drilling activity takes place after drilling ceases and before the core is broken from the underlying rock. In this aspect, in operation, when the core barrel head assembly 30 is retrieved back at the surface with the core sample), the external communication device interrogates the at least one electronic instrument 40 to identify the recorded core orientation data closest to T-t, *i.e.*, the timer of the external communication device is not synchronised to the timer of the at least one electronic instrument 40, and both timers are not commenced at a reference time.

[00103] For example and without limitation, orientation data may be recorded by the at least one electronic instrument 40 at regular irregular intervals of time within a known range of allowed time intervals, such as one or more of 10s, 15s, 20s or 30s intervals within a range of 1s to 1 minute. It is contemplated that the time intervals can be generated by a random (time) number generator operating within the minimum and maximum allowed range. Thus, the time intervals for obtaining orientation data may be repeated (e.g. 10s, 10s, 10s, 20s, 20s, 10s…). In this exemplary aspect, data recording events ('shots') are therefore not constantly taken on a set time period. However, it is contemplated that predetermined set time intervals may be used. That is, the at least one electronic instrument 40 may record orientation data every time interval, preferably up until the core is broken form the underlying rock, though recording may also continue afterwards.

[00104] In operation, the at least one electronic instrument 40 can be deployed down hole. Optionally, the at least one electronic instrument 40 can be started at the surface and its timer commence the survey time timing at the surface, or the timer can have a delay to save power until the at least one electronic instrument 40 is all or partway down the borehole. Subsequently, when the core sample has been captured sufficiently in the core tube, drilling ceases and during this period of non-drilling, the at least one electronic instrument 40 records orientation data relating to its own orientation in the borehole, and therefore, of the associated core sample that is captured in the core barrel head assembly 30, which cannot rotate unless the at least one electronic instrument 40 also rotates. Next, the core sample is broken

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away from the underlying rock and the core barrel head assembly 30 is retrieved to the surface.

[00105] In one aspect, an external communication device can record the elapsed time t by a user, *i.e.*, commencing the timer in the handheld external communication device at the surface. This is preferably either when drilling has ceased or immediately before breaking the core from the rock while drilling has ceased, or immediately after the core is broken. However, it will be appreciated that the elapsed time can be commenced after the core is broken away from the underlying rock because the at least one electronic instrument 40 can be programmed to identify the nearest recorded data older than the commencement of the elapsed time that occurred during no drilling. In this aspect, the external communication device retains a record of the elapsing time.

[00106] When the at least one electronic instrument 40 and core barrel head assembly 30 containing the core sample are retrieved to the surface, the user can interrogate the at least one electronic instrument 40. In this aspect, once the at least one electronic instrument 40 confirms receiving the interrogation command, the communication device can command halting of the survey time T (stopping the at least one electronic instrument 40's timer) and elapsed time t (stopping the external communication device's timer). In this aspect, the external communication device can instruct the at least one electronic instrument 40 to identify the recorded orientation data from immediately before or after the commencement of the elapsed period of time going back from the end of the survey time, *i.e.*, the at least one electronic instrument 40 has to 'look back' in time for the data recorded at or around the elapsed ago. In this aspect, the at least one electronic instrument 40 subtracts the elapsed time t from its survey time T to provide a time Tx associated with the required recorded data obtained when drilling was ceased.

[00107] In this aspect, once the correct recorded orientation data is identified in its memory, the at least one electronic instrument can go into orientation mode so that the core sample can be orientated and that orientation recorded. In one exemplary aspect, recording of orientation data by the at least one electronic instrument 40 is triggered on a time interval basis; this may be by the regular or random time intervals mentioned above. Recording the orientation data may only commence once the time delay has ended. For example, the timer within the at

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least one electronic instrument 40 may be running from deployment (or before) of the device into the borehole. However, the delay may prevent the device from recording orientation data until the delay has ended. Once the delay has ended, orientation data is recorded according to the prevailing time interval sequence, *i.e.*, randomly generated time intervals or regular time intervals.

[00108] Optionally, when vibration or other motion of the at least one electronic instrument 40 stops down hole sufficiently, the at least one electronic instrument 40 may resume recording orientation data according to the prevailing time interval regime or may switch to another time interval regime for sensing and recording orientation.

[00109] Optionally, the at least one electronic instrument 40 can be programmed to identify core orientation data recorded before breaking of the core sample but based on an elapsed time period commenced after breaking the core sample. The at least one electronic instrument 40 can be programmed to identify the recorded orientation data that that was recorded before commencement of the elapsed time. In a further aspect, the recorded data can be recorded after breaking of the core sample because of the time interval recording regime. In this aspect, if that data set was recorded while nothing was moving down hole (and has not moved since breaking the core), the data set can be trusted to be sufficiently accurate. It can be compared with one or more previous data sets, and if they concur, then can be deemed sufficiently accurate for orientation purposes. Only one of those data sets is needed and any other of them may be discarded or disregarded.

[00110] In a further aspect, it is contemplated that operation of the at least one electronic instrument 40 to commence recording orientation data can be initiated at the surface and device then deployed into the borehole. Commencement of recording orientation data can also be delayed, so as to save battery power by avoiding taking unnecessary or unusable orientation measurements whilst the device is progressing down the borehole. Orientation measurement immediately before or after breaking the core sample from the underlying rock is/are required. In one exemplary aspect, the at least one electronic instrument 40 can have a delay preventing recording of orientation data until the delay ends.

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[00111] In another aspect, the at least one electronic instrument 40 can take orientation measurements periodically, such as at random or regular periods of time, and record one or more of those measurements. Preferably the at least one electronic instrument 40 can be in a sleep mode, change to a power-up (wake-up) mode and then take a measurement, and re-enter sleep each interval. In one aspect, if two or more consecutive orientation measurements are the same, the at least one electronic instrument 40 can ignore, not record or delete from memory unnecessary repeat measurements and only retain one of the repeat measurements, preferably being the first of the identical measurements. In this aspect, each recorded measurement of orientation can be tagged or 'time stamped', preferably relative to the timer running in the at least one electronic instrument 40, *i.e.*, the recorded orientation data is given a time stamp Tx, where x is the particular time within the survey timeframe running in the device. Thus, Tx is the time since the survey time T commenced that that orientation data set was recorded. It is contemplated that Tx can be a real time or cumulative time since commencement of the survey time T. Thus, in this aspect, the at least one electronic instrument 40 can have a real time clock type timer or a 'start-stop' (counter or stopwatch) type timer. When drilling ceases and the core is to be broken from the underlying rock (because there is sufficient core sample in the core barrel), a 'mark' is taken, which commences an elapsed time t at the surface. In this aspect, it is contemplated that this mark can be taken before or after the break at either regular or irregular time intervals.

[00112] Referring now to Figure 14, an exemplary known hand held device 400 which receives wirelessly receives data or signals from the communication means of the core barrel head assembly. In this aspect, communication means of the core barrel head assembly comprises a transmitter which can use line of sight data transfer through the window, such as by infra-red data transfer, or a wireless radio transmission. The communication device 400 can store the signals or data received from the communication means of the core barrel head assembly. In one aspect, the communication device 400 can comprise a display 402, navigation buttons 404, 406, and a data accept confirmation button 408.

[00113] In one aspect, setting up of the core barrel head assembly 30 can be carried out before insertion into the drill hole. Data retrieval can be carried out by

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infrared communication between the communication means of the core barrel head assembly and a core orientation data receiver or communication device 400. In this aspect, after recovering the core sample inner tube back at the surface, and before removing the core sample from the tube, the operator can optionally remove the head assembly. The operator can use the remote communication device to obtain orientation data from the communication means of the core barrel head assembly using a line of sight wireless infrared communication between the remote device and communication means of the core barrel head assembly. However, it will be appreciated that communication of data between the communication means of the core barrel head assembly and the communication device 400 can be by other wireless means, such as by radio transmission.

[00114] In this prior art aspect, the whole inner tube, core sample, and core barrel head assembly can be rotated as necessary to determine a required orientation of the core sample. The indicators on the proximal end of the core barrel head assembly indicate to the operator which direction, clockwise or anti-clockwise, to rotate the core sample. One color of indicator can be used to indicate clockwise rotation and another color can be used to indicate anticlockwise rotation is required. This is carried out until the core sample is oriented with its lower section at the lower end of the tube. The core sample is then marked for correct orientation and then used for analysis.

[00115] In one aspect, it is contemplated that the visual and/or audible orientation indicators, under certain site and/or environmental conditions, may not be sufficiently visible or audible. Thus, an additional or alternative means and/or method may be utilized to ensure that the core sample has been correctly oriented. In this embodiment, the exterior surface 61 of the body of the core barrel head assembly 30 can have angular degree marks that optionally are scribed/ etched, machined, molded or otherwise provided, such as by printing or painting, on the exterior surface 61. For example, dashes can be equally spaced around the outside parameter represent one or more angular degrees of the full circle or perimeter. Further scribing of a number every five dashes starting with the number 0 then 5, 10, 15 etc. until 355.

[00116] When the core is retrieved and the communication means of the core barrel head assembly communicates with the hand held communicator 400, additional information can be transmitted from the core barrel head assembly to the

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communicator 400, such as a number between zero 0 and 359 (inclusive) denoting an angular degree of rotation of core barrel head assembly and the core sample. When the core is oriented during one or more embodiments of the method of the present invention, the numerical scribing the core barrel head assembly should be the same as the number transmitted, to the communicator 400, which re-confirms correct orientation. Thus, if the visual or audible means for indicating core orientation are not useful or available, then the core can be oriented using the angular degree arrangement to match the transmitted number, and then can be audited using the communicator 400.

[00117] Embodiments of the present invention provide the advantage of a fully operating down hole core barrel head assembly without having to disconnect or disassemble any part of the tool/device from the inner tube and/or from the head assembly or any other part of the drilling assembly that the core barrel head assembly would need to be assembled within for its normal operation. Disconnecting or disassembling the core barrel head assembly from the head assembly and/or inner tube risks failure of seals at those connections and/or risks cross threading of the joining thread. Also, because those sections are threaded together with high force, it takes substantial manual force and large equipment to separate the sections. High surrounding pressure in the drill hole means that the connecting seals between sections function to prevent water and dirt from ingressing into and damaging the device.

[00118] Although several embodiments of the invention have been disclosed in the foregoing specification, it is understood by those skilled in the art that many modifications and other embodiments of the invention will come to mind to which the invention pertains, having the benefit of the teaching presented in the foregoing description and associated drawings. It is thus understood that the invention is not limited to the specific embodiments disclosed hereinabove, and that many modifications and other embodiments are intended to be included within the scope of the appended claims. Moreover, although specific terms are employed herein, as well as in the claims which follow, they are used only in a generic and descriptive sense, and not for the purposes of limiting the described invention, nor the claims which follow.

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What is claimed is:

1. A core barrel head assembly, comprising:

an elongate tube body defining a selectively sealed interior cavity;

at least one electronic instrument that is configured to obtain orientation data mounted therein the sealed interior cavity, wherein the at least one electronic instrument comprises at least one digital and/or electro-mechanical sensors in a core orientation data recording tool that can be configured to determine a core orientation of a sample core just prior to or after the core break;

a power source in operable communication with the at least one electronic instrument, wherein the power source is mounted therein the interior cavity; and

communication means to receive and/or transmit core orientation data.

2. The core barrel head assembly of Claim 1, wherein the elongate tube body has a threaded proximal end for coupling to a wire line retrieval portion of a head assembly.

3. The core barrel head assembly of Claim 1, wherein the elongate tube body has a first interior cavity that extends distally to a base portion of the tube body.

4. The core barrel head assembly of Claim 3, wherein the selectively sealed interior cavity is spaced from and extends distally from the first interior cavity.

5. The core barrel head assembly of Claim 4, wherein a port is defined proximate the base portion of the sealed interior cavity that extends from the exterior surface of the elongate tube body into fluid communication with the first interior cavity.

6. The core barrel head assembly of Claim 5, wherein a pressure fitting is mounted in the port to allow for selective passage of fluid to and from the exterior surface of the barrel head assembly into communication with the first interior cavity

7. The core barrel head assembly of Claim 1, wherein the sealed interior cavity is sized and shaped to hermetically enclose at least one of the least one electronic instrument, the power source , and the communication means to receive and/or transmit orientation data.

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8. The core barrel head assembly of Claim 1, wherein the sealed interior cavity is sized and shaped to hermetically enclose the least one electronic instrument and the power source

9. The core barrel head assembly of Claim 1, further comprising a plurality of windows defined in the elongate tube body that extend from the exterior surface of the elongate tube body into optical communication with the sealed interior cavity proximate a closed proximal end of the sealed interior cavity

10. The core barrel head assembly of Claim 9, further comprising an orientation indicator module comprising a plurality of light emitters.

11. The core barrel head assembly of Claim 10, wherein the orientation indicator module is sized and shaped to sealingly close the sealed interior cavity from any intrusion of pressurized fluid into the sealed interior cavity via the plurality of windows.

12. The core barrel head assembly of Claim 10, wherein the orientation indicator module is configured to orient or otherwise position the plurality of light emitters so that each light emitter underlies one window.

13. The core barrel head assembly of Claim 10, wherein the orientation indicator module further comprises a first sealing means for preventing any pressurized fluid from entering the sealed interior cavity from the plurality of windows defined in the elongate tube body.

14. The core barrel head assembly of Claim 13, wherein the first sealing means comprises at least one O-ring seal that is mounted on an exterior portion of the orientation indicator module and that is configured to seal between an exterior portion of the orientation indicator module and a portion of an interior surface of the sealed interior cavity.

15. The core barrel head assembly of Claim 14, wherein the sealed interior cavity can comprised at least one orienting slot defined therein.

16. The core barrel head assembly of Claim 14, wherein a desired position of the orientation indicator module is maintained relative to at least one O-ring seal.

17. The core barrel head assembly of Claim 1, wherein the sealed interior cavity extends distally to an open threaded distal end of the elongate tube body.

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18. The core barrel head assembly of Claim 18, further comprising a seal coupler that is configured to be sealingly received in the open threaded distal end of the elongate tube body.

19. The core barrel head assembly of Claim 18, further comprises a second sealing means for preventing any pressurized fluid from entering the sealed interior cavity.

20. The core barrel head assembly of Claim 19, wherein the second sealing means comprises at least one O-ring seal that is mounted on a portion of the seal coupler and that is configured to seal between a portion of the seal coupler and a portion of an interior surface of the open distal end of the elongate tube body.

21. The core barrel head assembly of Claim 18, further comprising a check valve assembly configured to affect a hermetical seal of the sealed interior cavity and to provide fluid control for wire line operation.

22. The core barrel head assembly of Claim 21, wherein the check valve assembly comprises a coupled proximal end assembly and a distally tapered seat that defines an interior chamber for operative receipt of a check ball.

23. The core barrel head assembly of Claim 22, wherein the proximal end assembly defines a female threaded coupling that is configured to be threadably coupled to male threads defined on an exterior surface of a distal end of the elongate tube body.

24. The core barrel head assembly of Claim 23, wherein, when the proximal end assembly is threadably coupled to the distal end of the elongate tube body, the seal coupler is driven into a sealed position therein the sealed interior cavity to affect complete hermeticity.

25. The core barrel head assembly of Claim 22, wherein the interior chamber of the check valve assembly extends to a distal end of the check valve assembly, and wherein the check valve assembly further defines at least one port that extends from an exterior surface of the check valve assembly and is in fluid communication with the interior chamber of the check valve assembly.

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26. The core barrel head assembly of Claim 25, wherein the interior chamber has a distally tapered seat that is adapted to selectively receive the check ball that is sized to selectively block the distally tapered seat.

27. The core barrel head assembly of Claim 26, wherein the interior chamber is sized and shaped to allow the check ball to selectively move axially between an open position, in which the check ball is spaced proximally away from the surface of the tapered seat so that pressurized fluid can move through the distal end of the check valve assembly and subsequently through the interior chamber to exit out of the at least one port, and a closed position, in which the check ball is pressurized against the surface of the tapered seat so that pressurized fluid cannot move through the check valve assembly.

28. The core barrel head assembly of Claim 1, wherein an exterior surface of the elongate tube body defines a plurality of female planar stops proximate the mid-body portion.

29. The core barrel head assembly of Claim 1, wherein the at least one electronic instrument is programmed to obtain orientation data when the at least one electronic instrument senses no relative movement of the at least one electronic instrument.

30. The core barrel head assembly of Claim 29, wherein the at least one electronic instrument is programmed to obtain orientation data when the at least one electronic instrument senses no vibrations.

31. The core barrel head assembly of Claim 30, wherein the at least one electronic instrument does not take any orientation measurements if vibrations are sensed by the at least one electronic instrument.

32. The core barrel head assembly of Claim 29, wherein the at least one electronic instrument is programmed to not obtain orientation data when the at least one electronic instrument determines that the core barrel head assembly is in motion while descending down or ascending up the hole and during drilling.

33. The core barrel head assembly of Claim 1, wherein the at least one electronic instrument is programmed to obtain orientation data based on a predetermined time interval scheme.

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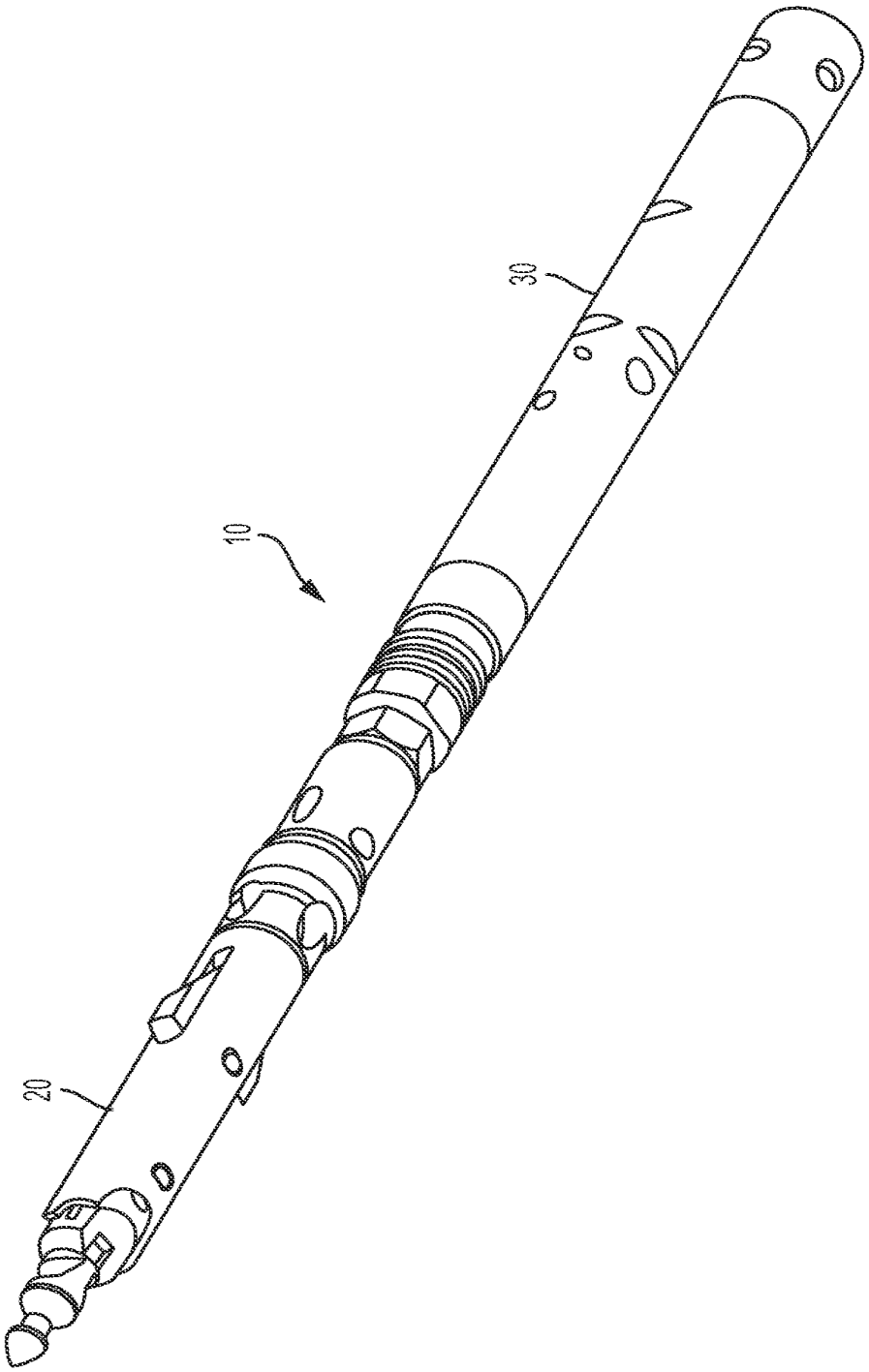


FIG. 1

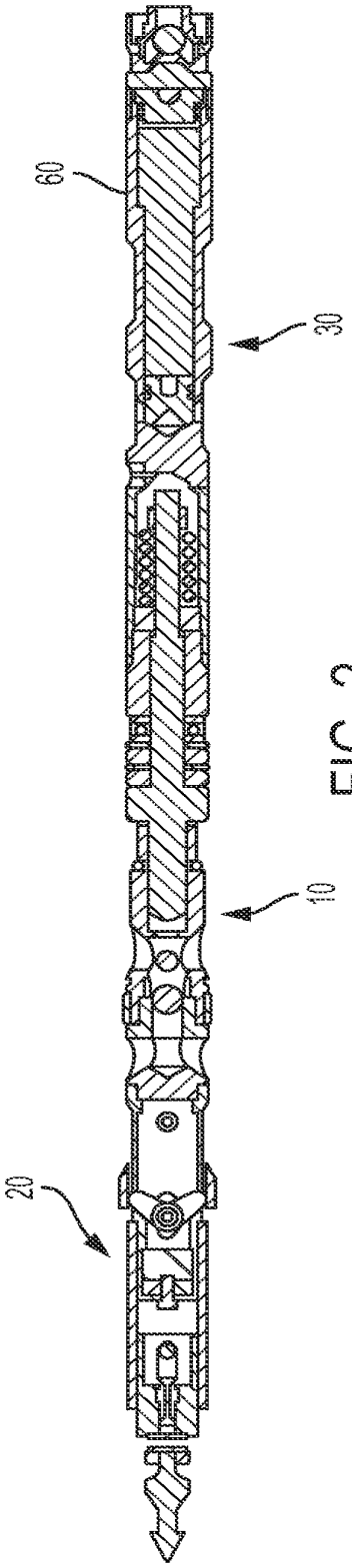

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FIG. 2

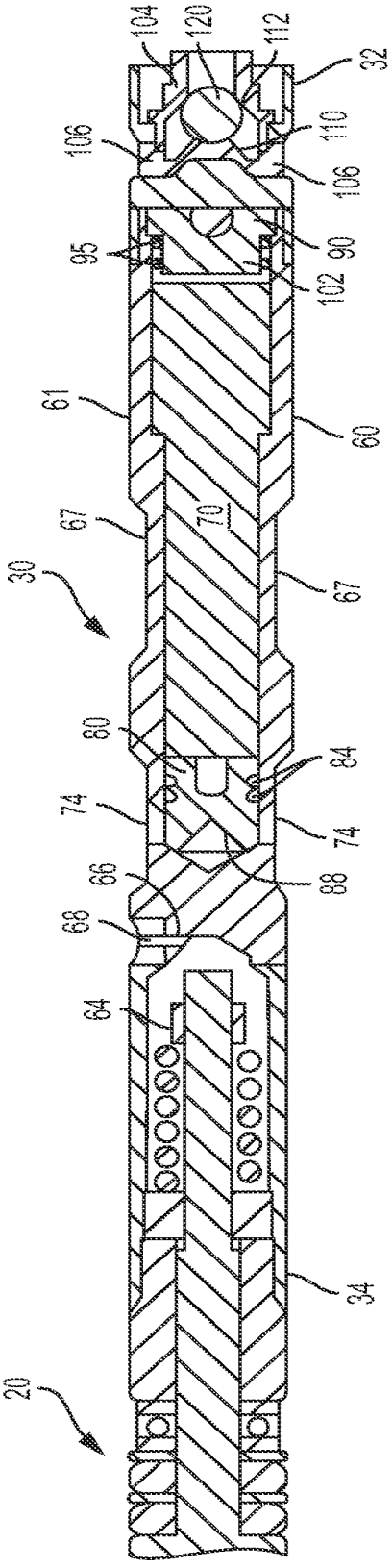

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FIG. 3

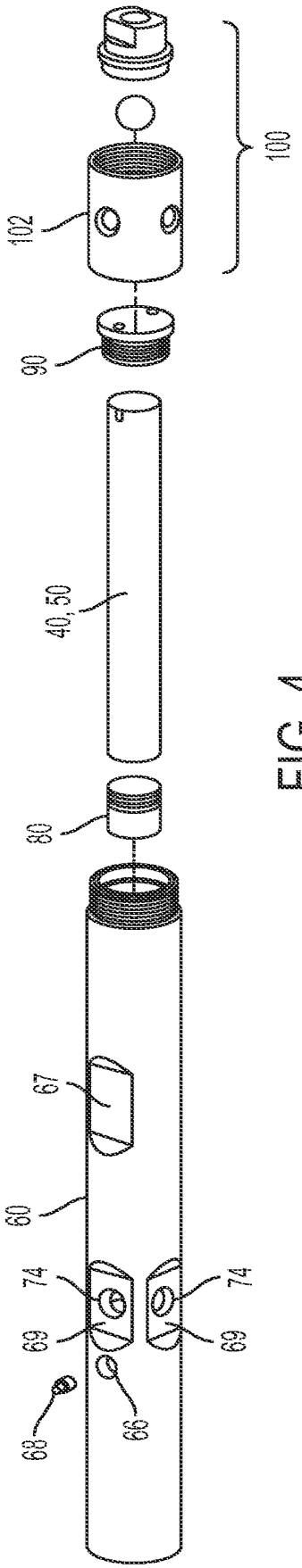

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FIG. 4

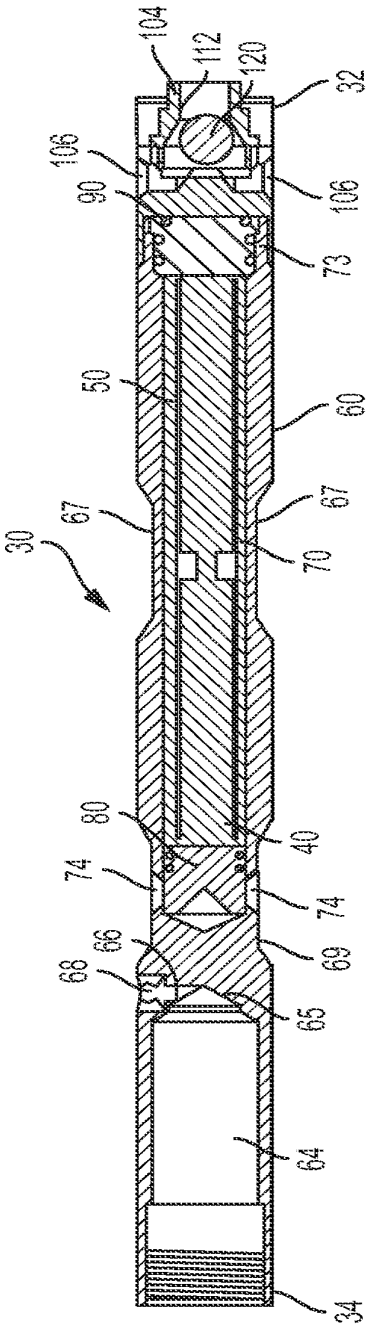

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FIG. 5

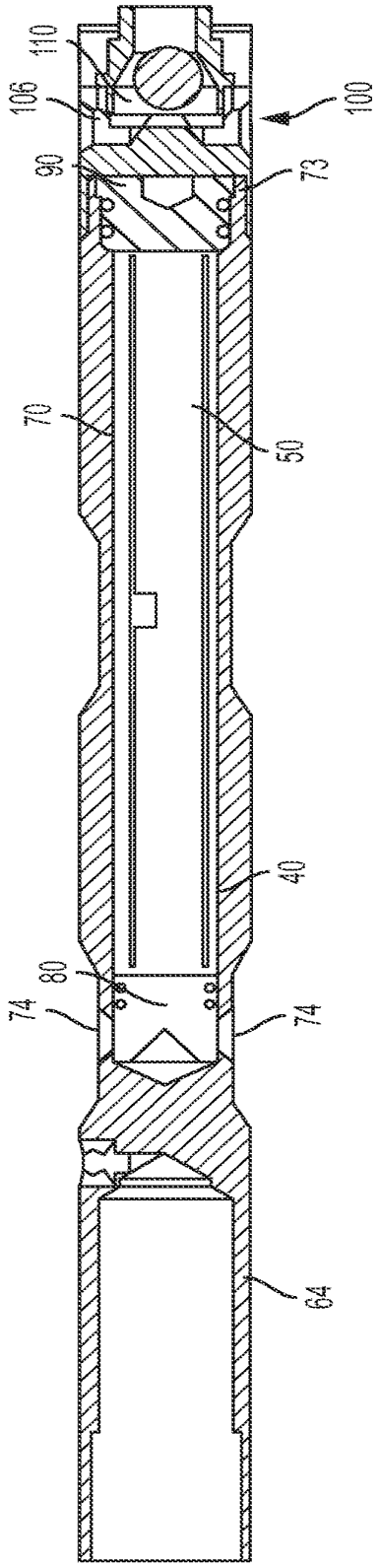


FIG. 6

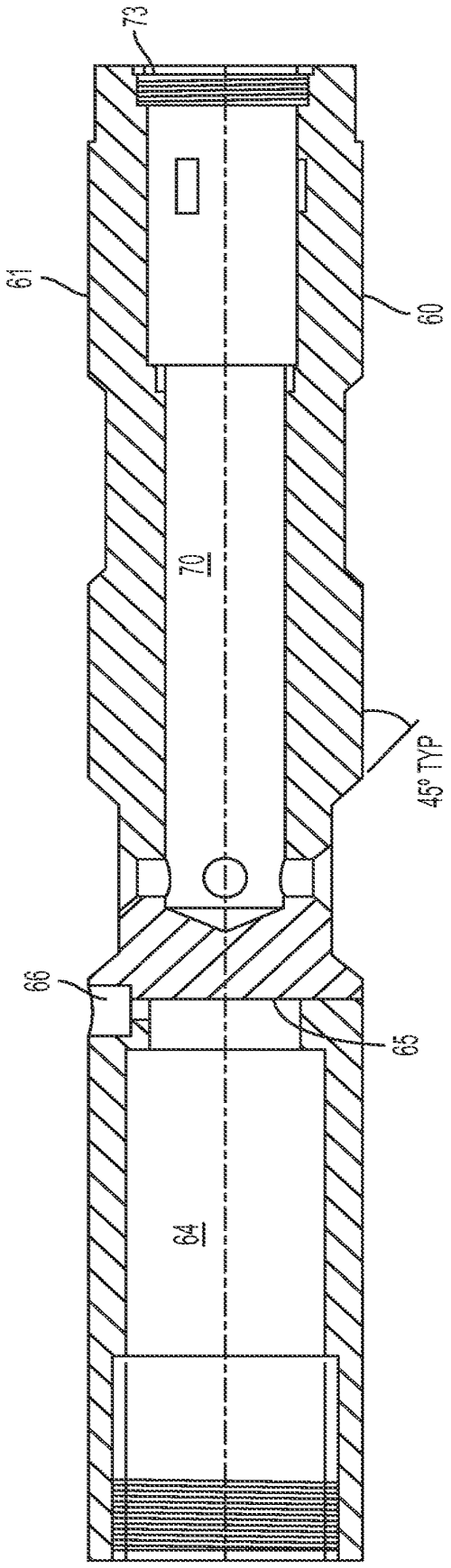


FIG. 7

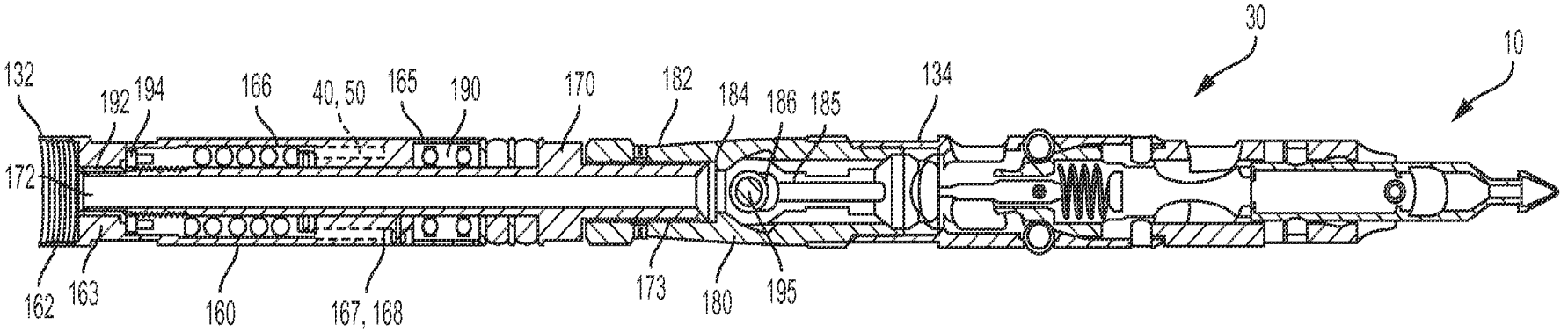

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FIG. 8

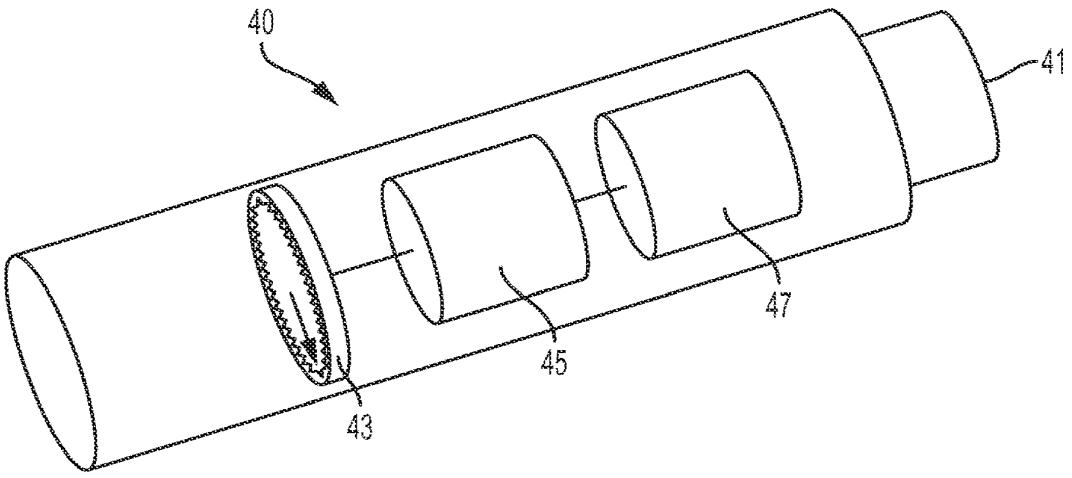


FIG. 9

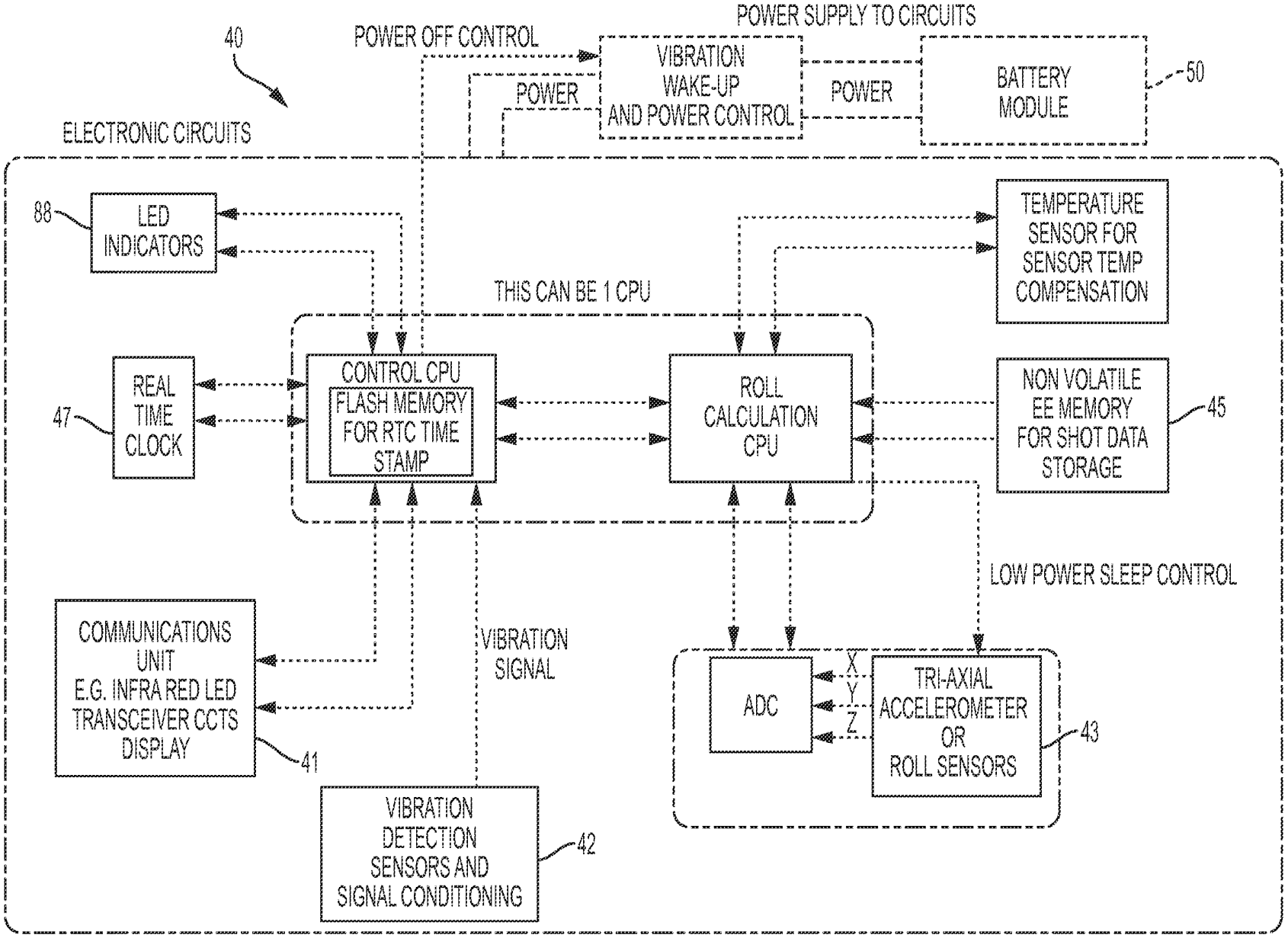

40
POWER OFF CONTROL
POWER SUPPLY TO CIRCUITS
VIBRATION WAKE-UP AND POWER CONTROL
POWER
POWER
BATTERY MODULE
50
ELECTRONIC CIRCUITS
88
LED INDICATORS
TEMPERATURE SENSOR FOR SENSOR TEMP COMPENSATION
THIS CAN BE 1 CPU
47
REAL TIME CLOCK
CONTROL CPU
FLASH MEMORY FOR RTC TIME STAMP
ROLL CALCULATION CPU
NON VOLATILE EE MEMORY FOR SHOT DATA STORAGE
45
LOW POWER SLEEP CONTROL
COMMUNICATIONS UNIT E.G. INFRA RED LED TRANSCEIVER CCTS DISPLAY
41
VIBRATION SIGNAL
ADC
X
Y
Z
TRI-AXIAL ACCELEROMETER OR ROLL SENSORS
43
VIBRATION DETECTION SENSORS AND SIGNAL CONDITIONING
42

FIG. 10

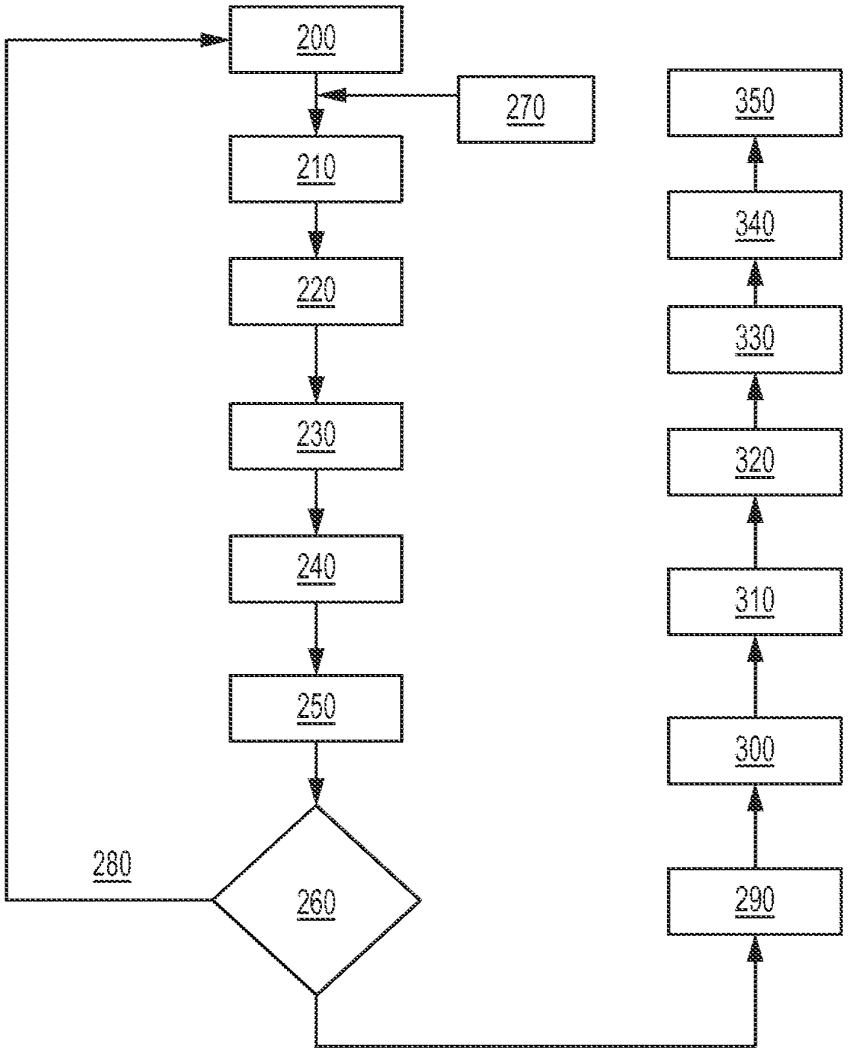


FIG. 11

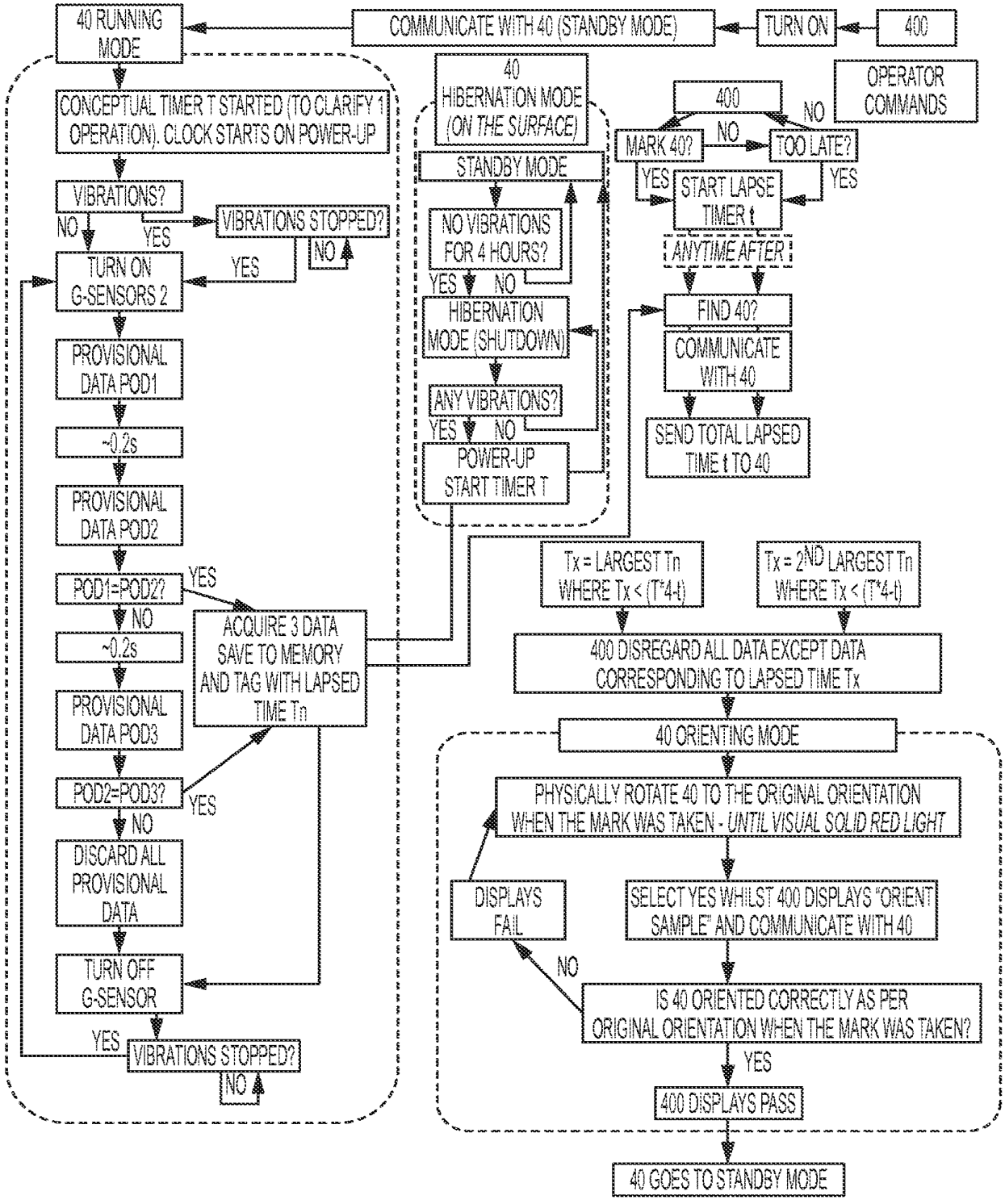

40 RUNNING MODE
COMMUNICATE WITH 40 (STANDBY MODE)
TURN ON
400
CONCEPTUAL TIMER T STARTED (TO CLARIFY 1 OPERATION). CLOCK STARTS ON POWER-UP
VIBRATIONS?
NO
YES
VIBRATIONS STOPPED?
NO
YES
TURN ON G-SENSORS 2
PROVISIONAL DATA POD1
~0.2s
PROVISIONAL DATA POD2
POD1=POD2?
YES
NO
~0.2s
ACQUIRE 3 DATA SAVE TO MEMORY AND TAG WITH LAPSED TIME Tn
PROVISIONAL DATA POD3
POD2=POD3?
YES
NO
DISCARD ALL PROVISIONAL DATA
TURN OFF G-SENSOR
YES
VIBRATIONS STOPPED?
NO
40 HIBERNATION MODE (ON THE SURFACE)
STANDBY MODE
NO VIBRATIONS FOR 4 HOURS?
YES
NO
HIBERNATION MODE (SHUTDOWN)
ANY VIBRATIONS?
YES
NO
POWER-UP START TIMER T
400
NO
OPERATOR COMMANDS
MARK 40?
NO
TOO LATE?
YES
YES
START LAPSE TIMER t
ANYTIME AFTER
FIND 40?
COMMUNICATE WITH 40
SEND TOTAL LAPSED TIME t TO 40
Tx = LARGEST Tn WHERE Tx < (T*4-t)
Tx = 2ND LARGEST Tn WHERE Tx < (T*4-t)
400 DISREGARD ALL DATA EXCEPT DATA CORRESPONDING TO LAPSED TIME Tx
40 ORIENTING MODE
PHYSICALLY ROTATE 40 TO THE ORIGINAL ORIENTATION WHEN THE MARK WAS TAKEN - UNTIL VISUAL SOLID RED LIGHT
DISPLAYS FAIL
SELECT YES WHILST 400 DISPLAYS "ORIENT SAMPLE" AND COMMUNICATE WITH 40
NO
IS 40 ORIENTED CORRECTLY AS PER ORIGINAL ORIENTATION WHEN THE MARK WAS TAKEN?
YES
400 DISPLAYS PASS
40 GOES TO STANDBY MODE

FIG. 12

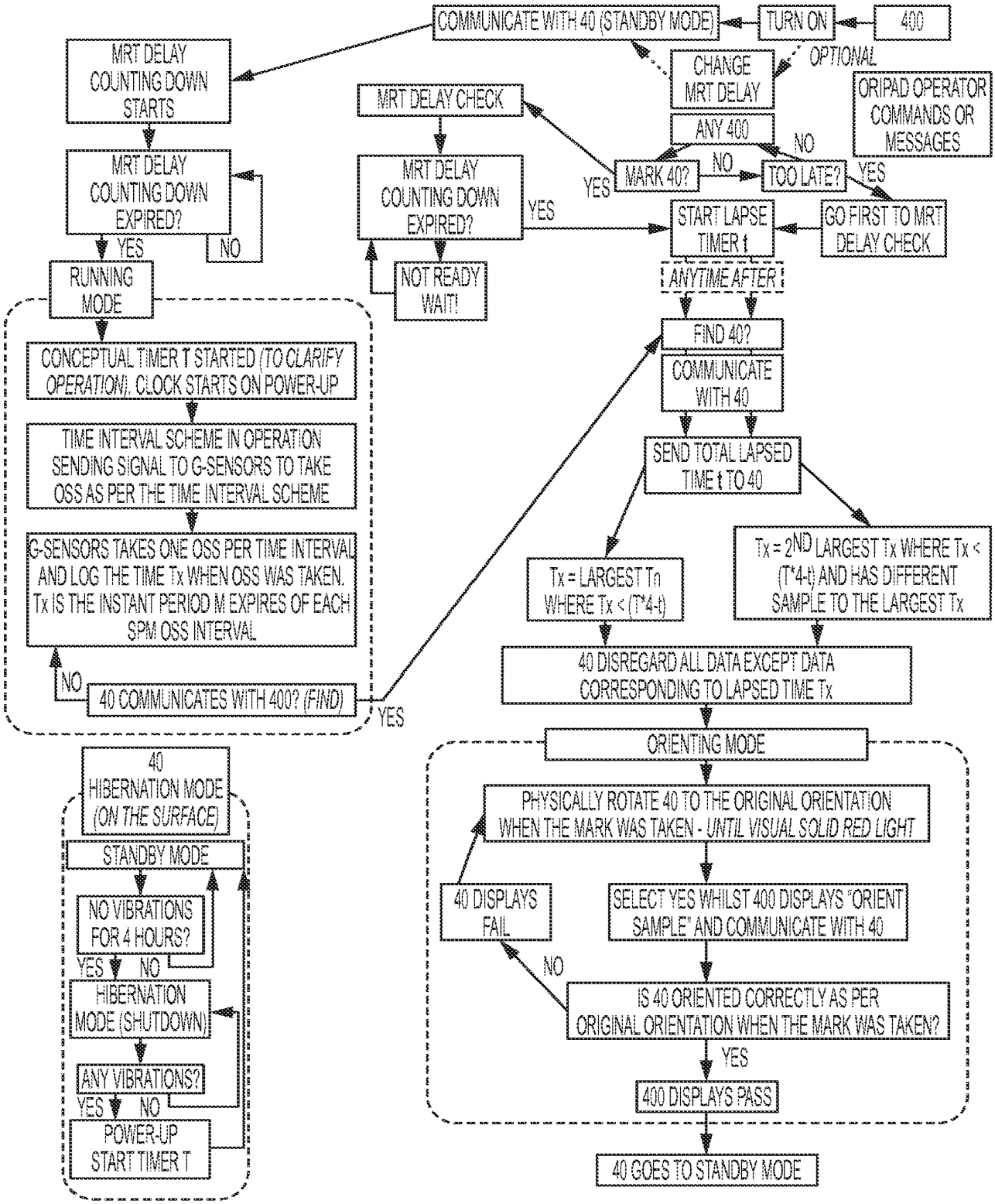

COMMUNICATE WITH 40 (STANDBY MODE)
TURN ON
400
OPTIONAL
CHANGE MRT DELAY
ORIPAD OPERATOR COMMANDS OR MESSAGES
MRT DELAY COUNTING DOWN STARTS
MRT DELAY CHECK
ANY 400
NO
MRT DELAY COUNTING DOWN EXPIRED?
MRT DELAY COUNTING DOWN EXPIRED?
YES
MARK 40?
NO
TOO LATE?
YES
YES
START LAPSE TIMER t
GO FIRST TO MRT DELAY CHECK
YES
NO
NOT READY WAIT!
RUNNING MODE
ANYTIME AFTER t
FIND 40?
COMMUNICATE WITH 40
CONCEPTUAL TIMER T STARTED (TO CLARIFY OPERATION). CLOCK STARTS ON POWER-UP
TIME INTERVAL SCHEME IN OPERATION SENDING SIGNAL TO G-SENSORS TO TAKE OSS AS PER THE TIME INTERVAL SCHEME
SEND TOTAL LAPSED TIME t TO 40
G-SENSORS TAKES ONE OSS PER TIME INTERVAL AND LOG THE TIME Tx WHEN OSS WAS TAKEN. Tx IS THE INSTANT PERIOD M EXPIRES OF EACH SPM OSS INTERVAL
Tx = LARGEST Tn WHERE Tx < (T*4-t)
Tx = 2ND LARGEST Tx WHERE Tx < (T*4-t) AND HAS DIFFERENT SAMPLE TO THE LARGEST Tx
NO
40 COMMUNICATES WITH 400? (FIND)
YES
40 DISREGARD ALL DATA EXCEPT DATA CORRESPONDING TO LAPSED TIME Tx
ORIENTING MODE
40 HIBERNATION MODE (ON THE SURFACE)
PHYSICALLY ROTATE 40 TO THE ORIGINAL ORIENTATION WHEN THE MARK WAS TAKEN - UNTIL VISUAL SOLID RED LIGHT
STANDBY MODE
40 DISPLAYS FAIL
SELECT YES WHILST 400 DISPLAYS "ORIENT SAMPLE" AND COMMUNICATE WITH 40
NO VIBRATIONS FOR 4 HOURS?
YES
NO
NO
HIBERNATION MODE (SHUTDOWN)
IS 40 ORIENTED CORRECTLY AS PER ORIGINAL ORIENTATION WHEN THE MARK WAS TAKEN?
ANY VIBRATIONS?
YES
NO
YES
POWER-UP START TIMER T
400 DISPLAYS PASS
40 GOES TO STANDBY MODE

FIG. 13

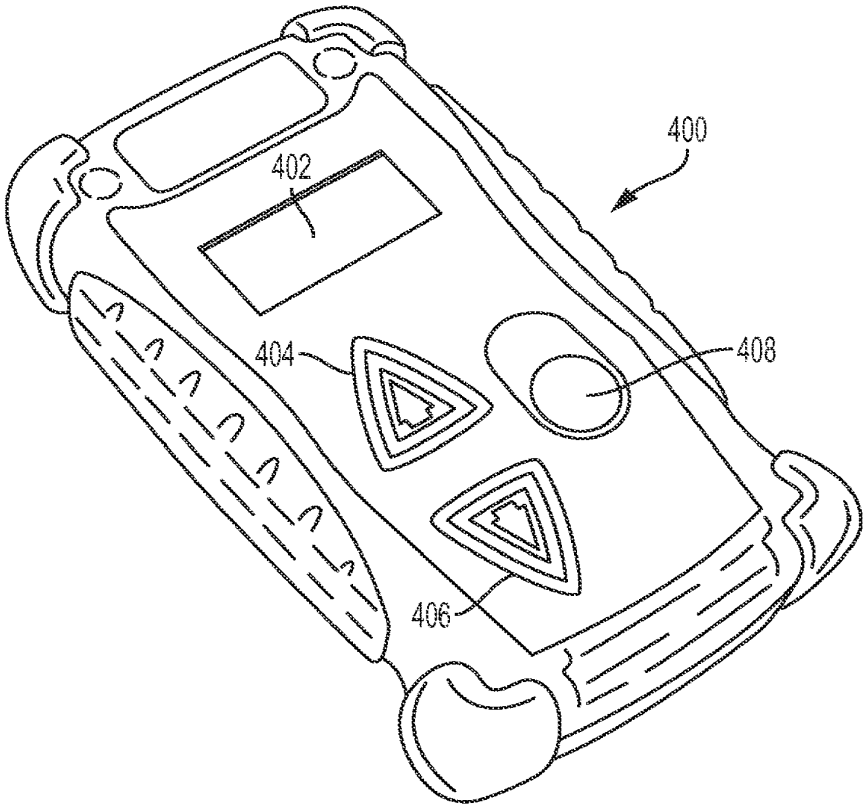


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/026907

A. CLASSIFICATION OF SUBJECT MATTER

E21B 10/02(2006.01)i, E21B 49/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E21B 10/02; E21B 49/02; E21B 25/16; E21B 25/00; E21B 49/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: core barrel, core sample, orientation, electronic instrument, port, window, light emitter, seal coupler

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2008-113127 A1 (2IC AUSTRALIA PTY LTD. et al.) 25 September 2008 See page 11, line 30 - page 12, line 28; page 14, lines 7-21; page 16, lines 12-22; page 26, lines 5-18 and figures 1-2.	1-4,7-8,17,28-33
A		5-6,9-16,18-27
A	WO 2014-053012 A1 (MINNOVARE PTY LTD.) 10 April 2014 See paragraph [0035] and figure 1.	1-33
A	WO 2007-104103 A1 (2IC AUSTRALIA PTY LTD. et al.) 20 September 2007 See page 6, line 16 - page 7, line 12 and figure 1.	1-33
A	US 2012-0145461 A1 (CRAVATTE, PHILLIPE) 14 June 2012 See paragraphs [0047]-[0058] and figures 1-3.	1-33
A	US 6732818 B2 (GREGORY, FRANK) 11 May 2004 See abstract and claim 1.	1-33

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"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)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 July 2015 (24.07.2015)	**24 July 2015 (24.07.2015)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer
HWANG, Chan Yoon
Telephone No. +82-42-481-3347

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2015/026907

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008-113127 A1	25/09/2008	AU 2008-100249 A4	12/06/2008
		AU 2008-229644 A1	25/09/2008
		AU 2008-229644 B2	16/06/2011
		EP 2134921 A1	23/12/2009
WO 2014-053012 A1	10/04/2014	None	
WO 2007-104103 A1	20/09/2007	None	
US 2012-0145461 A1	14/06/2012	EP 2072749 A2	24/06/2009
		EP 2072749 A3	19/01/2011
		EP 2072749 B1	11/07/2012
		US 2009-0159335 A1	25/06/2009
		US 2011-0083905 A1	14/04/2011
		US 7878269 B2	01/02/2011
		US 8146684 B2	03/04/2012
		US 8297376 B2	30/10/2012
US 6732818 B2	11/05/2004	US 2004-065478 A1	08/04/2004

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/588,026	09/30/2019	Christopher L. DRENTH	36362.0150U4

CONFIRMATION NO. 7130

PUBLICATION NOTICE

23859
Ballard Spahr LLP
SUITE 1000
999 PEACHTREE STREET
ATLANTA, GA 30309-3915

OC000000114146907

Title:CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

Publication No.US-2020-0024921-A1
Publication Date:01/23/2020

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The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

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In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/588,026	09/30/2019	3676	2220	36362.0150U4	25	1

CONFIRMATION NO. 7130

CORRECTED FILING RECEIPT

23859
Ballard Spahr LLP
SUITE 1000
999 PEACHTREE STREET
ATLANTA, GA 30309-3915

OC000000112319420

Date Mailed: 11/01/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

Christopher L. DRENTH, Burlington, CANADA;
Gordon STEWART, Claremont, AUSTRALIA;
Khaled HEJLEH, Peppermint Grove, AUSTRALIA;

Applicant(s)

LONGYEAR TM, INC, Salt Lake City, UT;
GLOBALTECH CORPORATION PTY LTD, Canning Vale, WA;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 16/017,334 06/25/2018 PAT 10465463
which is a CON of 14/692,484 04/21/2015 PAT 10047581
which claims benefit of 61/982,052 04/21/2014

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/588,026**

Projected Publication Date: 01/23/2020

Non-Publication Request: No

Early Publication Request: No

Title

CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

Preliminary Class

175

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop

technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

REFLEX EXHIBIT 1002 - 231/304

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/588,026	09/30/2019	3679	2220	36362.0150U4	25	1

CONFIRMATION NO. 7130

FILING RECEIPT

23859
Ballard Spahr LLP
SUITE 1000
999 PEACHTREE STREET
ATLANTA, GA 30309-3915

OC000000111932187

Date Mailed: 10/18/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Christopher L. DRENTH, Burlington, CANADA;
Gordon STEWART, Claremont, AUSTRALIA;
Khaled HEJLEH, Peppermint Grove, AUSTRALIA;

Applicant(s)

LONGYEAR TM, INC, Salt Lake City, UT;
GLOBALTECH cORPRATION PTY LTD, Canning Vale, WA;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 16/017,334 06/25/2018 PAT 10465463
which is a CON of 14/692,484 04/21/2015 PAT 10047581
which claims benefit of 61/982,052 04/21/2014

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

REFLEX EXHIBIT 1002 - 232/304

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 10/16/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/588,026**

Projected Publication Date: 01/23/2020

Non-Publication Request: No

Early Publication Request: No

Title

CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

Preliminary Class

175

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

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The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

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The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop

technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

REFLEX EXHIBIT 1002 - 235/304

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/588,026

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	660
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	25 minus 20 =	* 5			OR	x 100 =	500
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x 460 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2220

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

ATTORNEY DOCKET NO. 36362.0150U4
PATENT
VIA EFS-WEB

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	)	
	)	
DRENTH et al.	)	Art Unit: Unassigned
	)	
Application No.: Unassigned	)	Examiner: Unassigned
	)	
Filing Date: September 30, 2019	)	Confirmation No.: Unassigned
	)	
FOR: **CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME**	)	

AUTHORIZATION TO TREAT REPLY REQUIRING EXTENSION OF TIME AS INCORPORATING PETITION FOR EXTENSION OF TIME

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Ballard Spahr LLP
Customer Number 23859

Commissioner:

Pursuant to 37 C.F.R. §1.136(a)(3), the Commissioner is hereby requested and authorized to treat any concurrent or future reply in the above-identified application, requiring a petition for an extension of time for its timely submission, as incorporating a petition for extension of time for the appropriate length of time.

The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 14-0629.

Respectfully submitted,

BALLARD SPAHR LLP

/Joseph P. Anderson III/
Joseph P. Anderson III
Registration No. 59,245

Ballard Spahr LLP
Customer Number 23859
(678) 420-9300 Phone
(678) 420-9301 Fax

In accordance with 37 C.F.R. § 1.8, I certify that this correspondence is being transmitted to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 via the USPTO's EFS-Web Electronic Filing System on September 30, 2019

/Joseph P. Anderson III/
Joseph P. Anderson, III – Reg. No. 59,245

PTO/AIA/14 (02-18)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	36362.0150U4
	Application Number	
Title of Invention	Core Barrel Head Assembly With An Integrated Sample Orientation Tool And System For Using Same	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	CHRISTOPHER	L.	DRENTH	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Burlington	Country of Residence	CA

Mailing Address of Inventor:

Address 1	2311 Hoover Court
Address 2	

City	Burlington	State/Province	ON
Postal Code	L7P 4V2	Country	CA

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	GORDON		STEWART	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Claremont	Country of Residence	AU

Mailing Address of Inventor:

Address 1	18 Airle Street
Address 2	

City	Claremont	State/Province	
Postal Code	6010	Country	AU

Inventor 3 Remove

Legal Name

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	36362.0150U4
	Application Number	
Title of Invention	Core Barrel Head Assembly With An Integrated Sample Orientation Tool And System For Using Same	

Prefix	Given Name	Middle Name	Family Name	Suffix
	KHALED		HEJLEH	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Peppermint Grove	Country of Residence [i]	AU

Mailing Address of Inventor:

Address 1	34A Leake Street		
Address 2			
City	Peppermint Grove	**State/Province**	
Postal Code	6011	**Country** [i]	AU

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	23859		
Email Address	uspatentmail@ballardspahr.com	Add Email	Remove Email

Application Information:

Title of the Invention	Core Barrel Head Assembly With An Integrated Sample Orientation Tool And System For Using Same		
Attorney Docket Number	36362.0150U4	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)		**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country [i]

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	36362.0150U4
	Application Number	
Title of Invention	Core Barrel Head Assembly With An Integrated Sample Orientation Tool And System For Using Same	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	23859		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	16/017334	2018-06-25

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/017334	Continuation of	14/692484	2015-04-21	10047581	2018-08-14

Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14/692484	Claims benefit of provisional	61/982052	2014-04-21

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

PTO/AIA/14 (02-18)
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	36362.0150U4
	Application Number	
Title of Invention	Core Barrel Head Assembly With An Integrated Sample Orientation Tool And System For Using Same	

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	36362.0150U4
	Application Number	
Title of Invention	Core Barrel Head Assembly With An Integrated Sample Orientation Tool And System For Using Same	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	36362.0150U4
	Application Number	
Title of Invention	Core Barrel Head Assembly With An Integrated Sample Orientation Tool And System For Using Same	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

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Clear

◉ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	LONGYEAR TM, INC.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	36362.0150U4
	Application Number	
Title of Invention	Core Barrel Head Assembly With An Integrated Sample Orientation Tool And System For Using Same	

Applicant 2

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Clear

(●) Assignee	( ) Legal Representative under 35 U.S.C. 117	( ) Joint Inventor
( ) Person to whom the inventor is obligated to assign.	( ) Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

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If the Applicant is an Organization check here. [x]

Organization Name	GLOBALTECH CORPORATION PTY LTD

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Applicant 3

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Clear

( ) Assignee	( ) Legal Representative under 35 U.S.C. 117	( ) Joint Inventor
( ) Person to whom the inventor is obligated to assign.	( ) Person who shows sufficient proprietary interest	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	36362.0150U4
	Application Number	
Title of Invention	Core Barrel Head Assembly With An Integrated Sample Orientation Tool And System For Using Same	

If the Applicant is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Applicant:

Address 1			
Address 2			
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Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

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Mailing Address Information For Assignee including Non-Applicant Assignee:			
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Address 2			
City		**State/Province**	
Country		Postal Code	
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Signature:

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This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Joseph P. Anderson, III/			Date (YYYY-MM-DD)	2019-09-30
First Name	Joseph	Last Name	Anderson, III	Registration Number	59245

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 14/692,484

filed on April 21, 2015.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

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LEGAL NAME OF INVENTOR

Inventor: Christopher L. Drenth Date (Optional): May 13, 2015

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 14/692,484 filed on April 21, 2015.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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LEGAL NAME OF INVENTOR

Inventor: Gordon Stewart Date (Optional): 10/7/15

Signature: Gord Stew

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The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Khaled Hejleh Date (Optional): _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME

CROSS REFERENCE TO RELATED PATENT APPLICATION

[0001] This application is a continuation of U.S. Application No. 16/017,334, filed June 25, 2018, which is a continuation of U.S. Patent Application No. 14/692,484, filed on April 21, 2015, which is now U.S. Patent No. 10,047,581, issued August 14, 2018, which claims priority to U.S. Provisional Application No. 61/982,052, filed on April 21, 2014. Each of these applications is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to down hole surveying in drilling operations. More particularly, to a core barrel assembly having at least one electronic instrument that is configured for use in a core sample down hole surveying and sample orientation system. In one example, the at least one electronic instrument is configured to provide an indication of the orientation of a core sample relative to a body of material from which the core has been extracted, and also to a method of core sample orientation identification.

BACKGROUND

[0003] Conventionally, core samples are obtained through the use of core drilling systems that comprise outer and inner tube assemblies. In operation, a cutting head is attached to the outer tube assembly so that rotational torque applied to the outer tube assembly can be transmitted to the cutting head. A core is generated during the drilling operation, with the core progressively extending along the elongate axis of the inner tube assembly as drilling progresses. Typically, when a core sample is acquired, the core within the inner tube assembly is fractured and the inner tube assembly and the fractured core sample contained therein are then retrieved from within the drill hole, typically by way of a retrieval cable lowered down the drill hole. Once the inner tube assembly has been brought to ground surface, the core sample can be removed and subjected to the desired analysis.

[0004] It is desirable for analysis purposes to have an indication of the orientation of the core sample relative to the ground from which it was extracted. This is complicated in that it is common to drill at an angle relative to the vertical. For efficiency and accuracy of the mineralogical record, it is desirable to determine the orientation and survey position of each core's position underground before being drilled out and extracted. Such orientation and survey positions allow for the subsequent production of a three dimensional map of underground mineral/rock content.

[0005] One common way of obtaining an indication of the orientation of a core sample is through use of an orientation spear comprising a marker (such as a crayon) projecting from one end of a thin steel shank, the other end of which is attached to a wire line. The orientation spear is lowered down the drill hole, prior to the inner tube assembly being introduced. The marker on the orientation spear strikes the facing surface of material from which the core is to be generated, leaving a mark thereon. Because of gravity, the mark is on the lower side of the drill hole. The inner tube assembly is then introduced into the outer tube assembly in the drill hole. As drilling proceeds, a core sample is generated within the inner tube assembly. The core sample so generated carries the mark which was previously applied. Upon completion of the core drilling run and retrieval of the core sample, the mark provides an indication of the orientation of the core sample at the time it was in the ground.

[0006] Other conventional technologies use core orientation units attached to core inner tubes and back-end assemblies to determine the correct orientation of the drilled out core sample after a preferred predetermined drilling distance intervals during drilling. These core orientation units typically measure rotational direction of the core sample before extraction. On retrieval at the surface of the hole, the rotational direction can be determined by electronic means and the upper or lower side of the core material physically 'marked' for later identification by geologists.

[0007] Coupled with the core orientation system, a survey instrument is conventionally used. In this technique, at periodic depths, the survey instrument is lowered down the drill hole to determine azimuth (angular measurement relative to a reference point or direction), dip (or inclination) and any other required survey parameters. These periodic depth survey readings are used to approximate the drill-

path at different depths. Together with the rotational position of the extracted core (from the core orientation device), the three dimensional subsurface material content map can be determined.

[0008] It has been found desirable to provide an improved core barrel assembly having an integrated sample orientation subassembly and method for using same that is configured for use in a core sample down hole surveying and sample orientation that minimizes the need to add additional drill string elements, which allows for increased efficiency and speed of drilling.

SUMMARY

[0009] In one aspect, the present invention provides a core barrel head assembly having an elongate tube body that defines a selectively sealed interior cavity. The core barrel head assembly can have at least one electronic instrument positioned in the interior cavity that is configured to obtain core orientation data of a core sample and a power source positioned in the interior cavity and in electrical communication with the at least one electronic instrument. The core barrel head assembly can also have a communication means that is configured to receive and/or transmit orientation data for use in a core sample down hole surveying and/or sample orientation system. The derived core orientation data provides an indication of the orientation of the core sample relative to a body of material from which the core has been extracted, and also to a method of using same.

[0010] The core barrel head assembly is configured for connection to tube portions of a drill string via respective connection means. In another aspect, the at least one electronic instrument of the core barrel head assembly can be mounted, for example and without limitation, within the interior cavity defined the body, within an interior cavity that is defined therein a side wall of the body of the core barrel head assembly, or potted or in sealed contact with a portion of a side wall of the core barrel assembly (on either an exterior surface or an interior surface of a cavity defined therein the body). As one skilled in the art will contemplate, the core barrel head assembly can comprise at least one electronic instrument that is configured to obtain orientation data, an

electrically coupled power source and communication means to receive and/or transmit orientation data.

[0011] In another aspect, the communication means can comprise a wireless communication means that is configured to wirelessly receive and/or transmit survey data. Optionally, the communication means can be configured to communicate one way or two ways with each other, when drilling has ceased or during drilling.

[0012] In one aspect, the at least one electronic instrument of the core barrel head assembly advantageously enables obtaining drill hole survey readings without the need to insert unwieldy extension drill rods and/or a survey probe to measure azimuth and inclination/dip of the drill hole path. This results in a reduction of equipment handling and usage of equipment, a reduction of operations by not needing to periodically withdraw the drill bit a certain distance in order to advance a survey probe ahead of, and therefore distanced from, the drill bit, with a resultant increase in operational efficiency.

[0013] Another aspect of the present invention provides a method of conducting a down hole survey of drilling, the method including: a) drilling the core from a subsurface body of material; b) recording data relating to orientation of the core to be retrieved, the data recorded using the at least one electronic instrument of the core barrel head assembly, c) separating the core from the subsurface body, and d) obtaining an indication of the orientation of the core based on the recorded core orientation data obtained before the core was separated from the subsurface body.

[0014] Optionally, the method can comprise: determining that drilling has ceased for a period of time, using the at least one electronic instrument of the core barrel head assembly to record data relating to orientation of the core to be retrieved, separating the core from the subsurface body, retrieving the core to the surface, and obtaining an indication of the orientation of the core based on the recorded core orientation data obtained once the drilling had ceased and before the core was separated from the subsurface body.

[0015] Advantages are that there is more time available for drilling due to less time required for surveying and manipulating additional pieces of equipment and mechanical extensions during the survey process.

BRIEF DESCRIPTION OF THE FIGURES

[0016] Figure 1 shows a perspective view of a core barrel head assembly being operatively coupled to a head assembly.

[0017] Figure 2 shows a longitudinal cross-sectional view of Figure 1.

[0018] Figure 3 shows an expanded view of a portion of Figure 2, showing the core barrel head assembly.

[0019] Figure 4 shows a perspective exploded view of the core barrel head assembly of Figure 1.

[0020] Figure 5 shows a longitudinal cross-sectional view of the core barrel head assembly, showing an at least one electronic instrument and an electrically coupled power source disposed therein an interior cavity of a body of the core barrel head assembly.

[0021] Figure 6 shows a longitudinal cross-sectional view of another aspect of the core barrel head assembly, showing an at least one electronic instrument and an electrically coupled power source disposed therein an interior cavity of a body of the core barrel head assembly.

[0022] Figure 7 shows a longitudinal cross-sectional view of the body of the core barrel head assembly.

[0023] Figure 8 shows a longitudinal cross-sectional view of a core barrel head assembly being operatively coupled to a head assembly.

[0024] Figure 9 shows a schematic view of an exemplary at least one electronic instrument.

[0025] Figure 10 shows a schematic view of an exemplary at least one electronic instrument and an electrically coupled power source for disposition therein an interior cavity of a body of the core barrel head assembly.

[0026] Figure 11 shows an exemplary high level flowchart relating to a method of using the present invention.

[0027] Figure 12 shows an exemplary flowchart relating to an alternative embodiment of a method of using the present invention.

[0028] Figure 13 shows an exemplary flowchart relating to an alternative embodiment of a method of using the present invention.

[0029] Figure 14 shows an exemplary prior art hand held device for wirelessly interrogating the core barrel head assembly of the present invention.

DETAILED DESCRIPTION

[0030] The present invention can be understood more readily by reference to the following detailed description, examples, drawings, and claims, and their previous and following description. However, before the present devices, systems, and/or methods are disclosed and described, it is to be understood that this invention is not limited to the specific devices, systems, and/or methods disclosed unless otherwise specified, as such can, of course, vary. It is also to be understood that the terminology used herein is for the purpose of describing particular aspects only and is not intended to be limiting.

[0031] The following description of the invention is provided as an enabling teaching of the invention in its best, currently known embodiment. To this end, those skilled in the relevant art will recognize and appreciate that many changes can be made to the various aspects of the invention described herein, while still obtaining the beneficial results of the present invention. It will also be apparent that some of the desired benefits of the present invention can be obtained by selecting some of the features of the present invention without utilizing other features. Accordingly, those who work in the art will recognize that many modifications and adaptations to the present invention are possible and can even be desirable in certain circumstances and are a part of the present invention. Thus, the following description is provided as illustrative of the principles of the present invention and not in limitation thereof.

[0032] As used throughout, the singular forms “a,” “an” and “the” include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to “a port” can include two or more such ports unless the context indicates otherwise.

[0033] Ranges can be expressed herein as from “about” one particular value, and/or to “about” another particular value. When such a range is expressed, another aspect includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent

"about," it will be understood that the particular value forms another aspect. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint.

[0034] As used herein, the terms "optional" or "optionally" mean that the subsequently described event or circumstance may or may not occur, and that the description includes instances where said event or circumstance occurs and instances where it does not.

[0035] The word "or" as used herein means any one member of a particular list and also includes any combination of members of that list.

[0036] As will be appreciated by one skilled in the art, the methods and systems may take the form of an entirely hardware embodiment, an entirely software embodiment, or an embodiment combining software and hardware aspects. Furthermore, the methods and systems may take the form of a computer program product on a computer-readable storage medium having computer-readable program instructions (*e.g.*, computer software) embodied in the storage medium. More particularly, the present methods and systems may take the form of web-implemented computer software. Any suitable computer-readable storage medium may be utilized including, without limitation, hard disks, CD-ROMs, optical storage devices, magnetic storage devices, or solid-state electronic storage devices.

[0037] Embodiments of the methods and systems are described below with reference to block diagrams and flowchart illustrations of methods, systems, apparatuses and computer program products. It will be understood that each block of the block diagrams and flowchart illustrations, and combinations of blocks in the block diagrams and flowchart illustrations, respectively, can be implemented by computer program instructions. These computer program instructions may be loaded onto a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions which execute on the computer or other programmable data processing apparatus create a means for implementing the functions specified in the flowchart block or blocks.

[0038] These computer program instructions may also be stored in a computer-

readable memory that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer-readable memory produce an article of manufacture including computer-readable instructions for implementing the function specified in the flowchart block or blocks. The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer-implemented process such that the instructions that execute on the computer or other programmable apparatus provide steps for implementing the functions specified in the flowchart block or blocks.

[0039] Accordingly, blocks of the block diagrams and flowchart illustrations support combinations of means for performing the specified functions, combinations of steps for performing the specified functions and program instruction means for performing the specified functions. It will also be understood that each block of the block diagrams and flowchart illustrations, and combinations of blocks in the block diagrams and flowchart illustrations, can be implemented by special purpose hardware-based computer systems that perform the specified functions or steps, or combinations of special purpose hardware and computer instructions.

[0040] In one aspect, a drill assembly for drilling into a subsurface body of material can comprise a drill string 10 comprising a drill bit, an outer tube formed of linearly connected tube sections, and an inner tube for receiving the core drilled from the subsurface body. In one aspect, the core barrel head assembly 30 is integrated into the drill string 10 to form a portion of the drill string, such as shown in Figure 1, where the core barrel head assembly is operably coupled to a conventional head assembly 20.

[0041] The core barrel head assembly is configured for connection to tube portions of a drill string via respective connection means. In another aspect, the at least one electronic instrument of the core barrel head assembly can be mounted, for example and without limitation, within the interior cavity defined the body, within an interior cavity that is defined therein a side wall of the body of the core barrel head assembly, or potted or in sealed contact with a portion of a side wall of the core barrel assembly (on

either an exterior surface or an interior surface of a cavity defined therein the body). As one skilled in the art will contemplate, the core barrel head assembly can comprise at least one electronic instrument that is configured to obtain orientation data, an electrically coupled power source and communication means to receive and/or transmit orientation data.

[0042] In one aspect, and referring to Figures 1-7, the core barrel head assembly 30 can comprise at least one electronic instrument 40 that is configured to obtain orientation data, a operatively electrically coupled power source 50 and communication means to receive and/or transmit orientation data. In one aspect, at least one electronic instrument 40 can comprise at least one digital and/or electro-mechanical sensors 42, and/or one or more physical data sensors 44 in a core orientation data recording tool that can be configured to determine the core orientation just prior to or after the core break, and, optionally, to detect the signal of the break of the core from the body of material. In various aspects, it is contemplated that the recorded data can optionally include "dip" angle and/or azimuth datum to increase the reliability of the core orientation results as described below.

[0043] In this aspect, the at least one digital and/or electro-mechanical sensor 42 in operative communication with the at least one electronic instrument 40 of the core barrel assembly can be configured to detect vibration and/or to detect tri-axial gravitation loading acting on the electronic instrument. In one exemplary aspect, once a desired vibration state is detected and/or a desired G-loading state is detected , drilling can cease and the core barrel head assembly can record data relating to the orientation of the core, such as, for example and without limitation, gravitational field strength and direction, and/or magnetic field strength and direction.

[0044] The core barrel head assembly 30 has a proximal end 32 that is operatively oriented toward the drill bit end of the drill string and an opposed distal end 34. As shown in Figures 1 and 5-6, the core barrel head assembly 30 has an elongate tube body 60 that is conventionally joined to a conventional wire line retrieval portion of a head assembly 10. Thus, the head assembly of the drill string is complete without the necessity for the use of an unwieldy extension tube as required in the prior art designs.

[0045] The threaded proximal end 62 of the elongate tube body 60 is in communication with a first interior cavity 64 that extends distally to a base portion 65. Proximate the base portion of the second interior cavity, a port 66 is defined that extends from the exterior surface of the elongate tube body into fluid communication with the first interior cavity. Optionally, in this aspect, it is contemplated that a grease fitting 68 can be mounted in the port 66 to allow for selective passage of grease or lubricant into communication with the first interior cavity and vice versa.

[0046] A second interior cavity 70 is defined therein the elongate tube body 60 that is spaced from and extends distally from the first interior cavity. The second interior cavity 70 can be sized to hermetically enclose at least one of the least one electronic instrument 40 that is configured to obtain orientation data, the power source 50 and the communication means to receive and/or transmit orientation data. In another aspect, the second interior cavity 70 can be sized to hermetically enclose the least one electronic instrument 40 that is configured to obtain orientation data and the power source 50. In one aspect, the at least one electronic instrument 40 can comprise the electronic instrument discussed above and schematically shown in Figures 8 and 9. The at least one electronic instrument 40 is operatively electrically coupled to the power source 50, which can comprise any conventional power source, such as, for example and without limitation, a battery, a rechargeable battery, and the like.

[0047] In one aspect, as shown, a plurality of windows 74 can be defined in the elongate tube body that extend from the exterior surface 61 of the elongate tube body into the second interior chamber 70 proximate the closed proximal end 72 of the second interior chamber. In a further aspect, an orientation indicator module 80 can be provided that comprises a plurality of light emitters 82. The orientation indicator module 80 can be sized and shaped to sealingly close the second interior chamber from any intrusion of pressurized fluid into the second interior chamber 70 via the defined plurality of windows 74.

[0048] In another aspect, it is contemplated that the second interior cavity can comprise at least one orienting slot defined therein. In this aspect, the orientation indicator module can be oriented manually and the desired position can be maintained

to the at least one O-ring seal 84 described below. Optionally, in a further aspect, the orientation indicator module 82 is configured to orient or otherwise position a plurality of light emitters 88 so that each light emitter underlies one window.

[0049] In one aspect, the orientation indicator module 80 can further comprise a sealing means for preventing any pressurized fluid from entering the second interior cavity 70 from the defined windows 74. In one aspect, the sealing means can comprise at least one O-ring seal 84 that is mounted on an exterior portion of the orientation indicator module and that is configured to seal between the exterior portion of the orientation indicator module and a portion of the interior surface of the second interior cavity.

[0050] In one exemplary aspect, light from the plurality of light emitters 88 (*e.g.* LEDs, and the like) passes through or can be observed through the plurality of windows 74. Reference arrow A refers to the drill bit end direction, and reference arrow B refers to the head assembly direction. Further, as described above, the process of obtaining core orientation is made easier by only requiring two color lights, such as, for example and without limitation, green and red, to indicate one or other direction of rotation to establish correct core orientation prior to marking. The indicators form part of the sealed device and can be low power consumption LED lights.

[0051] Alternatively, flashing lights may be used, such as, for example and without limitation, a certain frequency or number of flashes for one direction and another frequency or number of flashes for the other direction of rotation. A steady light could be given when correct orientation is achieved. Thus, advantageously, when the core barrel head assembly 30 and the core sample are recovered from down the hole, the core barrel head assembly 30 need not be separated from the drill string in order to determine a required orientation of the core sample. Wireless communication to a remote device, such as a hand held device, to transfer data between the core barrel head assembly and the remote device, can also be effected by transmitting through the at least one aperture.

[0052] In another aspect, the second interior cavity 70 extends distally to the open distal end 73 of the elongate tube body 60. To further effect a hermetical enclosure of

the least one electronic instrument 40 that is configured to obtain orientation data, the power source 50 and, optionally, the communication means to receive and/or transmit orientation data, a seal coupler 90 can be provided that is configured to be sealingly received in the open threaded distal end 73 of the elongate tube body 60. As noted, a sealing means can be provided to prevent any pressurized fluid from entering the second interior cavity. In one aspect, the sealing means can comprise at least one O-ring seal 95 that is mounted on a portion of the seal coupler and that is configured to seal between a portion of the seal coupler and a portion of the interior surface of the open distal end of the elongate tube body.

[0053] In a further aspect, to further effect a hermetical seal of the second interior cavity and to provide fluid control for the wire line operation, a check valve assembly 100 is provided. In one aspect, the check valve assembly 100 comprises a coupled proximal end assembly and a distally tapered seat that defines an interior chamber 110 for operative receipt of a check ball 120.

[0054] In one aspect, the proximal end assembly102 of the check valve assembly can define a female threaded coupling that is configured to be threadably coupled to the male threads defined on the exterior surface of the distal end 73 of the elongate tube body 60. As one skilled in the art will appreciate, as the proximal end assembly of the check valve assembly 100 is threadably coupled to the distal end 73 of the elongate tube body, the seal coupler 90 is driven into a sealed position therein the second interior cavity 70 to affect complete hermeticity.

[0055] Further, as one skilled in the art will appreciate, because the orientation indicator module 90 is sealingly disposed in the proximal end of the second interior chamber 70, the least one electronic instrument 40, the power source 50 and, optionally, the communication means to receive and/or transmit orientation data is disposed in operative contact with the orientation indicator module, and the seal coupler 90 is disposed in contact with the least one electronic instrument 40, the power source 50 and, optionally, the communication means to receive and/or transmit orientation data, as the proximal end assembly of the check valve assembly is threadably coupled to the distal 73 end of the elongate tube body, both the sealing means on the respective

orientation indicator module 80 and the seal coupler 90 are driven into a sealed position therein the second interior cavity to affect complete hermeticity of the second interior cavity.

[0056] In another aspect, the interior chamber 110 of the check valve assembly extends to a distal end 104 of the check valve assembly. In this aspect, at least one port 106 is provided that extends from the exterior surface of the check valve assembly and is in fluid communication with the interior chamber of the check valve assembly. In one aspect, the at least one port 106 can comprise a plurality of ports. In this aspect, it is contemplated that the plurality of ports can be angularly spaced an equal or an unequal number of degrees apart.

[0057] In this aspect, the interior chamber 110 can have a distally tapered seat 112 that is adapted to selectively receive the ball 120 that is sized to selectively block the distally tapered seat. One skilled in the art will appreciate that the interior chamber 110 of the check valve assembly 100 can be sized and shaped to allow the ball to selectively move axially between an open position, in which the ball is spaced proximally away from the surface of the tapered seat so that pressurized fluid can move through the distal end of the check valve assembly and subsequently through the interior chamber to exit out of the at least one port, and a closed position, in which the ball is pressurized against the surface of the tapered seat so that pressurized fluid cannot move through the check valve assembly.

[0058] In a further aspect, the exterior surface 61 of the elongate tube body 60 can define a plurality of female planar stops 67 proximate the mid-body portion. These female planar stops aid in grasping and selectively orienting the orientation of the core barrel head assembly 30. Optionally, additional female planar stops 69 can be defined proximate the indicator widows defined in the elongate tube body to aid in ease of selectively orienting the sample.

[0059] Referring now to Figure 8, an alternative embodiment of the core barrel head assembly 30 is shown that comprises at least one electronic instrument 40 that is configured to obtain orientation data, a operatively electrically coupled power source 50 and communication means to receive and/or transmit orientation data.

[0060] In this aspect the core barrel head assembly 130 has a proximal end 132 that is operatively oriented toward the drill bit end of the drill string and an opposed distal end 134. As shown in Figure 8, the core barrel head assembly 130 is conventionally joined to a conventional wire line retrieval portion of a head assembly 10. Thus, the head assembly of the drill string is complete without the necessity for the use of an unwieldy extension tube as required in the prior art designs.

[0061] The core barrel head assembly 130 has an elongate tube body 160 that is operably coupled to elongate hollow spindle 170 that is, in turn, operably coupled to a selectively open check valve assembly 180. The elongate tube body has a threaded proximal end 162 that defines an internal bushing mount 163. The open distal end 164 of the elongate tube body defines an internal shoulder 165 that is sized and shaped to receive at least one conventional cylindrical bearing 190.

[0062] A bushing 192 is mounted in the bushing mount and is sized and shaped to rotatably receive the proximal end 172 of the hollow spindle 170. As shown in the figures, a mid-portion of the hollow spindle is rotatably supported by the at least one bearing 190. In a further aspect, a nut 194 is coupled to a treaded portion 174 of the hollow spindle 170 adjacent to the proximal end of the hollow spindle 170.

[0063] The a portion of the interior wall 165 of the elongate tube body 160, a portion of the nut 194 and a portion of the exterior surface of the hollow spindle define a an interior cavity 166 into which a spring is mounted and the at least one electronic instrument 40 that is configured to obtain orientation data, a operatively electrically coupled power source 50 and communication means to receive and/or transmit orientation data are mounted. The least one electronic instrument 40 that is configured to obtain orientation data, a operatively electrically coupled power source 50 and communication means to receive and/or transmit orientation data can be integrated; potted or otherwise affixed to the elongate tube body within the interior cavity 166. As one skilled in the art will appreciate, as the hollow spindle turns, the elongate tube body will remain in the same position, *i.e.*, the elongate tube body does not turn when the hollow spindle is turned.

[0064] In an optional aspect, a port 167 is defined that extends from the exterior surface of the elongate tube body into fluid communication with the interior cavity. Optionally, in this aspect, it is contemplated that a grease fitting 168 can be mounted in the port 167 to allow for selective passage of grease or lubricant into communication with the interior cavity.

[0065] It is contemplated that the interior cavity 166 can be sized to hermetically enclose at least one of the least one electronic instrument 40 that is configured to obtain orientation data, the power source 50 and the communication means to receive and/or transmit orientation data. In another aspect, the interior cavity 166 can be sized to hermetically enclose the least one electronic instrument 40 that is configured to obtain orientation data and the power source 50. In one aspect, the at least one electronic instrument 40 can comprise the electronic instrument discussed above and schematically shown in Figures 9 and 10. The at least one electronic instrument 40 is operatively electrically coupled to the power source 50, which can comprise any conventional power source, such as, for example and without limitation, a battery, a rechargeable battery, and the like.

[0066] In a further aspect, to provide fluid control for the wire line operation, a selectively open check valve assembly 180 is provided. In one aspect, the check valve assembly 180 comprises a coupled end assembly 182 defining a proximally tapered seat 184 that defines an interior chamber 185 for operative receipt of a check ball 195.

[0067] In one aspect, the coupled end assembly 182 of the check valve assembly can define a female threaded coupling that is configured to be threadably coupled to the male threads defined on the exterior surface of the distal end 173 of the hollow spindle 170. Thus, as shown in the figures, the tapered seat 184 is operably coupled to the distal end 173 of the spindle 170 such that the hollow interior of the spindle 170 can be selectively placed in fluid communication with fluid governed by the check valve assembly 180.

[0068] As one skilled in the art will appreciate, the end assembly 182 of the check valve assembly defines at least one port 186 that extends from the exterior surface of the check valve assembly and is in fluid communication with the interior chamber of the

check valve assembly. In one aspect, the at least one port 186 can comprise a plurality of ports. In this aspect, it is contemplated that the plurality of ports can be angularly spaced an equal or an unequal number of degrees apart.

[0069] In this aspect, the interior chamber 185 can have a proximally tapered seat 184 that is adapted to selectively receive the ball 195 that is sized to selectively block the proximally tapered seat. One skilled in the art will appreciate that the interior chamber 185 of the check valve assembly 180 can be sized and shaped to allow the ball to selectively move axially between an open position, in which the ball is spaced proximally away from the surface of the tapered seat so that pressurized fluid can move out through the elongate spindle into the proximal end of the check valve assembly and subsequently through the interior chamber of the check valve assembly to exit out of the at least one port, and a closed position, in which the ball is pressurized against the surface of the tapered seat so that pressurized fluid cannot move through the check valve assembly to through the hollow spindle.

[0070] In operation, it is contemplated that, in one non-limiting example, the at least one electronic instrument 40 of the core barrel head assembly 30 does not take any orientation measurements while vibrations, such as from the drilling operation, are present. In this aspect, the combination of mechanical, electromechanical and/or electronic sensors and software algorithms programmed into the at least one electronic instrument of the core barrel head assembly are configured to determine that the core barrel head assembly is in motion while descending down the hole and during drilling and is therefore not yet needed to detect breaking of the core sample from the body of material. Similarly, in a further aspect, it is contemplated that the at least one electronic instrument of the core barrel head assembly can be configured to detect that the core barrel head assembly is ascending to the surface for core retrieval after core breaking and subsequently will not take any core orientation measurements during the ascending operation.

[0071] In one non-limiting example, in operation, when the driller is ready to break the core, the driller can selectively not rotate the drill string for a first predetermined delay time period that can range from between about 10 seconds to about 90 seconds.

During the delay time period, it is contemplated that an orientation and dip measurement can be taken during this non-rotation, *i.e.*, minimal vibration, period. Subsequently, after breaking the core, the driller can wait a second predetermined delay time period that can range from between about 60 seconds to about 120 seconds, or at least 90 seconds before initiating further rotation.

[0072] Optionally, it is contemplated that pressure created within the borehole by drilling mud and/or water, which may be pumped down the borehole from the surface can be detected by the at least one electronic instrument 42, which can comprise at least one pressure sensor. In various non-limiting examples, the at least one pressure sensor can be mounted on the drill string, such as on the inner and/or outer drill tube or on the drill bit or on the core barrel head assembly. The detected pressure, such as, for example and without limitation, pressure within the inner tube receiving the core, or pressure differential, such as, for example and without limitation, pressure differential between/across the inner and outer tubes, can be indicative of the inner tube being nearly or totally full of core material. This can occur before the core is separated from the subsurface body of material (such as by breaking the core from the body by a sharp pull back on the core) and hence can provide an indicator that the core is about to be broken.

[0073] Optionally, it is contemplated that the least one electronic instrument 40, which is configured to obtain orientation data, the power source 50 and the communication means to receive and/or transmit orientation data can be sized and shaped to be integrally mounted therein conventional wire line assemblies. It this aspect, the least one electronic instrument 40 that is configured to obtain orientation data, the power source 50 and the communication means to receive and/or transmit orientation data can be miniaturized and/or flexible to be received within defined cavities therein the conventional wire line assemblies and can be subsequently hermetically sealed, such as with, for example and without limitation, an epoxy, therein the defined cavities.

[0074] One skilled in the art will appreciate that the core barrel head assembly 30 does not need to be separated from the head assembly 20 in order to determine core sample orientation and/or to gather data recorded by the tool means that there is less

risk of equipment failure and drilling downtime, as well as reduced equipment handling time through not having to separate the sections in order to otherwise obtain core sample orientation. Known systems require an end-on interrogation of the tool. By providing a sealed apparatus and the facility to determine orientation of the core sample by observing the orientation indications through one or more windows 74 in the side of the elongate tube body 60, reliability and efficiency of core sample collection and orientating is improved. Consequently operational personnel risk injury, as well as additional downtime of the drilling operation. Without having to separate core barrel head assembly 30 from the head assembly, the orientation of the core sample can be determined and the gathered information retrieved with less drilling delay and risk of equipment damage/failure.

[0075] Further, unlike known systems, the core barrel head assembly 30 provides for the desired flow of pressurized fluid in the wire-line assemblies to conventionally operate the fluid control vales that are commonly used in wire-line operations. As noted, the check valve assembly 100 allows for the selectively passage of fluid therethrough that assembly and to the exterior surface of the core barrel head assembly 30 and subsequently through the pressure relief valve to exit out of the first interior cavity of the elongate tube body.

[0076] In one aspect, the one or more pressure sensors 42 can be provided to detect pressure data, which can comprise pressure readings; changes in pressure and/or pressure differentials. The pressure data can be operative communication with the core barrel head assembly 30 and/or an operator at the surface. In one exemplary aspect, once a desired pressure value is detected, drilling can cease and the at least one electronic instrument 40 of the core barrel head assembly 30 can record data relating to the orientation of the core, such as gravitational field strength and direction, and/or magnetic field strength and direction.

[0077] In various aspects, it is contemplated that the recorded data can optionally include “dip” angle or azimuth datum to increase the reliability of the core orientation results. Conventionally, dip is the angle of the inner core tube drill assembly with respect to the horizontal plane and can be the angle above or below the horizontal

plane depending on drilling direction from above ground level or from underground drilling in any direction. This provides further confirmation that the progressive drilling of a hole follows a maximum progressive dip angle which may incrementally change as drilling progresses, but not to the extent which exceeds a dogleg severity, *i.e.,* a normalized estimate (*e.g.* degrees / 30 meters) of the overall curvature of an actual drill-hole path between two consecutive directional survey/orientation stations.

[0078] In operation, prior to obtaining an orientation and core sample, a remote external communication device can be set by an operator to a start time. The remote external communication device communicates with the at least one electronic instrument 40 of the core barrel head assembly 30 before it is tripped into the drill hole. Subsequently, after a predetermined timed interval has elapsed from the start time, the at least one electronic instrument 40 can be configured to begin normal operation to detect the signature of vibration indicating a core break.

[0079] Optionally, in another aspect, pressure changes or levels can be detected to indicate a pre-break condition or period, such as pressure of mud/water within the inner tube increasing due to the core filling or nearly filling the inner tube holding the core.

[0080] In one aspect, the at least one electronic instrument 40 of the core barrel head assembly 30 can be configured to not take any orientation measurements while vibrations, such as from the drilling operation, are present. In this aspect, the combination of mechanical, electromechanical and/or electronic sensors and software algorithms programmed into the at least one electronic instrument 40 of the core barrel head assembly 30 can be configured to determine that the core barrel head assembly is in motion while descending down the hole and during drilling and is therefore not yet needed to detect breaking of the core sample from the body of material. Similarly, in a further aspect, it is contemplated that the at least one electronic instrument 40 of the core barrel head assembly 30 can be configured to detect that the core barrel head assembly is ascending to the surface for core retrieval after core breaking and subsequently will not take any core orientation measurements during the ascending operation.

[0081] Optionally, dip angle can be included in determining orientation of the core. In one aspect, the dip angle of the drill hole can be used to determine whether or not to

use the obtained orientation data. For example, a valid core orientation sample can be determined from the previously discussed validation steps being acceptable and, additionally, from the dip angle of the drill hole also being within acceptable limits. In one aspect, the dip can be sampled as a reference prior to the first run of a new drill hole. This particular reference is called a setup function. In this aspect, the setup function can be selected on the remote communications device, which then communicates to the core barrel head assembly. For clarity, the core sample orientation subassembly does not orientation the core, rather, it records signals indicative of the orientation of the core to be retrieved. The core barrel head assembly can then be lowered down the hole or aligned to the angle of the drill rods in the case of no hole yet to be drilled. Once the core barrel head assembly is down to a desired position or to the end of the hole the user can "mark" the "shot," preferably via use of the remote communications device.

[0082] Subsequently, the core barrel head assembly is retrieved and the remote communications device can be used to communicate the dip (angle) of the drill hole to the communication means of the core barrel head assembly. Optionally, the dip of the end of the hole can be manually entered into the remote communications device and this communicated back to the core barrel head assembly.

[0083] In one aspect, a compliant datum is obtained when one or more signals indicative of the orientation of the core is/are obtained by the core orientation device during a period of no drilling vibration prior to detecting vibration from breaking the core and that being prior to a subsequent period of no drilling vibration. It is contemplated that one or more embodiments can utilize the final compliant datum instead of the first obtained compliant datum.

[0084] In one aspect, it is contemplated that the at least one electronic instrument 40 can comprise an LCD display 41 at one end. This can allow for setting up of the orientation system prior to deployment and to indicate visually alignment of the core sample when retrieved to the surface. The core barrel head assembly 30 can be connected to the core barrel head assembly which can be operably is connected to a sample tube for receiving a core sample. In one aspect, and as exemplarily shown in Figures 8 and 9, the at least one electronic instrument 40 can comprise at least one

vibration sensor, at least one accelerometer 43, a memory 45, a timer 47 and the aforementioned LCD display 41. Optionally, at least one electronic instrument 40 can further comprise one or more of at least one of a gravity sensor, magnetic field sensor, inclinometer, a direction measuring sensor, a gyro, and/or preferably a combination two or more of these devices.

[0085] In this aspect, the at least one electronic instrument 40 can be configured to record orientation data every few seconds during core sampling. The start time can be synchronized with actual time using a common stop watch. The operably coupled core barrel head assembly 30 and the core barrel head assembly can then be lowered into the drill string outer casing to commence core sampling. After drilling and capturing a core sample in the inner core sample tube, the operator, can stop the stop watch and retrieve the core sample tube back to the surface. At the surface, before removing the core sample from the inner tube, the operator can views the LCD display, if it is still working, which steps the operator through instructions to rotate the core tube until the core sample lower section is at the core tube lower end . The core sample is then marked and stored for future analysis.

[0086] Another aspect of the present invention provides a method of conducting a down hole survey of drilling, the method including: a) drilling the core from a subsurface body of material; b) recording data relating to orientation of the core to be retrieved, the data recorded using the at least one electronic instrument of the core barrel head assembly, c) separating the core from the subsurface body, and d) obtaining an indication of the orientation of the core based on the recorded core orientation data obtained before the core was separated from the subsurface body.

[0087] Optionally, the method can comprise: determining that drilling has ceased for a period of time, using the at least one electronic instrument of the core barrel head assembly to record data relating to orientation of the core to be retrieved, separating the core from the subsurface body, retrieving the core to the surface, and obtaining an indication of the orientation of the core based on the recorded core orientation data obtained once the drilling had ceased and before the core was separated from the subsurface body.

[0088] In one exemplary aspect, for the embodiment shown in the flowchart in Figure 11, the core orientation can be validated when the following events have occurred:

a) Step 200: detecting no vibration above a threshold by the core barrel head assembly, or is detected to be below a threshold, for the first predetermined delay time period;

b) Step 220: taking a core orientation measurement during the first predetermined delay time period;

c) Step 230: detecting noise from breaking the core from the subsurface body after the first predetermined delay time period and before the second predetermined delay time period;

d) Step 240: detecting no vibration above a threshold by the core barrel head assembly, or is detected to be below a threshold, for the second predetermined delay time period;

e) Step 250: retaining the orientation measurement obtained in Step 220 only if Steps 200, 230 and 240 are present;

f) Step 260: disregarding detected signals or to not detect vibration or lack of vibration if only if Steps 200, 230 and 240 are obtained. If the detected signals are disregarded, a vibration silence signal in Step 280 must be detected before the core is broken.

[0089] Optionally, as shown in Step 270, a dip measurement can be obtained during the period of no drilling prior to breaking the core (period Y), preferably if dip is within the set limits.

[0090] In one aspect, once the required core orientation is obtained, the core barrel head assembly may be shut down or turned to low power standby mode in Step 290 in preparation to be subsequently placed into an orientation mode. Once the core barrel head assembly 30 is retrieved to the surface in Step 300, an operator can set the core barrel head assembly to the orientation mode in Step 310. In one example, and not meant to be limiting, this can be done via the remote communication means for

communicating with the communication means of the core barrel head assembly in Step 320.

[0091] In a further aspect, it is contemplated that the core barrel head assembly can comprise an orientation indicator assembly that comprises one or more lights or other visual indicators, such as, for example and without limitation, one or more display panels to give an indication of orientation direction and required orientation for marking the core. In this aspect, once in orientation mode, visual indications, such as flashing of one or more LEDs, can indicate to the operator which direction to rotate the core to find the" correct down side" for marking. In this aspect, the "correct downside" is the part of the core that was lowermost prior to separating from the subsurface body.

[0092] Once the correct downside is identified in Step 330, the operator can again effect communication to the communication means of the core barrel head assembly via the remote communication device. In Step 340, and based on the orientation data recorded, the remote communication device can be configured to verify that the correct orientation was achieved. Subsequently, in Step 350, the operator can perform another orientation operation.

[0093] Optional and exemplary methods of using the present invention are shown in Figures 12 and 13. In one aspect, as shown in Figure 12, the at least one electronic instrument 40 of the core barrel head assembly 30 can be programmed to be used in a running mode, a hibernation mode and an orientating mode. In this aspect, the at least one electronic instrument 40 of the core barrel head assembly 30 is configured to actuate and take sequential provisional data readings (POD1, POD2, POD3, etc.) when the at least one electronic instrument senses that vibrations have stopped. These provisional data readings are taken as desired time intervals that can be between about 0.1 to about 1.0 seconds. In this aspect, the core barrel head assembly 30 is configured to actuate or power up when the at least one electronic instrument is taken out hibernation. Further, it is contemplated that the time clock starts operation whenever the at least one electronic instrument 40. For example, this could happen on the surface prior to insertion into the hole. The programming can also optionally disregard any acquired provisional data (POD1, POD2, POD3, etc.) if vibrations are sensed during any portion of the acquisition of the sequential provisional data readings.

In this case, the programming would automatically go to the step "Turn Off G-Sensor" in the running mode.

[0094] In one aspect, as shown in Figure 13, the at least one electronic instrument 40 of the core barrel head assembly 30 can be similarly programmed to be used in a running mode, a hibernation mode and an orientating mode. In this aspect, the at least one electronic instrument 40 of the core barrel head assembly 30 is configured to actuate in accord with a time interval scheme in which a signal is sent to the tri-axial g-sensors to take readings in accord with the predetermined time interval scheme.

[0095] In one aspect, it is contemplated that the core barrel head assembly 30 can be utilized in asynchronous time operation for core sampling. In this aspect, the data recording events taken by the core barrel head assembly 30 are not synchronized in time with the communication device. That is, the core barrel head assembly can be programmed to not commence timing from a reference time, and can optionally be programmed such that the at least one electronic instrument 40 of the core barrel head assembly 30 does not take samples (shots) at specific predetermined time intervals. For example, and not meant to be limiting, the at least one electronic instrument 40 of the core barrel head assembly 30 can be programmed to not take a three second sample every one minute with that one minute interval synchronized to the remote, which would therefore know when each sample is about to take place. In this aspect, the communication means or device is not synchronized to the core orientation unit, *i.e.* asynchronous operation, and therefore the communication device does not know if or when a sample is being taken. Thus, obtaining an indication of core sample orientation is simplified over known arrangements.

[0096] In one aspect, while the core barred head assembly is on the surface, the external communication device can signal to the at least one electronic instrument 40 to activate or come out of a standby mode prior to deployment down hole. Optionally, the at least one electronic instrument 40 can already be activated such that it is not necessary to have the at least one electronic instrument 40 switch on from a deactivated ('turned off') state.

[0097] Alternatively, the at least one electronic instrument 40 can be configured to activate and commence taking data samples after a predetermined period from

deployment from the surface or after elapse of an activation delay timer or other delay mechanism. For example, the data gathering device may be configured at the surface to only 'wake-up' from a standby mode to an activated mode after at least a predetermined period of time has elapsed or a counter has completed a predetermined count relating to a time period delay.

[0098] In one aspect, it is contemplated that the at least one electronic instrument 40 can be programmed to take measurements/record orientation data based on the time intervals and/or randomly generated time intervals. In this aspect, the programmed instructions to record data generated as a result of the regular or randomly generated time intervals can remain on-going while the at least one electronic instrument 40 activated. However, because at least one of the sensor(s) in the at least one electronic instrument 40 may be shut down/deactivated during sensed vibrations, no orientation data gets acquired during time period in which vibrations are sensed. When the vibrations stop, the sensors are turned on and the time intervals instructions would then resume execution as per the time regular or random intervals. In this aspect, orientation data is being measured/obtained per the time intervals being used, as preferably initiated at the beginning of the run or after a delay timer. But, data will not be recorded during the time intervals due to the fact that the sensor(s) will be off/deactivated, *e.g.* during a time period in which vibrations are sensed. In this aspect, when drilling ceases, which results in vibrations ceasing, data will be taken, and may preferably continue to be taken, in accordance with the time intervals scheme initiated at the surface, and preferably may always running in the background even when the sensor(s) is/are off or deactivated (*e.g.*, asleep).

[0099] In a further aspect, the at least one electronic instrument 40 can log and/or record orientation related data down hole at intervals (regular or randomly generated intervals within minimum and maximum interval time limits) and can also measures total lapsed survey time T.

[00100] In a further aspect, the at least one electronic instrument 40 can be started by an external communication device at the surface but a second, different, communication device can be used to 'mark' (to set) the point in time, *i.e.*, to commence the elapsed period of time t relating to breaking the core sample from the

underlying rock and thereby be used for identifying the data set recorded immediately before that break.

[00101] In one aspect, to compensate for taking regular or random time period orientation measurements, which uses up battery power as the at least one electronic instrument 40 advances down hole, a start delay can be provided. For example, when the external communication device at the surface is operated, *e.g.*, turned on, an option to set a delay time in the at least one electronic instrument 40 may be displayed. For example, a delay in minutes between 0 to 99 minutes might be displayed. In this aspect, when the at least one electronic instrument 40 is started-up and the communication device communicates the delay period to the at least one electronic instrument 40, the timer in the at least one electronic instrument 40 will allow the delay period to elapse before any orientation measurements are recorded.

[00102] In one aspect, orientation data can be recorded while drilling is ceased and closest to time Tx, where Tx is preferably less than or equal to T-t, and where T is the time recorded by the at least one electronic instrument 40 (survey time) and t is the elapsed time recorded by the external communication device that was commenced once drilling ceased and the orientation data was recorded. In this exemplary aspect, it will be appreciated that the required recorded data may be at a time Tx greater than T-t, *i.e.*, if the drilling remained ceased after commencing the elapsed time and separating (breaking) the core sample from the rock was delayed while the at least one electronic instrument 40 recorded orientation data. Thus, Tx can be greater than T-t providing no drilling activity takes place after drilling ceases and before the core is broken from the underlying rock. In this aspect, in operation, when the core barrel head assembly 30 is retrieved back at the surface with the core sample), the external communication device interrogates the at least one electronic instrument 40 to identify the recorded core orientation data closest to T-t, *i.e.*, the timer of the external communication device is not synchronised to the timer of the at least one electronic instrument 40, and both timers are not commenced at a reference time.

[00103] For example and without limitation, orientation data may be recorded by the at least one electronic instrument 40 at regular irregular intervals of time within a

known range of allowed time intervals, such as one or more of 10s, 15s, 20s or 30s intervals within a range of 1s to 1 minute. It is contemplated that the time intervals can be generated by a random (time) number generator operating within the minimum and maximum allowed range. Thus, the time intervals for obtaining orientation data may be repeated (e.g. 10s, 10s, 10s, 20s, 20s, 10s…). In this exemplary aspect, data recording events ('shots') are therefore not constantly taken on a set time period. However, it is contemplated that predetermined set time intervals may be used. That is, the at least one electronic instrument 40 may record orientation data every time interval, preferably up until the core is broken form the underlying rock, though recording may also continue afterwards.

[00104] In operation, the at least one electronic instrument 40 can be deployed down hole. Optionally, the at least one electronic instrument 40 can be started at the surface and its timer commence the survey time timing at the surface, or the timer can have a delay to save power until the at least one electronic instrument 40 is all or partway down the borehole. Subsequently, when the core sample has been captured sufficiently in the core tube, drilling ceases and during this period of non-drilling, the at least one electronic instrument 40 records orientation data relating to its own orientation in the borehole, and therefore, of the associated core sample that is captured in the core barrel head assembly 30, which cannot rotate unless the at least one electronic instrument 40 also rotates. Next, the core sample is broken away from the underlying rock and the core barrel head assembly 30 is retrieved to the surface.

[00105] In one aspect, an external communication device can record the elapsed time t by a user, *i.e.*, commencing the timer in the handheld external communication device at the surface. This is preferably either when drilling has ceased or immediately before breaking the core from the rock while drilling has ceased, or immediately after the core is broken. However, it will be appreciated that the elapsed time can be commenced after the core is broken away from the underlying rock because the at least one electronic instrument 40 can be programmed to identify the nearest recorded data older than the commencement of the elapsed time that occurred during no drilling. In this aspect, the external communication device retains a record of the elapsing time.

[00106] When the at least one electronic instrument 40 and core barrel head assembly 30 containing the core sample are retrieved to the surface, the user can interrogate the at least one electronic instrument 40. In this aspect, once the at least one electronic instrument 40 confirms receiving the interrogation command, the communication device can command halting of the survey time T (stopping the at least one electronic instrument 40's timer) and elapsed time t (stopping the external communication device's timer). In this aspect, the external communication device can instruct the at least one electronic instrument 40 to identify the recorded orientation data from immediately before or after the commencement of the elapsed period of time going back from the end of the survey time, *i.e.*, the at least one electronic instrument 40 has to 'look back' in time for the data recorded at or around the elapsed ago. In this aspect, the at least one electronic instrument 40 subtracts the elapsed time t from its survey time T to provide a time Tx associated with the required recorded data obtained when drilling was ceased.

[00107] In this aspect, once the correct recorded orientation data is identified in its memory, the at least one electronic instrument can go into orientation mode so that the core sample can be orientated and that orientation recorded. In one exemplary aspect, recording of orientation data by the at least one electronic instrument 40 is triggered on a time interval basis; this may be by the regular or random time intervals mentioned above. Recording the orientation data may only commence once the time delay has ended. For example, the timer within the at least one electronic instrument 40 may be running from deployment (or before) of the device into the borehole. However, the delay may prevent the device from recording orientation data until the delay has ended. Once the delay has ended, orientation data is recorded according to the prevailing time interval sequence, *i.e.*, randomly generated time intervals or regular time intervals.

[00108] Optionally, when vibration or other motion of the at least one electronic instrument 40 stops down hole sufficiently, the at least one electronic instrument 40 may resume recording orientation data according to the prevailing time interval regime or may switch to another time interval regime for sensing and recording orientation.

[00109] Optionally, the at least one electronic instrument 40 can be programmed to identify core orientation data recorded before breaking of the core sample but based on an elapsed time period commenced after breaking the core sample. The at least one electronic instrument 40 can be programmed to identify the recorded orientation data that that was recorded before commencement of the elapsed time. In a further aspect, the recorded data can be recorded after breaking of the core sample because of the time interval recording regime. In this aspect, if that data set was recorded while nothing was moving down hole (and has not moved since breaking the core), the data set can be trusted to be sufficiently accurate. It can be compared with one or more previous data sets, and if they concur, then can be deemed sufficiently accurate for orientation purposes. Only one of those data sets is needed and any other of them may be discarded or disregarded.

[00110] In a further aspect, it is contemplated that operation of the at least one electronic instrument 40 to commence recording orientation data can be initiated at the surface and device then deployed into the borehole. Commencement of recording orientation data can also be delayed, so as to save battery power by avoiding taking unnecessary or unusable orientation measurements whilst the device is progressing down the borehole. Orientation measurement immediately before or after breaking the core sample from the underlying rock is/are required. In one exemplary aspect, the at least one electronic instrument 40 can have a delay preventing recording of orientation data until the delay ends.

[00111] In another aspect, the at least one electronic instrument 40 can take orientation measurements periodically, such as at random or regular periods of time, and record one or more of those measurements. Preferably the at least one electronic instrument 40 can be in a sleep mode, change to a power-up (wake-up) mode and then take a measurement, and re-enter sleep each interval. In one aspect, if two or more consecutive orientation measurements are the same, the at least one electronic instrument 40 can ignore, not record or delete from memory unnecessary repeat measurements and only retain one of the repeat measurements, preferably being the first of the identical measurements. In this aspect, each recorded measurement of

orientation can be tagged or 'time stamped', preferably relative to the timer running in the at least one electronic instrument 40, *i.e.*, the recorded orientation data is given a time stamp Tx, where x is the particular time within the survey timeframe running in the device. Thus, Tx is the time since the survey time T commenced that that orientation data set was recorded. It is contemplated that Tx can be a real time or cumulative time since commencement of the survey time T. Thus, in this aspect, the at least one electronic instrument 40 can have a real time clock type timer or a 'start-stop' (counter or stopwatch) type timer. When drilling ceases and the core is to be broken from the underlying rock (because there is sufficient core sample in the core barrel), a 'mark' is taken, which commences an elapsed time t at the surface. In this aspect, it is contemplated that this mark can be taken before or after the break at either regular or irregular time intervals.

[00112] Referring now to Figure 14, an exemplary known hand held device 400 which receives wirelessly receives data or signals from the communication means of the core barrel head assembly. In this aspect, communication means of the core barrel head assembly comprises a transmitter which can use line of sight data transfer through the window, such as by infra-red data transfer, or a wireless radio transmission. The communication device 400 can store the signals or data received from the communication means of the core barrel head assembly. In one aspect, the communication device 400 can comprise a display 402, navigation buttons 404, 406, and a data accept confirmation button 408.

[00113] In one aspect, setting up of the core barrel head assembly 30 can be carried out before insertion into the drill hole. Data retrieval can be carried out by infrared communication between the communication means of the core barrel head assembly and a core orientation data receiver or communication device 400. In this aspect, after recovering the core sample inner tube back at the surface, and before removing the core sample from the tube, the operator can optionally remove the head assembly. The operator can use the remote communication device to obtain orientation data from the communication means of the core barrel head assembly using a line of sight wireless infrared communication between the remote device and communication means of the core barrel head assembly. However, it will be appreciated that communication of data

between the communication means of the core barrel head assembly and the communication device 400 can be by other wireless means, such as by radio transmission.

[00114] In this prior art aspect, the whole inner tube, core sample, and core barrel head assembly can be rotated as necessary to determine a required orientation of the core sample. The indicators on the proximal end of the core barrel head assembly indicate to the operator which direction, clockwise or anti-clockwise, to rotate the core sample. One color of indicator can be used to indicate clockwise rotation and another color can be used to indicate anticlockwise rotation is required. This is carried out until the core sample is oriented with its lower section at the lower end of the tube. The core sample is then marked for correct orientation and then used for analysis.

[00115] In one aspect, it is contemplated that the visual and/or audible orientation indicators, under certain site and/or environmental conditions, may not be sufficiently visible or audible. Thus, an additional or alternative means and/or method may be utilized to ensure that the core sample has been correctly oriented. In this embodiment, the exterior surface 61 of the body of the core barrel head assembly 30 can have angular degree marks that optionally are scribed/ etched, machined, molded or otherwise provided, such as by printing or painting, on the exterior surface 61. For example, dashes can be equally spaced around the outside parameter represent one or more angular degrees of the full circle or perimeter. Further scribing of a number every five dashes starting with the number 0 then 5, 10, 15 etc. until 355.

[00116] When the core is retrieved and the communication means of the core barrel head assembly communicates with the hand held communicator 400, additional information can be transmitted from the core barrel head assembly to the communicator 400, such as a number between zero 0 and 359 (inclusive) denoting an angular degree of rotation of core barrel head assembly and the core sample. When the core is oriented during one or more embodiments of the method of the present invention, the numerical scribing the core barrel head assembly should be the same as the number transmitted, to the communicator 400, which re-confirms correct orientation. Thus, if the visual or audible means for indicating core orientation are not useful or available, then

the core can be oriented using the angular degree arrangement to match the transmitted number, and then can be audited using the communicator 400.

[00117] Embodiments of the present invention provide the advantage of a fully operating down hole core barrel head assembly without having to disconnect or disassemble any part of the tool/device from the inner tube and/or from the head assembly or any other part of the drilling assembly that the core barrel head assembly would need to be assembled within for its normal operation. Disconnecting or disassembling the core barrel head assembly from the head assembly and/or inner tube risks failure of seals at those connections and/or risks cross threading of the joining thread. Also, because those sections are threaded together with high force, it takes substantial manual force and large equipment to separate the sections. High surrounding pressure in the drill hole means that the connecting seals between sections function to prevent water and dirt from ingressing into and damaging the device.

[00118] Although several embodiments of the invention have been disclosed in the foregoing specification, it is understood by those skilled in the art that many modifications and other embodiments of the invention will come to mind to which the invention pertains, having the benefit of the teaching presented in the foregoing description and associated drawings. It is thus understood that the invention is not limited to the specific embodiments disclosed hereinabove, and that many modifications and other embodiments are intended to be included within the scope of the appended claims. Moreover, although specific terms are employed herein, as well as in the claims which follow, they are used only in a generic and descriptive sense, and not for the purposes of limiting the described invention, nor the claims which follow.

What is claimed is:

1. A core barrel head assembly having an exterior surface and comprising:

a first interior cavity;

a selectively sealed interior cavity spaced distally from the first interior cavity and having a closed proximal end;

a threaded proximal end portion for coupling to a wire line retrieval portion of a head assembly;

a base portion, wherein the first interior cavity extends distally from the threaded proximal end portion to the base portion;

a window that extends from the exterior surface into optical communication with the sealed interior cavity proximate the closed proximal end of the sealed interior cavity;

at least one electronic instrument that is configured to obtain core orientation data, wherein the at least one electronic instrument comprises at least one digital and/or electro-mechanical sensor in a core orientation data recording tool; and

a transmitter configured to transmit core orientation data,

wherein the sealed interior cavity is sized and shaped to enclose the at least one electronic instrument.

2. The core barrel head assembly of Claim 1, further comprising:

a port positioned proximate the base portion and extending from the exterior surface into fluid communication with the first interior cavity; and

a grease fitting mounted in the port to allow for selective passage of grease or other lubricant to and from the exterior surface of the barrel head assembly into communication with the first interior cavity.

3. The core barrel head assembly of Claim 1, wherein the sealed interior cavity is sized and shaped to hermetically enclose the transmitter.

4. The core barrel head assembly of Claim 1, further comprising an orientation indicator module comprising a light emitter.

5. The core barrel head assembly of Claim 4, wherein the core barrel head assembly comprises a plurality of windows that extend from the exterior surface into optical communication with the sealed interior cavity proximate the closed proximal end of the sealed interior cavity, wherein the orientation indicator module is sized and shaped to sealingly close the sealed interior cavity from any intrusion of pressurized fluid into the sealed interior cavity via the plurality of windows.

6. The core barrel head assembly of Claim 5, wherein the orientation indicator module is configured to orient or otherwise position the plurality of light emitters so that each light emitter underlies one window.

7. The core barrel head assembly of Claim 6, wherein the orientation indicator module further comprises at least one first O-ring seal for preventing any pressurized fluid from entering the sealed interior cavity from the plurality of windows, wherein the at least one first O-ring seal is mounted on an exterior portion of the orientation indicator module and is configured to seal between an exterior portion of the orientation indicator module and a portion of an interior surface of the sealed interior cavity.

8. The core barrel head assembly of Claim 1, further comprising an open and threaded distal end portion, wherein the sealed interior cavity extends distally to the open and threaded distal end portion of the core barrel head assembly.

9. The core barrel head assembly of Claim 8, further comprising a seal coupler that is configured to be sealingly received in the open threaded distal end portion of the core barrel head assembly.

10. The core barrel head assembly of Claim 9, further comprising at least one second O-ring seal for preventing any pressurized fluid from entering the sealed interior cavity, wherein the at least one second O-ring seal is mounted on a portion of the seal coupler and is configured to seal between a portion of the seal coupler and a portion of an interior surface of the open and threaded distal end portion of the core barrel head assembly.

11. The core barrel head assembly of Claim 6, further comprising a check valve assembly configured to affect a hermetical seal of the sealed interior cavity and to provide fluid control for wire line operation.

12. The core barrel head assembly of Claim 11, wherein the check valve assembly comprises a coupled proximal end assembly and a distally tapered seat that defines an interior chamber for operative receipt of a check ball.

13. The core barrel head assembly of Claim 12, further comprising a distal end portion, wherein the proximal end assembly of the check valve assembly defines a female threaded coupling that is configured to be threadably coupled to male threads defined on an exterior surface of the distal end portion of the core barrel head assembly.

14. The core barrel head assembly of Claim 12, wherein the interior chamber of the check valve assembly extends to a distal end of the check valve assembly, and wherein the check valve assembly further defines at least one port that extends from an exterior surface of the check valve assembly and is in fluid communication with the interior chamber of the check valve assembly.

15. The core barrel head assembly of Claim 14, wherein the interior chamber has a distally tapered seat that is adapted to selectively receive the check ball that is sized to selectively block the distally tapered seat.

16. The core barrel head assembly of Claim 15, wherein the interior chamber is sized and shaped to allow the check ball to selectively move axially between an open position, in which the check ball is spaced proximally away from the surface of the tapered seat so that pressurized fluid can move through the distal end of the check valve assembly and subsequently through the interior chamber to exit out of the at least one port, and a closed position, in which the check ball is pressurized against the surface of the tapered seat so that pressurized fluid cannot move through the check valve assembly.

17. The core barrel head assembly of Claim 1, wherein the exterior surface defines a plurality of female planar stops.

18. The core barrel head assembly of Claim 1, wherein the at least one electronic instrument is programmed to obtain orientation data when the at least one electronic instrument senses no relative movement of the at least one electronic instrument.

19. The core barrel head assembly of Claim 18, wherein the at least one electronic instrument is programmed to obtain orientation data when the at least one electronic instrument senses no vibrations, and wherein the at least one electronic instrument is programmed to not obtain orientation data when the at least one electronic instrument determines that the core barrel head assembly is in motion while descending down or ascending up the hole and during drilling.

20. The core barrel head assembly of Claim 1, wherein the at least one electronic instrument is programmed to obtain orientation data based on a predetermined time interval scheme.

21. The core barrel head assembly of Claim 1, wherein the at least one electronic instrument is configured to obtain orientation data at random periods of time.

22. The core barrel head assembly of Claim 1, wherein the at least one electronic instrument is programmed to:

record orientation data relating to an orientation of the at least electronic instrument in a borehole; and

receive an interrogation command from an external communication device.

23. The core barrel head assembly of Claim 1, wherein the transmitter is configured to transmit core orientation data to a remote device through the window.

24. The core barrel head assembly of Claim 4, wherein the light emitter underlies the window, and wherein following retrieval of the core barrel head assembly from down a borehole, the light emitter is configured to provide a visual indication that a desired rotational orientation of the core barrel head assembly has been achieved.

25. The core barrel head assembly of Claim 24, wherein the light emitter is further configured to provide a visual indication that further rotation of the core barrel head assembly is required to reach the desired rotational orientation.

ABSTRACT

A core barrel head assembly having at least one electronic instrument that is configured to obtain orientation data; a power source; and a communication means to receive and/or transmit orientation data for use in a core sample down hole surveying and sample orientation system that is configured to provide an indication of the orientation of a core sample relative to a body of material from which the core has been extracted, and also to a method of core sample orientation identification..

REFLEX EXHIBIT 1002 - 287/304

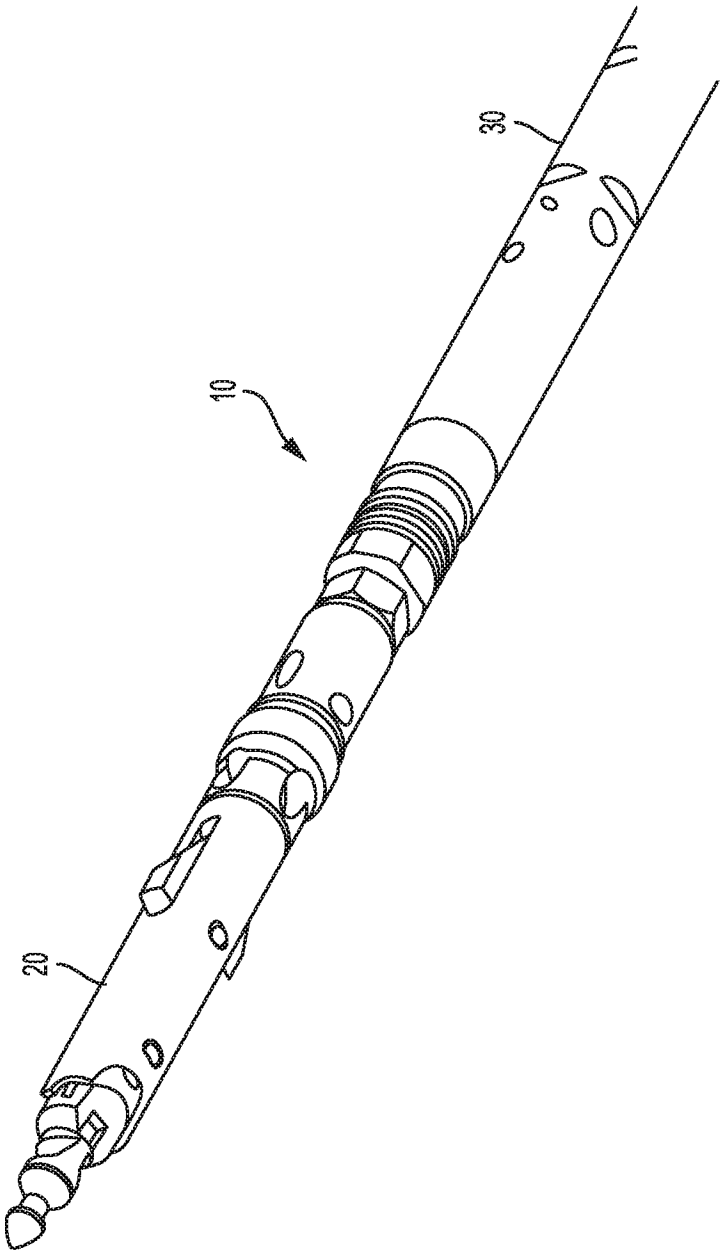


FIG. 1

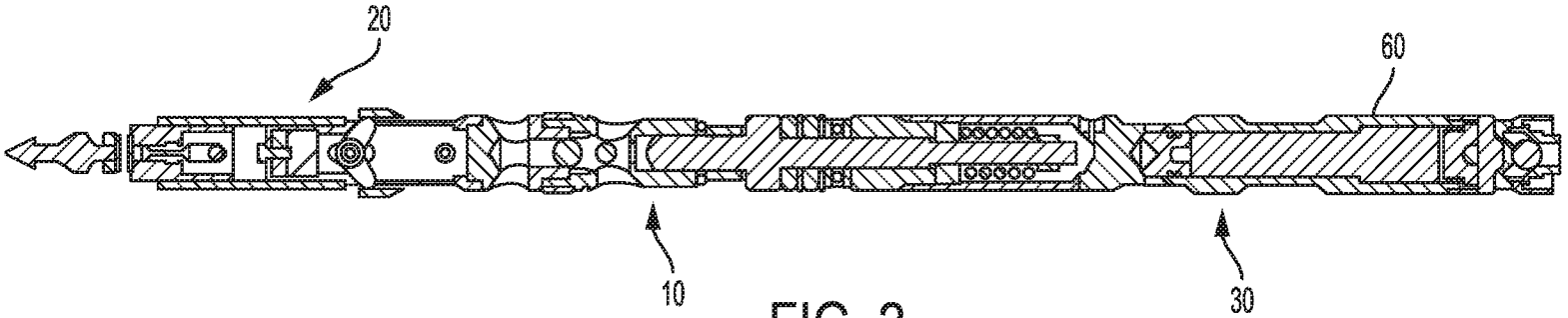

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FIG. 2

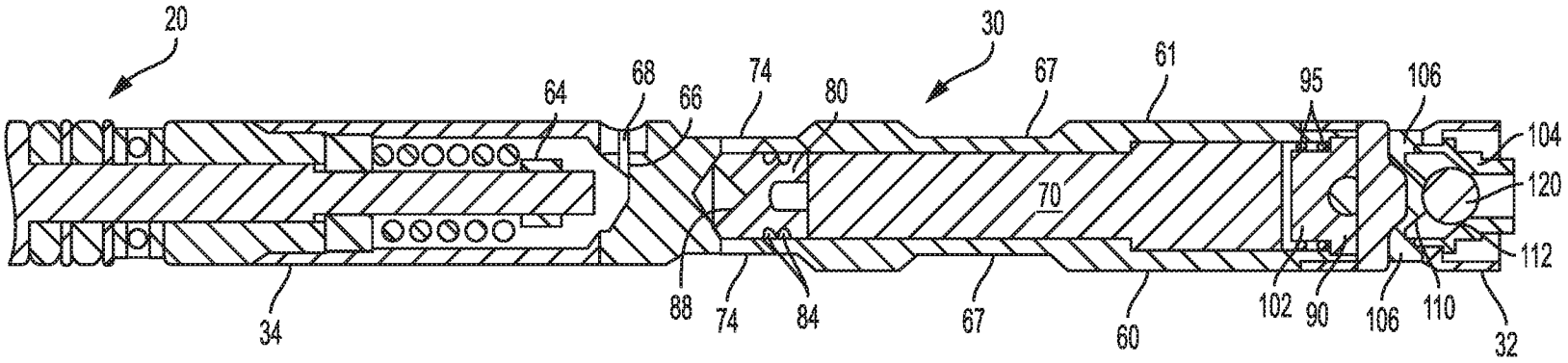

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FIG. 3

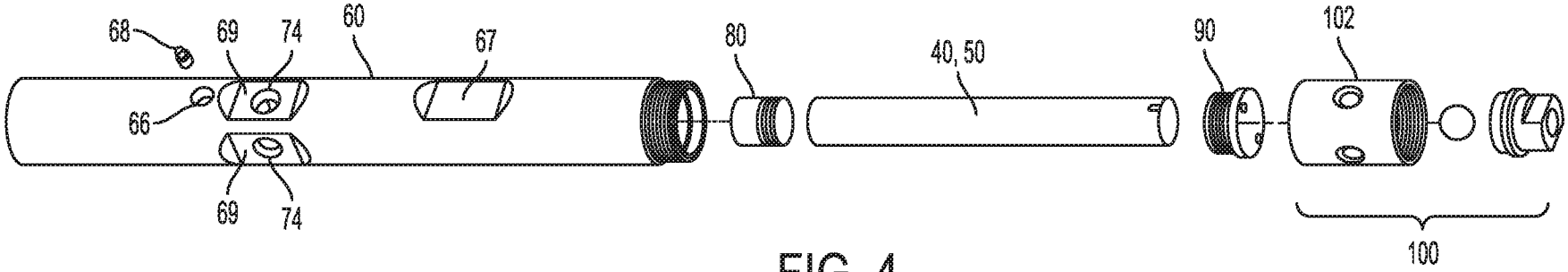

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FIG. 4

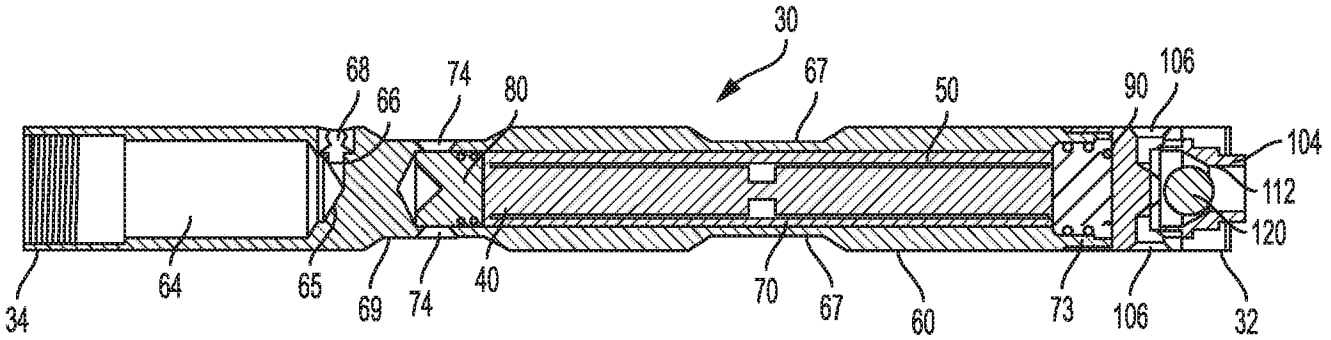

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FIG. 5

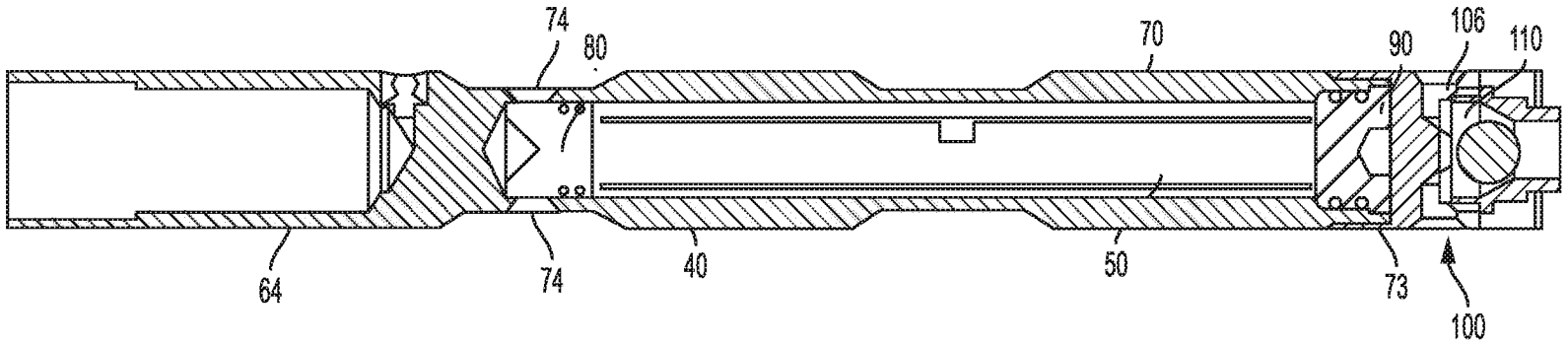


FIG. 6

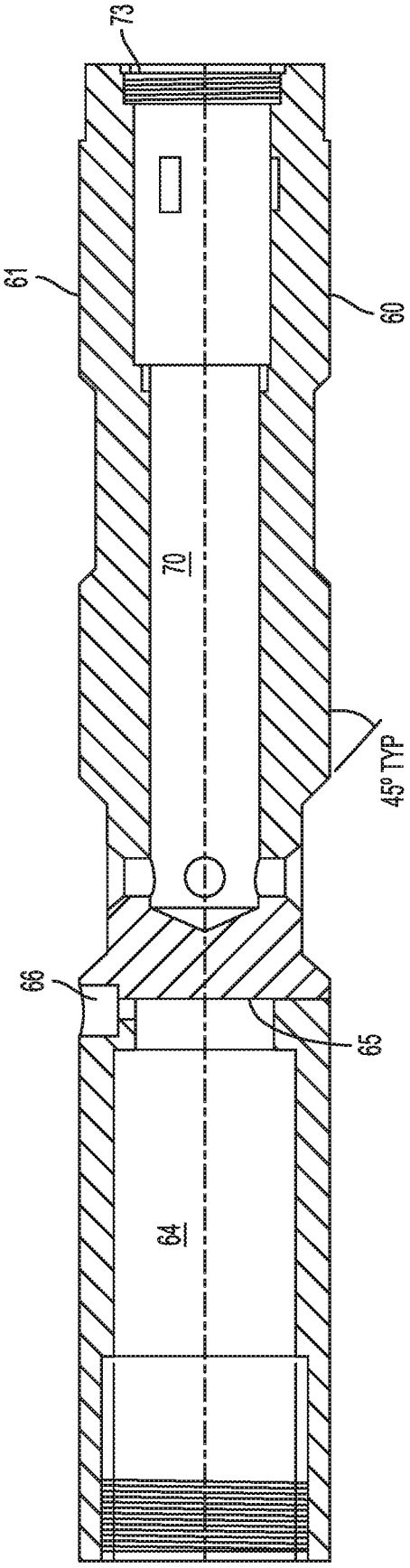


FIG. 7

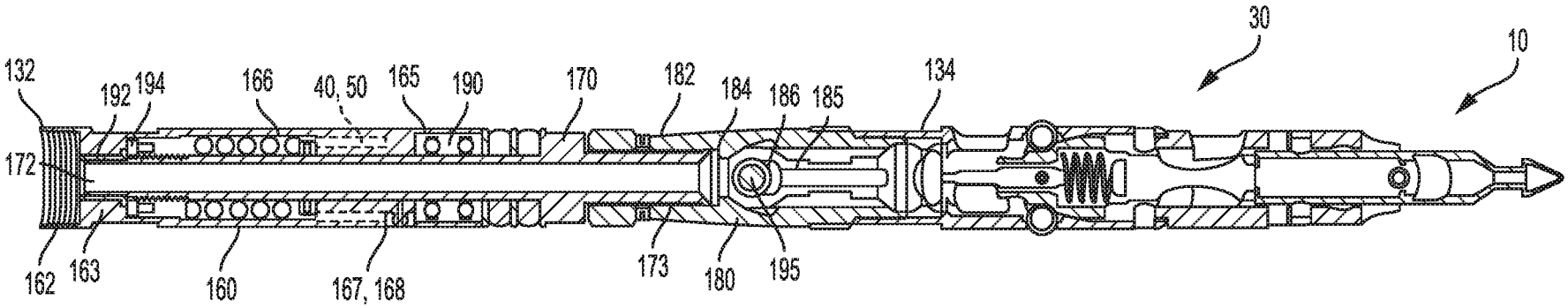

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FIG. 8

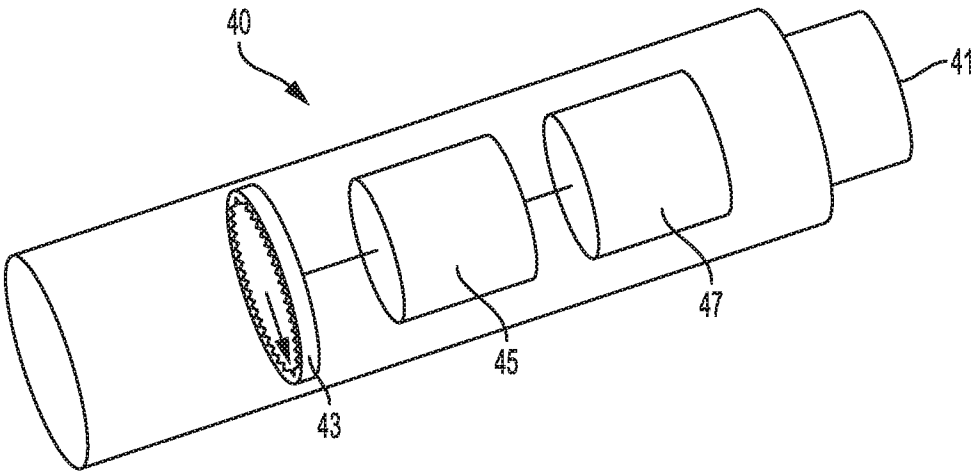


FIG. 9

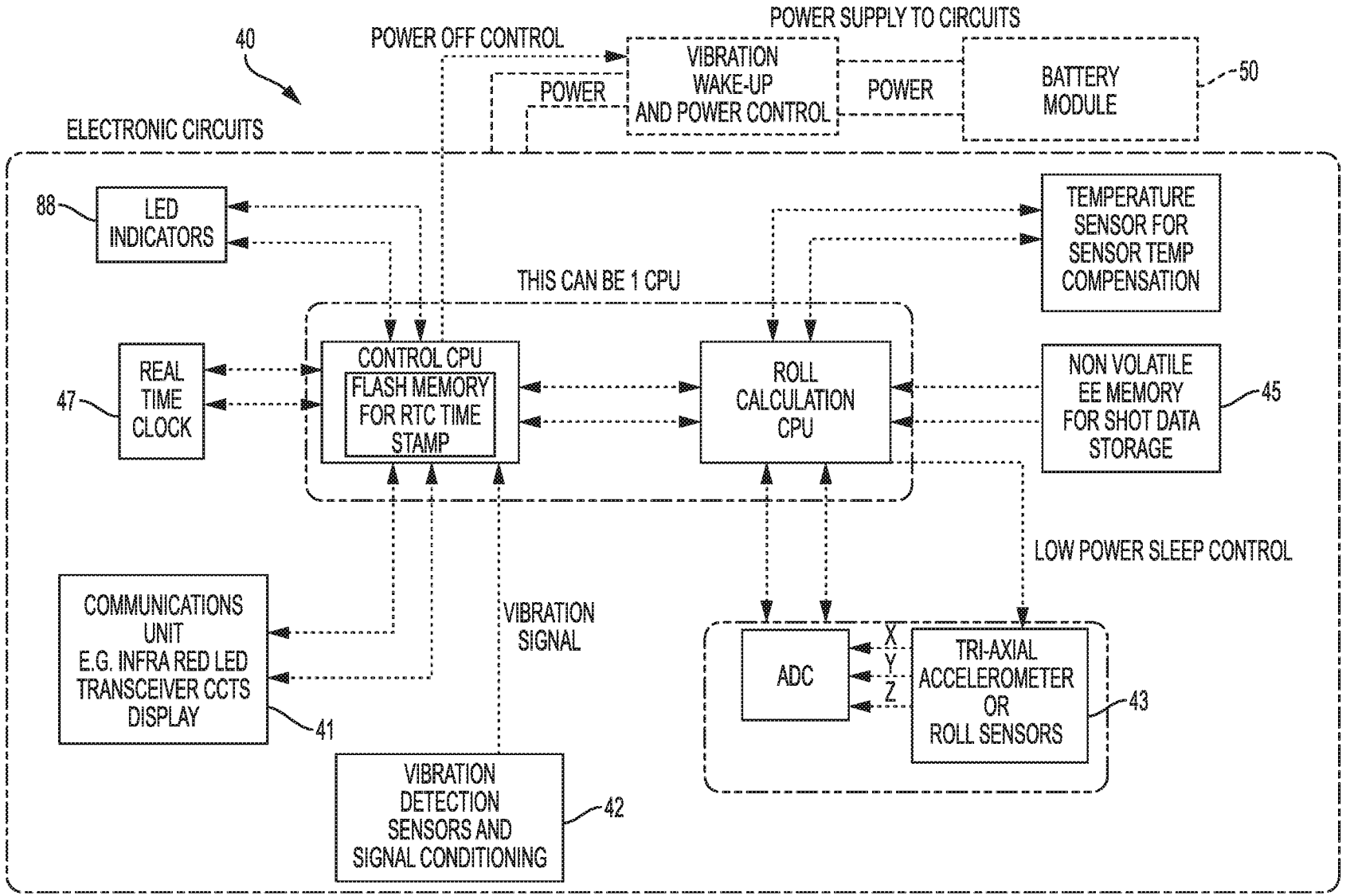

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POWER OFF CONTROL
POWER SUPPLY TO CIRCUITS
POWER
VIBRATION WAKE-UP AND POWER CONTROL
POWER
BATTERY MODULE
50
ELECTRONIC CIRCUITS
88
LED INDICATORS
TEMPERATURE SENSOR FOR SENSOR TEMP COMPENSATION
THIS CAN BE 1 CPU
47
REAL TIME CLOCK
CONTROL CPU
FLASH MEMORY FOR RTC TIME STAMP
ROLL CALCULATION CPU
NON VOLATILE EE MEMORY FOR SHOT DATA STORAGE
45
LOW POWER SLEEP CONTROL
COMMUNICATIONS UNIT E.G. INFRA RED LED TRANSCEIVER CCTS DISPLAY
41
VIBRATION SIGNAL
ADC
X
Y
Z
TRI-AXIAL ACCELEROMETER OR ROLL SENSORS
43
VIBRATION DETECTION SENSORS AND SIGNAL CONDITIONING
42

FIG. 10

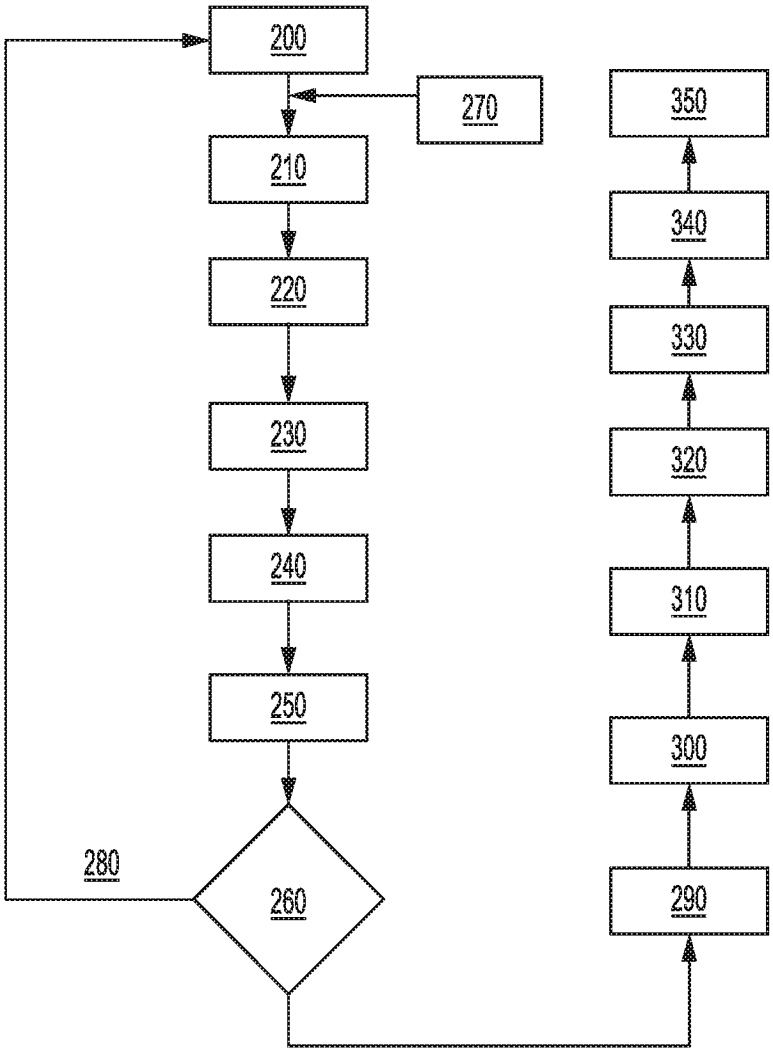


FIG. 11

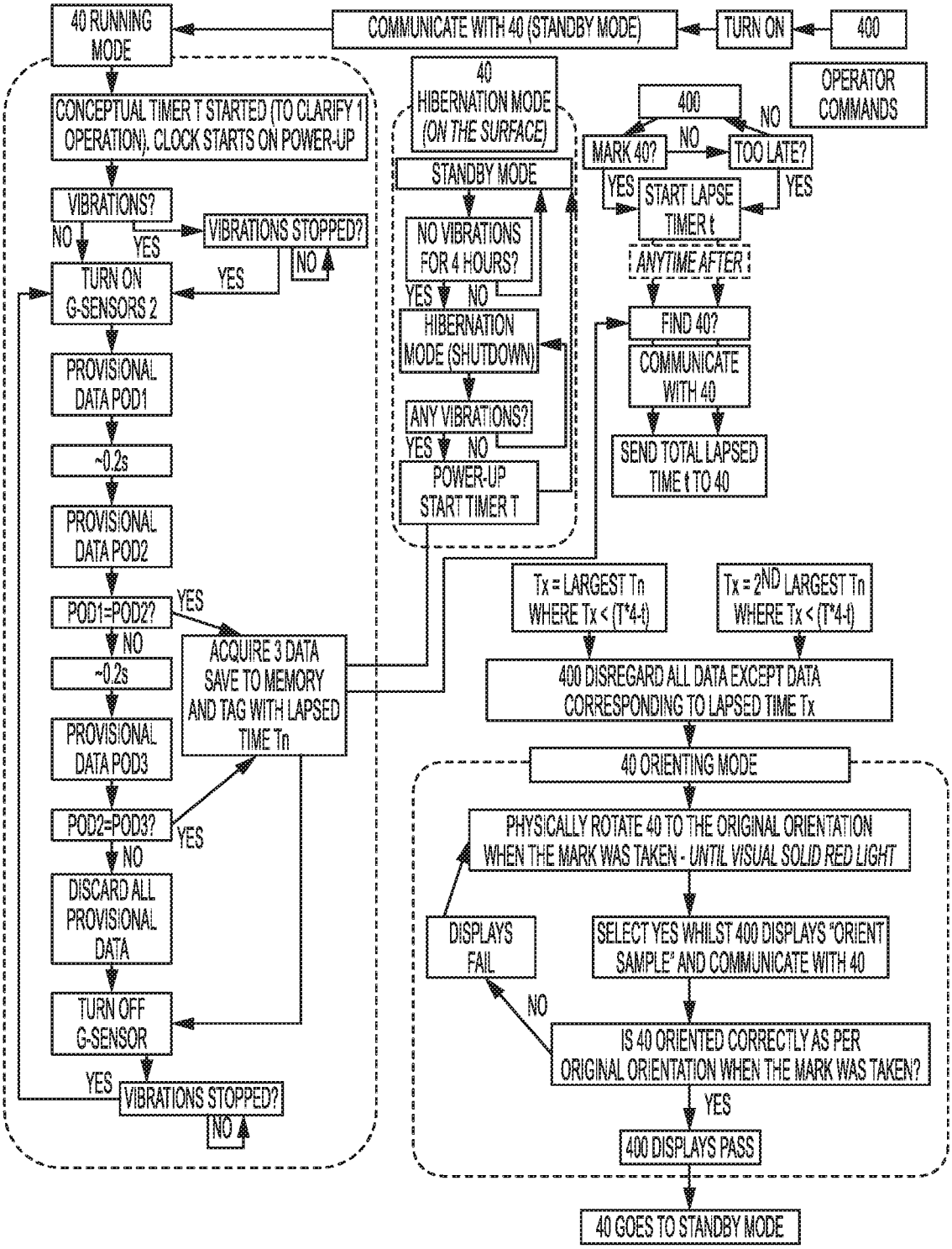

40 RUNNING MODE
COMMUNICATE WITH 40 (STANDBY MODE)
TURN ON
400
CONCEPTUAL TIMER T STARTED (TO CLARIFY 1 OPERATION). CLOCK STARTS ON POWER-UP
40 HIBERNATION MODE (ON THE SURFACE)
OPERATOR COMMANDS
400
NO
MARK 40?
NO
TOO LATE?
YES
YES
START LAPSE TIMER t
ANYTIME AFTER
VIBRATIONS?
NO
YES
VIBRATIONS STOPPED?
NO
YES
TURN ON G-SENSORS 2
STANDBY MODE
NO VIBRATIONS FOR 4 HOURS?
YES
NO
HIBERNATION MODE (SHUTDOWN)
ANY VIBRATIONS?
YES
NO
POWER-UP START TIMER T
FIND 40?
COMMUNICATE WITH 40
SEND TOTAL LAPSED TIME t TO 40
PROVISIONAL DATA POD1
~0.2s
PROVISIONAL DATA POD2
POD1=POD2?
YES
NO
~0.2s
ACQUIRE 3 DATA SAVE TO MEMORY AND TAG WITH LAPSED TIME Tn
PROVISIONAL DATA POD3
POD2=POD3?
YES
NO
DISCARD ALL PROVISIONAL DATA
TURN OFF G-SENSOR
YES
VIBRATIONS STOPPED?
NO
Tx = LARGEST Tn WHERE Tx < (T*4-t)
Tx = 2ND LARGEST Tn WHERE Tx < (T*4-t)
400 DISREGARD ALL DATA EXCEPT DATA CORRESPONDING TO LAPSED TIME Tx
40 ORIENTING MODE
PHYSICALLY ROTATE 40 TO THE ORIGINAL ORIENTATION WHEN THE MARK WAS TAKEN - UNTIL VISUAL SOLID RED LIGHT
DISPLAYS FAIL
SELECT YES WHILST 400 DISPLAYS "ORIENT SAMPLE" AND COMMUNICATE WITH 40
NO
IS 40 ORIENTED CORRECTLY AS PER ORIGINAL ORIENTATION WHEN THE MARK WAS TAKEN?
YES
400 DISPLAYS PASS
40 GOES TO STANDBY MODE

FIG. 12

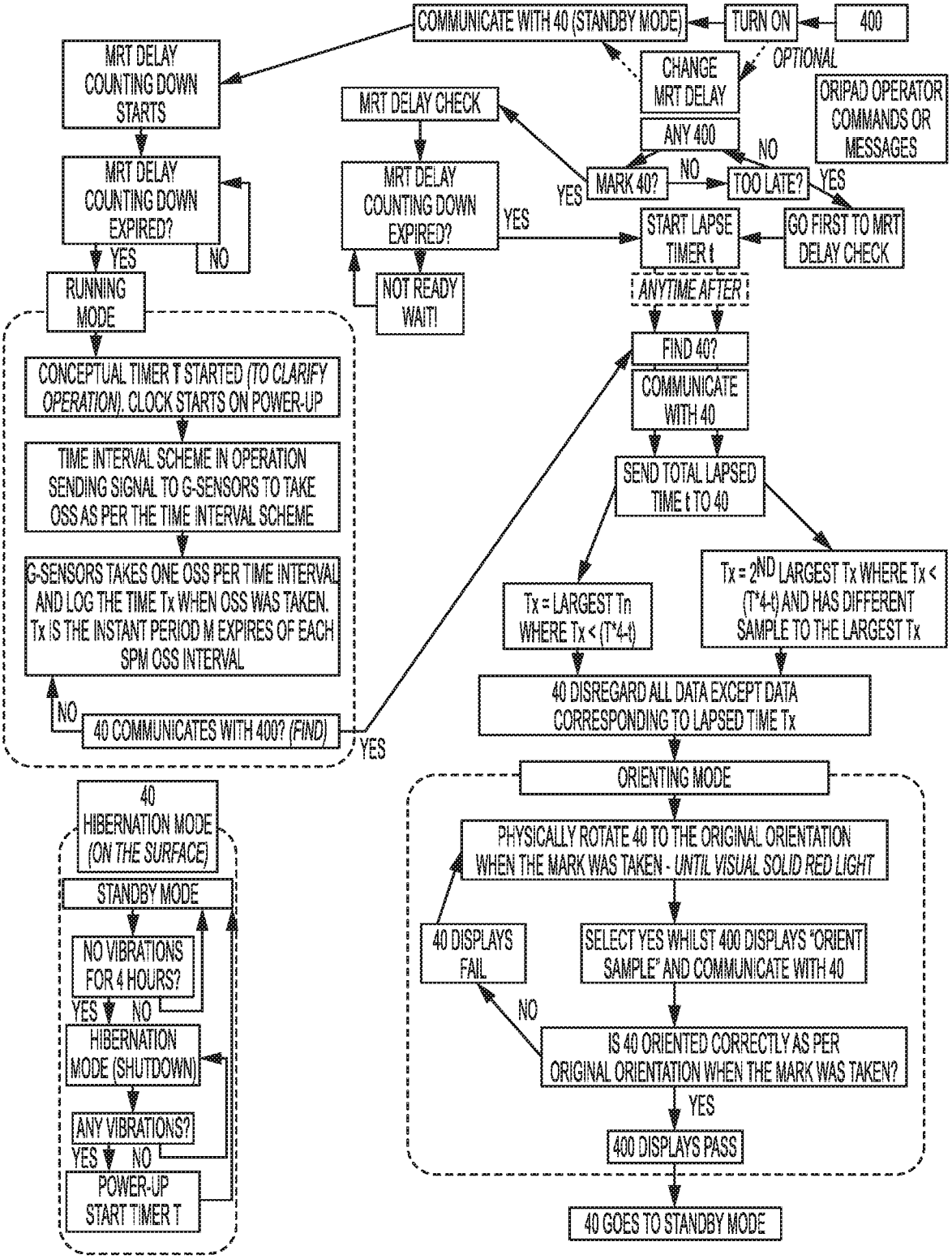

COMMUNICATE WITH 40 (STANDBY MODE)
TURN ON
400
OPTIONAL
CHANGE MRT DELAY
ORIPAD OPERATOR COMMANDS OR MESSAGES
MRT DELAY COUNTING DOWN STARTS
MRT DELAY CHECK
ANY 400
NO
MRT DELAY COUNTING DOWN EXPIRED?
MRT DELAY COUNTING DOWN EXPIRED?
YES
MARK 40?
NO
TOO LATE?
YES
YES
START LAPSE TIMER t
GO FIRST TO MRT DELAY CHECK
NO
NOT READY WAIT!
ANYTIME AFTER
RUNNING MODE
FIND 40?
COMMUNICATE WITH 40
CONCEPTUAL TIMER T STARTED (TO CLARIFY OPERATION). CLOCK STARTS ON POWER-UP
TIME INTERVAL SCHEME IN OPERATION SENDING SIGNAL TO G-SENSORS TO TAKE OSS AS PER THE TIME INTERVAL SCHEME
SEND TOTAL LAPSED TIME t TO 40
G-SENSORS TAKES ONE OSS PER TIME INTERVAL AND LOG THE TIME Tx WHEN OSS WAS TAKEN. Tx IS THE INSTANT PERIOD M EXPIRES OF EACH SPM OSS INTERVAL
Tx = LARGEST Tn WHERE Tx < (T*4-t)
Tx = 2ND LARGEST Tx WHERE Tx < (T*4-t) AND HAS DIFFERENT SAMPLE TO THE LARGEST Tx
NO
40 COMMUNICATES WITH 400? (FIND)
YES
40 DISREGARD ALL DATA EXCEPT DATA CORRESPONDING TO LAPSED TIME Tx
ORIENTING MODE
40 HIBERNATION MODE (ON THE SURFACE)
PHYSICALLY ROTATE 40 TO THE ORIGINAL ORIENTATION WHEN THE MARK WAS TAKEN - UNTIL VISUAL SOLID RED LIGHT
STANDBY MODE
40 DISPLAYS FAIL
SELECT YES WHILST 400 DISPLAYS "ORIENT SAMPLE" AND COMMUNICATE WITH 40
NO VIBRATIONS FOR 4 HOURS?
YES
NO
NO
HIBERNATION MODE (SHUTDOWN)
IS 40 ORIENTED CORRECTLY AS PER ORIGINAL ORIENTATION WHEN THE MARK WAS TAKEN?
ANY VIBRATIONS?
YES
NO
YES
POWER-UP START TIMER T
400 DISPLAYS PASS
40 GOES TO STANDBY MODE

FIG. 13

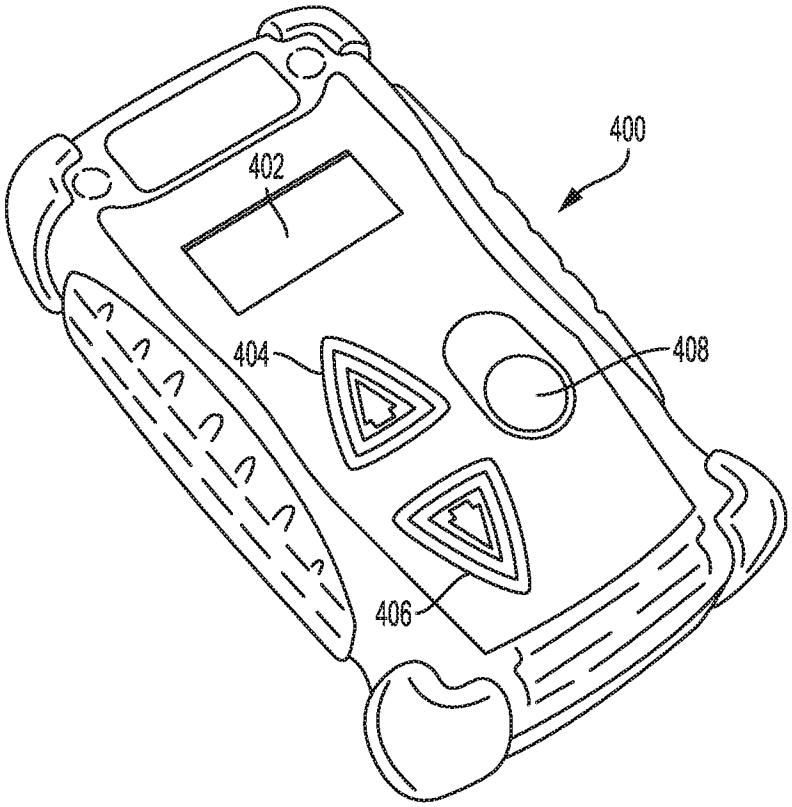


FIG. 14

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME
First Named Inventor/Applicant Name:	CHRISTOPHER L. DRENTH
Filer:	Joseph P. Anderson/Sharon DeLee
Attorney Docket Number:	36362.0150U4

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	300	300
UTILITY SEARCH FEE	1111	1	660	660
UTILITY EXAMINATION FEE	1311	1	760	760
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	1202	5	100	500
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2220**

Electronic Acknowledgement Receipt

EFS ID:	37319994
Application Number:	16588026
International Application Number:	
Confirmation Number:	7130
Title of Invention:	CORE BARREL HEAD ASSEMBLY WITH AN INTEGRATED SAMPLE ORIENTATION TOOL AND SYSTEM FOR USING SAME
First Named Inventor/Applicant Name:	CHRISTOPHER L. DRENTH
Customer Number:	23859
Filer:	Joseph P. Anderson/Sharon DeLee
Filer Authorized By:	Joseph P. Anderson
Attorney Docket Number:	36362.0150U4
Receipt Date:	30-SEP-2019
Filing Date:	
Time Stamp:	16:00:40
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$2220
RAM confirmation Number	E20199TG01172653
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1	Authorization for Extension of Time all replies	36362_0150U4_Authorization_to_Treat.PDF	105975 b17c6bb1abe444322f514805acd27b049781faa8	no	1
Warnings:					
Information:					
2	Application Data Sheet	36362_0150U4_ADS.pdf	129834 a2a750de354a3a6394dce6f41b6e254e43d5bd9f	no	10
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
3	Oath or Declaration filed	36362_0150U4_Declarations.PDF	289722 bc99b865efd3e990431d00ea6faab1acfb1f3f53	no	3
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4		36362_0150U4_Application.PDF	271319 74443450984da8dd7414e3a991ad1ce6b0532ce5	yes	37

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Specification	1	32
	Claims	33	36
	Abstract	37	37

Warnings:	
Information:	

5	Drawings-only black and white line drawings	36362_0150U4_Figures.pdf	1297847 faf285186a7b565bae8a6071dcd1381057832eb7	no	12
Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	36541 897b2ac30c30ec13b1e1dede68f60f439bc0aca3	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2131238		

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National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

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