

EX-1002

File History of U.S. Patent No. 12,460,537 B2 (U.S. Application No. 17/549,519)

Assembled from the USPTO Patent Center Image File Wrapper; documents in chronological order. Index below.

Date	Doc code	Description	EX-1002 page
2021-12-13	IDS	Information Disclosure Statement (IDS) Form (SB08)	3
2021-12-13	PA..	Power of Attorney	7
2021-12-13	OATH	Oath or Declaration filed	9
2021-12-13	WFEE	Fee Worksheet (SB06)	12
2021-12-13	ABST	Abstract	14
2021-12-13	CLM	Claims	15
2021-12-13	SPEC	Specification	20
2021-12-13	N417	Electronic Filing System Acknowledgment Receipt	36
2021-12-13	ADS	Application Data Sheet	39
2021-12-13	DRW	Drawings-only black and white line drawings	47
2021-12-28	APP.FILE.REC	Filing Receipt	50
2021-12-28	WFEE	Fee Worksheet (SB06)	54
2021-12-28	NTC.MISS.PRT	Notice to File Missing Parts	55
2022-01-01	PEFR	Applicant Response to Pre-Exam Formalities Notice	57
2022-01-01	PEFR	Applicant Response to Pre-Exam Formalities Notice	58
2022-01-01	WFEE	Fee Worksheet (SB06)	60
2022-01-01	N417	Electronic Filing System Acknowledgment Receipt	62
2022-01-04	APP.FILE.REC	Filing Receipt	64
2022-01-04	WFEE	Fee Worksheet (SB06)	68
2022-01-05	C.AD.PAIR	Change of Address via Patent Application Information Retrieval (PAIR)	69
2022-01-05	MF.AD.PAIR	Maintenance Fee Address Change for PAIR	70
2022-06-08	OATH	Oath or Declaration filed	71
2023-02-27	IDS	Information Disclosure Statement (IDS) Form (SB08)	88
2023-02-27	N417	Electronic Filing System Acknowledgment Receipt	92
2023-02-27	REF.OTHER	Other reference-Patent/Application/Search Documents	94
2023-06-15	NTC.PUB	Notice of Publication	104
2023-10-30	3P.RELEVANCE	Concise Description of Relevance	105
2023-10-30	N417	Electronic Filing System Acknowledgment Receipt	126
2023-10-30	3P.RELEVANCE	Concise Description of Relevance	128
2023-10-30	IDS.3P	Third-Party Submission Under 37 CFR 1.290	149
2023-10-30	3P.RELEVANCE	Concise Description of Relevance	151
2023-11-01	M327	Miscellaneous Communication to Applicant - No Action Count	153
2024-03-13	N417	Electronic Filing System Acknowledgment Receipt	155
2024-03-13	R3.73	Assignee showing of ownership per 37 CFR 3.73	157
2024-03-13	PA..	Power of Attorney	160
2024-03-13	ADS	Application Data Sheet	161
2024-03-20	N572	Response - Re: Informal Power of Attorney (PTOL-308)	169
2024-03-20	PA..	Power of Attorney	171
2024-03-20	ADS	Application Data Sheet	172
2024-03-20	R3.73	Assignee showing of ownership per 37 CFR 3.73	180
2024-03-20	N417	Electronic Filing System Acknowledgment Receipt	183
2024-03-28	N570	Communication - Re: Power of Attorney (PTOL-308)	185
2024-03-28	N570	Communication - Re: Power of Attorney (PTOL-308)	186
2024-03-28	APP.FILE.REC	Filing Receipt	187
2024-06-14	892	List of references cited by examiner	191
2024-06-14	FWCLM	Index of Claims	192
2024-06-14	SRFW	Search information including classification, databases and other search	193
2024-06-14	SRNT	Examiner's search strategy and results	194
2024-06-14	1449	List of References cited by applicant and considered by examiner	199
2024-06-14	BIB	Bibliographic Data Sheet	203

EX-1002 — Index (continued)

Date	Doc code	Description	EX-1002 page
2024-06-14	1449	List of References cited by applicant and considered by examiner	204
2024-06-14	1449	List of References cited by applicant and considered by examiner	208
2024-06-14	CTNF	Non-Final Rejection	210
2024-06-18	WELCOME.LET2	Welcome Letter from USPTO Commissioner	225
2024-09-17	WFEE	Fee Worksheet (SB06)	226
2024-09-17	APP.TEXT	Application body structured text document	227
2024-09-17	N417.PYMT	Electronic Fee Payment	242
2024-09-17	XT/	Extension of Time	244
2024-09-17	N417	Electronic Filing System Acknowledgment Receipt	246
2024-09-17	A...	Amendment/Request for Reconsideration-After Non-Final Rejection	248
2024-09-17	CLM	Claims	249
2024-09-17	REM	Applicant Arguments/Remarks Made in an Amendment	255
2025-02-04	892	List of references cited by examiner	262
2025-02-04	FWCLM	Index of Claims	263
2025-02-04	SRNT	Examiner's search strategy and results	264
2025-02-04	CTFR	Final Rejection	271
2025-05-05	WFEE	Fee Worksheet (SB06)	288
2025-05-05	APP.TEXT	Application body structured text document	289
2025-05-05	AMSB	Amendment Submitted/Entered with Filing of Continued Prosecution Applica	303
2025-05-05	CLM	Claims	304
2025-05-05	REM	Applicant Arguments/Remarks Made in an Amendment	311
2025-05-05	RCEX	Request for Continued Examination (RCE)	317
2025-05-05	N417	Electronic Filing System Acknowledgment Receipt	320
2025-05-05	N417.PYMT	Electronic Fee Payment	322
2025-07-11	NOA	Notice of Allowance and Fees Due (PTOL-85)	324
2025-07-11	FWCLM	Index of Claims	335
2025-07-11	SRFW	Search information including classification, databases and other search	336
2025-07-11	IIFW	Issue Information including classification, examiner, name, claim, renum	337
2025-07-11	SRNT	Examiner's search strategy and results	340
2025-10-10	N417	Electronic Filing System Acknowledgment Receipt	350
2025-10-10	N417.PYMT	Electronic Fee Payment	352
2025-10-10	IFEE	Issue Fee Payment (PTO-85B)	354
2025-10-10	REM	Applicant Arguments/Remarks Made in an Amendment	357
2025-10-14	1449	List of References cited by applicant and considered by examiner	359
2025-10-22	ISSUE.NTF	Issue Notification	360
2025-11-04	EGRANT.PDF	Digitally signed official patent eGrant document	362
2025-11-04	EGRANT.NTF	eGrant day-of Notification	377

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		2021-12-13
	First Named Inventor	Terry Treiberg	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	CHX.1002US	

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	1	20200263531	A1	2020-08-20	4iiii Innovations Inc	
	2	20130181844	A1	2013-07-18	Weatherford Technology Holdings LLC	
	3	20190203579	A1	2019-07-04	Walter Phillips	
	4	20200340309	A1	2020-10-29	Norris Rods Inc	

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**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number		
Filing Date		2021-12-13
First Named Inventor	Terry Treiberg	
Art Unit		
Examiner Name		
Attorney Docket Number	CHX.1002US	

1							
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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	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, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
1		International Search Report and Written Opinion, mailed 15 October 2015 in corresponding International Application No. PCT/US2015/032766 with International Filing Date of 27 May 2015.	

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EXAMINER SIGNATURE

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

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2021-12-13
First Named Inventor	Terry Treiberg
Art Unit	
Examiner Name	
Attorney Docket Number	CHX.1002US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Gregory Baker/	Date (YYYY-MM-DD)	2021-12-13
Name/Print	Gregory Baker	Registration Number	61,335

This collection of information is required by 37 CFR 1.97 and 1.98. 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 1 hour 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.**

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 the Freedom of Information Act requires disclosure of these records.
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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.
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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)).
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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 inspections 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.

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	
Filing Date	12-13-2021
First Named Inventor	Terry Treiberg
Title	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE
Art Unit	
Examiner Name	
Attorney Docket Number	CHX.1002US

SIGNATURE of Applicant or Patent Practitioner

Signature	/Gregory C. Baker/	Date (Optional)	
Name	Gregory C. Baker	Registration Number	61,335
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

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 _____ 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.**

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

102983

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☒ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name

Address

City

State

Zip

Country

Telephone

Email

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

THETA OILFIELD SERVICES, INC.

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature

Date (Optional)

Name

Title

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

☐ Total of 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.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING ANTitle of
Invention**DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE
OR MORE COMPONENTS FOR USE WITH A WELLBORE**

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 Serial No. _____

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:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Terry Treiberg

Date (Optional): 12/13/2011

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/D1 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute 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.

**DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN
APPLICATION DATA SHEET (37 CFR 1.76)**

Title of
Invention

**DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE
COMPONENTS FOR USE WITH A WELLBORE**

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 Serial No. _____

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.

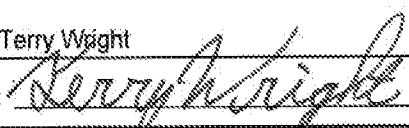
WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Terry Wright

Date (Optional): 12/13/2021

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.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. This 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 1 minute 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.

**DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN
APPLICATION DATA SHEET (37 CFR 1.76)**

Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE
-----------------------	---

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 Serial No. _____

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:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Eric Larson

Date (Optional): 12/13/2021

Signature: _____

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Electronic Patent Application Fee Transmittal

Application Number:				
Filing Date:				
Title of Invention:	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE			
First Named Inventor/Applicant Name:	Terry Treiberg			
Filer:	Gregory C. Baker			
Attorney Docket Number:	CHX.1002US			
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	320	320
UTILITY SEARCH FEE	1111	1	700	700
UTILITY EXAMINATION FEE	1311	1	800	800
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 (\$)				1820

ABSTRACT

Sensor systems and methods for downhole pumping systems include a sensor subsystem for detecting movement of at least one component of the downhole pumping system. The sensor subsystem includes an axial motion sensor to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system and a rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system.

CLAIMS

What is claimed is:

1. A sensor system for a downhole pumping system, comprising:
a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising:
an axial motion sensor subsystem comprising a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system; and
a rotation sensor subsystem comprising a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system; and
a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:
determine axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and
determine rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system with the gyroscope.

2. The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore.

3. The sensor system of claim 2, wherein the processor subsystem is configured to verify the axial movement of the at least one rod before determining the rotation.

4. The sensor system of claim 2, wherein the processor subsystem is configured to determine a change in direction the at least one rod.

5. The sensor system of claim 4, wherein the processor subsystem is configured to begin sampling the rotational velocity after determining the change in direction the at least one rod.

6. The sensor system of claim 5, wherein the processor subsystem is configured to continue sampling the rotational velocity until another change in direction the at least one rod is detected.

7. The sensor system of claim 5, wherein the processor subsystem is configured to continue sampling the rotational velocity along substantially an entire stroke of the at least one rod, the sampling beginning at a first change of direction of the at least one rod, continuing through a second change of direction of the at least one rod, and ceasing at a third change of direction of the at least one rod.

8. The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising a tubing rotator of the downhole pumping system.

9. The sensor system of claim 8, wherein the sensor subsystem is configured to detect rotation of the tubing rotator while detecting axial movement of a polished of the downhole pumping system.

10. The sensor system of claim 1, wherein the processor subsystem is configured to determine the rotational velocity of the at least one component of the downhole pumping system

by summing both positive and negative samples of the rotational velocity values sensed by the rotation sensor subsystem.

11. The sensor system of claim 10, wherein the processor subsystem is configured to compare the determined rotational velocity of the at least one component of the downhole pumping system with an expected amount of rotational velocity to determine a failure in the rotation of the at least one component of the downhole pumping system.

12. The sensor system of claim 1, further comprising a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system over a vibrational baseline.

13. A sensor system for a downhole pumping system, comprising:
 a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising:
 an axial motion sensor subsystem comprising an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations detected by the axial motion sensor generated by movement of the at least one component of the downhole pumping system; and
 a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system; and
 a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:
 verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and

when the axial movement has been verified, determine rotational velocity of the at least one component of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

14. The sensor system of claim 13, wherein the axial motion sensor subsystem comprises a magnetometer and the rotation sensor subsystem comprises a gyroscope.

15. The sensor system of claim 14, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore, and wherein the processor subsystem is configured to continue sampling the rotational velocity values of the at least one rod over a stroke of the at least one rod.

16. A sensor system for a downhole pumping system, comprising:
a sensor subsystem for detecting movement of a tubing rotator of the downhole pumping system, the sensor subsystem comprising a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the tubing rotator of the downhole pumping system and to detect rotational movement of the tubing rotator of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the tubing rotator of the downhole pumping system; and
a processor subsystem to receive data from the rotation sensor subsystem, the processor subsystem to determine rotational velocity of the tubing rotator of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

17. The sensor system of claim 16, wherein the rotation sensor subsystem comprises at least one of a gyroscope or an accelerometer.

18. The sensor system of claim 16, wherein the rotation sensor subsystem is configured to monitor the rotation of the tubing rotator along a path that extends in a direction substantially perpendicular to a surface upon which the downhole pumping system is positioned.

19. A method of detecting motion of at least one component of a downhole pumping system, the method comprising:
detecting axial movement of at least one component of the downhole pumping system based on variations detected by an axial motion sensor coupled to the at least one component of the downhole pumping system generated by translation of the at least one component of the downhole pumping system;
detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system; and
verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the at least one component of the downhole pumping system with the rotational sensor.

20. The method of claim 19, further comprising comparing a rotational velocity detected with the rotational sensor with a threshold value to determine a performance characteristic of the at least one component of the downhole pumping system.

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

TECHNICAL FIELD

[0001] The present disclosure relates to the detection of rotation of one or more components used in the production of fluid from a wellbore. More specifically, the present disclosure relates to the production of fluids from a wellbore using artificial lift and detecting the mechanical rotation of components during operation of a surface pumping unit and related assemblies, apparatuses, systems, and methods.

BACKGROUND

[0002] In a wellbore for the production of hydrocarbon fluids, a string of production tubing is run into the casing. The production tubing serves as a conduit for carrying production fluids to the surface. A packer is optionally set at a lower end of the production tubing to seal an annular area formed between the tubing and the surrounding strings of casing. In order to carry the hydrocarbon fluids to the surface, a pump may be placed at a lower end of the production tubing in order to produce the fluids through artificial lift. In some cases, oil wells undergoing artificial lift use a reciprocating plunger-type of pump. The pump has one or more valves that capture fluid on a downstroke, and then lift the fluid up on the upstroke through positive displacement.

[0003] Mechanically actuated downhole pumps generally build pressure to lift fluid to the surface. Reciprocal movement of the pump is induced by cycling a rod-string hung within the production tubing. The rod-string comprises a series of long, thin joints of steel bar that are threadedly connected through couplings. The rod-string is pivotally attached to a pumping unit at the surface. In response to movement of the pumping unit, the rod-string moves up and down within the production tubing to incrementally lift production fluids from a subsurface formation up to the surface.

[0004] The production of hydrocarbon fluids using a sucker rod pump creates friction and wear as the rods reciprocate up and down within the production tubing. Wellbore deviations and other factors may impart a side-load on the rod-string, resulting in friction and wear at deviation points. To mitigate this wear, it is desirable to rotate the rods during pumping to more evenly distribute wear along the circumference of the rods. This is accomplished by using a

slow-moving gear, actuated through a ratchet mechanism by the stroking motion of the pumping unit.

[0005] Because the rotation is relatively very slow, it is difficult for the operator to visually observe rotation at the wellhead. For this reason, a failed rotation mechanism can go undetected for an extended period of time, sometimes weeks. A failed or otherwise ineffective rod rotator can result in premature failure due to uneven downhole rod or tubing wear. Further, adverse downhole conditions can prevent the rotational motion of the rotator from transferring torque to the rod string. Examples of such conditions include the presence of heavy crude, paraffin, or down-hole friction which may impede the fall of the rod string. This condition is known as rod float and can cause the polished rod clamp to briefly lift off the rod rotator table, losing the frictional contact and associated torque imparted on the rods. Additionally, dynamic conditions such as pump impact or fluid pound can cause the rotator and polished rod to briefly separate and lose the imparted torque. These conditions are virtually impossible to identify from a brief, onsite observation as they are transient.

SUMMARY

[0006] Embodiments of the instant disclosure may be directed to a sensor system for a downhole pumping system. The sensor system including a sensor subsystem for detecting movement of at least one component of the downhole pumping system. The sensor subsystem including: an axial motion sensor subsystem including a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system; and a rotation sensor subsystem including a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system. The sensor system further including a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to: determine axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and determine rotational velocity of the at least one component of the downhole pumping system

with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system with the gyroscope.

[0007] In some aspects, embodiments described herein relate to a sensor system for a downhole pumping system. The sensor system including: a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem including: an axial motion sensor subsystem including an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations detected by the axial motion sensor generated by movement of the at least one component of the downhole pumping system; and a rotation sensor subsystem including a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system. The sensor system further including a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to: verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and when the axial movement has been verified, determine rotational velocity of the at least one component of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

[0008] In some aspects, embodiments described herein relate to a sensor system for a downhole pumping system, The sensor system including: a sensor subsystem for detecting movement of a tubing rotator of the downhole pumping system, the sensor subsystem including a rotation sensor subsystem including a rotational sensor, the rotational sensor to be coupled to the tubing rotator of the downhole pumping system and to detect rotational movement of the tubing rotator of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the tubing rotator of the downhole pumping system. The sensor system further including a processor subsystem to receive data from the rotation sensor subsystem, the processor subsystem to determine rotational velocity of the tubing rotator of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

[0009] In some aspects, embodiments described herein relate to a method of detecting motion of at least one component of a downhole pumping system. The method including: detecting axial movement of at least one component of the downhole pumping system based on variations detected by an axial motion sensor coupled to the at least one component of the downhole pumping system generated by translation of the at least one component of the downhole pumping system; detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system; and verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the at least one component of the downhole pumping system with the rotational sensor.

[0010] Features from any of the above-mentioned embodiments may be used in combination with one another in accordance with the general principles described herein. These and other embodiments, features, and advantages will be more fully understood upon reading the following detailed description in conjunction with the accompanying drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The accompanying drawings illustrate a number of exemplary embodiments and are a part of the specification. Together with the following description, these drawings demonstrate and explain various principles of the instant disclosure.

[0012] FIG. 1 is an elevational view of a pumping system according to embodiments of the disclosure.

[0013] FIG. 2 illustrates a simplified representation of a sensor system for use in a pumping system to perform a plurality of functions in accordance with embodiments of the present disclosure.

[0014] FIG. 3 illustrates a flow chart of a method of detecting motion of at least one component of the downhole pumping system in accordance with embodiments of the present disclosure.

DETAILED DESCRIPTION

[0015] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof, and in which are shown, by way of illustration, specific

example embodiments in which the present disclosure may be practiced. These embodiments are described in sufficient detail to enable a person of ordinary skill in the art to practice the present disclosure. However, other embodiments may be utilized, and structural, material, and process changes may be made without departing from the scope of the disclosure. The illustrations presented herein are not meant to be actual views of any particular method, system, device, or structure, but are merely idealized representations that are employed to describe the embodiments of the present disclosure. The drawings presented herein are not necessarily drawn to scale. Similar structures or components in the various drawings may retain the same or similar numbering for the convenience of the reader; however, the similarity in numbering does not mean that the structures or components are necessarily identical in size, composition, configuration, or any other property.

[0016] It will be readily understood that the components of the embodiments as generally described herein and illustrated in the drawings could be arranged and designed in a wide variety of different configurations. Thus, the following description of various embodiments is not intended to limit the scope of the present disclosure, but is merely representative of various embodiments. While the various aspects of the embodiments may be presented in drawings, the drawings are not necessarily drawn to scale unless specifically indicated.

[0017] Furthermore, specific implementations shown and described are only examples and should not be construed as the only way to implement the present disclosure unless specified otherwise herein. Elements, circuits, and functions may be shown in block diagram form in order not to obscure the present disclosure in unnecessary detail. Conversely, specific implementations shown and described are exemplary only and should not be construed as the only way to implement the present disclosure unless specified otherwise herein. Additionally, block definitions and partitioning of logic between various blocks is exemplary of a specific implementation. It will be readily apparent to one of ordinary skill in the art that the present disclosure may be practiced by numerous other partitioning solutions. For the most part, details concerning timing considerations and the like have been omitted where such details are not necessary to obtain a complete understanding of the present disclosure and are within the abilities of persons of ordinary skill in the relevant art.

[0018] Those of ordinary skill in the art would understand that information and signals may be represented using any of a variety of different technologies and techniques. For

example, data, instructions, commands, information, signals, bits, symbols, sensors, and chips that may be referenced throughout this description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof. Some drawings may illustrate signals as a single signal for clarity of presentation and description. It will be understood by a person of ordinary skill in the art that the signal may represent a bus of signals, wherein the bus may have a variety of bit widths and the present disclosure may be implemented on any number of data signals including a single data signal.

[0019] The various illustrative logical blocks, modules, and circuits described in connection with the embodiments disclosed herein may be implemented or performed with a general purpose processor, a special purpose processor, a Digital Signal Processor (DSP), an Application Specific Integrated Circuit (ASIC), a Field Programmable Gate Array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, such as a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. A general-purpose computer including a processor is considered a special-purpose computer while the general-purpose computer is configured to execute computing instructions (e.g., software code) related to embodiments of the present disclosure.

[0020] Also, it is noted that the embodiments may be described in terms of a process that is depicted as a flowchart, a flow diagram, a structure diagram, or a block diagram. Although a flowchart may describe operational acts as a sequential process, many of these acts can be performed in another sequence, in parallel, or substantially concurrently. In addition, the order of the acts may be rearranged. A process may correspond to a method, a thread, a function, a procedure, a subroutine, a subprogram, etc. Furthermore, the methods disclosed herein may be implemented in hardware, software, or both. If implemented in software, the functions may be stored or transmitted as one or more instructions or code on computer-readable media.

Computer-readable media includes both computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another.

[0021] Several aspects of the embodiments disclosed herein may be implemented as software modules or components. As used herein, a software module or component may include any type of computer instruction or computer-executable code located within a memory device that is operable in conjunction with appropriate hardware to implement the programmed instructions. A software module or component may, for instance, comprise one or more physical or logical blocks of computer instructions, which may be organized as a routine, program, object, component, data structure, etc., that performs one or more tasks or implements particular abstract data types.

[0022] In certain embodiments, a particular software module or component may comprise disparate instructions stored in different locations of a memory device, which together implement the described functionality of the module. Indeed, a module or component may comprise a single instruction or many instructions, and may be distributed over several different code segments, among different programs, and across several memory devices. Some embodiments may be practiced in a distributed computing environment where tasks are performed by a remote processing device linked through a communications network. In a distributed computing environment, software modules or components may be located in local and/or remote memory storage devices. In addition, data being tied or rendered together in a database record may be resident in the same memory device, or across several memory devices, and may be linked together in fields of a record in a database across a network.

[0023] Embodiments may be provided as a computer program product including a non-transitory machine-readable medium having stored thereon instructions that may be used to program a computer or other electronic device to perform processes described herein. The non-transitory machine-readable medium may include, but is not limited to, hard drives, floppy diskettes, optical disks, CD-ROMs, DVD-ROMs, ROMs, RAMs, EPROMs, EEPROMs, magnetic or optical cards, solid-state memory devices, or other types of media/machine-readable media suitable for storing electronic instructions.

[0024] As used herein, relational terms, such as “first,” “second,” “top,” “bottom,” etc., are generally used for clarity and convenience in understanding the disclosure and

accompanying drawings and do not connote or depend on any specific preference, orientation, or order, except where the context clearly indicates otherwise.

[0025] As used herein, the term “and/or” means and includes any and all combinations of one or more of the associated listed items.

[0026] As used herein, the terms “vertical,” “lateral,” and “radial” refer to the orientations as depicted in the figures.

[0027] Embodiments of the disclosure may include systems including one or more remote wireless sensors (e.g., an array of sensors) that are implemented near a wellhead involved in the production of fluid (e.g., hydrocarbon) from a wellbore. Such sensors may provide enhancements in detecting and preventing failures during the production of the fluid. For example, a rod rotator sensor may be used to detect when the rod rotator is not functioning properly. Rod rotators that fail to operate lead to premature failures of rods and tubing. A wireless sensor may be installed on the rod string above the rod clamp and/or below a carrier bar. The sensor may include a rotational sensor (e.g., a gyroscope) to measure rotational velocity and a magnetometer to measure axial movement in order to provide detection of proper rotation of the rods. This detected data may be reported back through the point of connection at the wellhead and displayed in associated local or remote software for use and reference for an operator.

[0028] In some embodiments, the sensors may be used to detect rod string vibration. Such vibration detection may be used to detect fluid pound/tagging, high friction, and/or other rod motion anomalies. By tracking accurate rod position, along with the addition of a force sensor, such as a load cell, may provide a full load/position sensor. During operation, the rods generally exhibit vibrational motion as the rods slide up and down within the tubing. This vibration is amplified by excessive friction, obstruction, plunger hitting fluid on the downstroke, and/or other potential failures in the pumping system. By establishing a vibrational baseline during the stroke of a unit under normal circumstances, deviation from this baseline may be monitored and reported to prompt investigation into the cause of this deviation from baseline. The vibrational baseline may be derived from the sensor (e.g., an accelerometer) in three axes during the stroke of the pumping unit. A configurable limit may be established to alert the operator when the current vibrations exceed this limit.

[0029] In some embodiments, sensors (e.g., accelerometer and/or vibration sensor) may be used with other components of the pumping unit system to facilitate early detection of equipment failure, such as, for example, beams, gearboxes, and/or other components.

[0030] For example, the sensors may be implemented with a tubing rotator, which serves to reduce wear in the tubing, similar to how a rod rotator reduces wear in the rods. Tubing rotators are mechanical devices that are prone to failure where a sensor may report back the proper functioning of the rotator. In some embodiments, the tubing rotator sensor may use similar or the same components as the rod rotator sensor. However, as the orientation of the rotating shaft is horizontal (e.g., substantially parallel to the surface of the Earth on which the pumping system is positioned), the gyro axis may be aligned to a different plane. In some embodiments, the tubing rotator sensor may use an accelerometer to measure the tilt of the sensor as it rotates about the horizontal axis.

[0031] The present disclosure relates, in some embodiments, to gear rod systems used in a reciprocating sucker rod pumping systems (e.g., pumping system 100) that transport oil from oil wells. Such sucker rod pumping systems 100 may function on the positive displacement principle used by cylinder and piston pumps. FIG. 1 illustrates the basic components of a sucker rod pumping system 100. As shown in FIG. 1, the basic sucker rod pumping system 100 components include a motor base 105, a gearbox 110, a walking beam 115, a horsehead 120, a wellhead 125, a flowline 130, a polished rod 135, a casing 140, a tubing 145, a rod string 150, a plunger 155, cable 165, Samson beam 170, and a barrel 160.

[0032] The motor base 105 provides the driving power to the system 100 and can be an electric motor or a gas engine. The gearbox 110 reduces the high rotational speed of the motor base 105 into the reciprocating motion required to operate the downhole pump. The main element of the gearbox 110, the walking beam 115, functions as a mechanical lever that adjusts the position of the horsehead 120 that is connected to the polished rod 135. The Samson beam 170 serves as a vertical stabilizing leg to hold up the horsehead 120 and the walking beam 115. The Samson beam 170 can be connected through a cable 165 to the polished rod. The horsehead 120 translates the rotational motion from the motor base 105 into the reciprocating motion of the polished rod 135, which reciprocates through the wellhead 125 and into the oil well. At the end of the polished rod 135 or a string of sucker rods is the plunger 155 that is the main mechanical driver of fluid out of the oil well. Around the polished rod 135 and within the oil well is a casing

140 that surrounds tubing 145. Together, the casing 140 and tubing 145 form a casing-tubing annulus that surrounds the sub-surface pump system components. Sucker rod string 150, composed of sucker rods, runs inside the tubing string of the well and provides the mechanical link between the surface drive and the subsurface pump. The pump barrel 160 or working barrel is the stationary part of the subsurface pump that serves as a stopping point for the plunger 155. The barrel 160 generally contains a standing valve that acts together with the plunger 155 as a suction valve through which well fluids enter the pump barrel during an upstroke.

[0033] As discussed above, as the sucker rod string 150 reciprocates (e.g., translates) within the well, the sucker rod string 150 may asymmetrically wear through rod-on-tubing friction. This friction may increase in cases with crooked wells, cases with fluid or gas over-pressurization, and situations where there is tubing or rod buckling. To help minimize this uneven wear, the gradual rotation of the polished rod and/or the tubing in which the rod is translated is used to balance the wear may be implemented to substantially increase their operating life.

[0034] In order to monitor the rotation of one or more components of the pumping system 100 (e.g., the polished rod 135 and/or the tubing 145), a sensor system may be used. For example, a rod sensor 175 may be secured to a movable portion of the pumping system 100 (e.g., the polished rod 135). The rod sensor 175 may monitor the rotation of the polished rod 135 about an axis along which the polished rod 135 extends into the wellbore (e.g., about the longitudinal axis of the polished rod 135) as a rod rotator 180 gradually rotates the polished rod 135 during strokes of the sucker rod string 150. In some embodiments, the rod rotator 180 may be similar to those disclosed in U.S. Patent Application Publication No. US 2020/0340309 A1, the disclosure of which is incorporated herein, in its entirety, by this reference.

[0035] In additional embodiments, a tubing sensor 185 may be coupled to a portion of a tubing rotator 190. As discussed above, the tubing rotator 190 may rotate the tubing 145 in order to spread wear caused by the translation of the polished rod 135 and the sucker rod string 150 over the inner surface of the tubing 145. In some embodiments, the tubing rotator 190 may include a worm drive the interaction with a worm wheel coupled to the tubing 145. The tubing sensor 185 may be coupled to a portion of the worm drive of the tubing rotator 190 in order to monitor the rotation of the tubing rotator 190 directly. The tubing sensor 185 may monitor the rotation of the tubing rotator 190 (e.g., the worm drive) about an axis that extends along a surface

of the Earth on which the pumping system 100 is positioned. For example, the rotational path of the tubing sensor 185 may extend in a direction (e.g., lie in a plane) that is substantially perpendicular to a surface upon which the downhole pumping system 100 is positioned.

[0036] In additional embodiments, the tubing sensor 185 may be coupled to a portion of the tubing 145 in order to directly monitor the rotation of the tubing 145.

[0037] The sensor system may include a base unit 195 (e.g., a stationary point of connection) that communicates (e.g., wirelessly communicates via radio waves without the use of an electrical conductor between two or more components) with one or more of the sensors (e.g., the rod sensor 175 and/or tubing sensor 185) of the sensor system coupled to movable components of the pumping system 100. The base unit 195 may be in communication with additional systems, such as, operational systems of the overall pumping system 100. For example, an operator of the pumping system 100 may receive data from the wireless the rod sensor 175 and/or tubing sensor 185 via the base unit 195 as the movable wireless sensors 175, 185 provide data relating to the operation of the components on which the wireless sensors 175, 185 are mounted.

[0038] FIG. 2 illustrates a simplified representation of a sensor system 200 for use in a pumping system (e.g., the pumping system 100 shown in FIG. 1). As shown in FIGS. 1 and 2, the sensor system 200 may include a sensor subsystem 204 for detecting movement of at least one component of the downhole pumping system 100. In some embodiments, the rod sensor 175 and/or tubing sensor 185 may each include such a sensor subsystem 204. The sensor subsystem 204 may include sensors for sensing various types of motion of the components of the downhole pumping system 100 as discussed below. In some embodiments, the sensor subsystem 204 may include sensors that are self-calibrating, wireless, and/or independently powered (e.g., battery-powered). In some embodiments, these sensors or others sensors may measure conductivity, temperature, humidity, acoustics, load, etc.

[0039] The sensor subsystem 204 may include an axial motion sensor subsystem 206 including one or more sensors for detecting linear movement (e.g., a magnetometer, a capacitive sensor, a Hall effect sensor, an optical sensor, etc.). For example, the axial motion sensor subsystem 206, which may be contained in the sensors 175, 185 may be coupled to one or more components (e.g., the polished rod 135) of the downhole pumping system 100 to detect axial movement of the polished rod 135 of the downhole pumping system 100. In embodiments where

the axial motion sensor subsystem 206 includes a magnetometer, the axial motion of the polished rod 135 may be monitored based on variations in a magnetic field detected by the magnetometer generated by movement of the polished rod 135 of the downhole pumping system 100. For example, the magnetic field surrounding the polished rod 135 and the nearby metallic structures (e.g., the wellhead 125) may provide a sinusoidal-type waveform in the magnetometer that can be monitored to determine when the polished rod 135 changes axial (e.g., vertical) direction (e.g., during an up and down stroke of the polished rod 135).

[0040] The sensor subsystem 204 may include a rotation sensor subsystem 208 including a sensor for determining rotational motion or a component thereof (e.g., a gyroscope, an accelerometer, etc.). The rotation sensor subsystem 208 may be coupled to one or more components (e.g., the polished rod 135 and/or the tubing rotator 190) of the downhole pumping system 100 to detect rotational movement of the polished rod 135 and/or the tubing rotator 190 of the downhole pumping system 100. For example, the rotation sensor subsystem 208 may be used to determine rotational velocity (e.g., by the sampling of rotational velocity values) generated by rotation of the polished rod 135 and/or the tubing rotator 190 of the downhole pumping system 100. In some embodiments, the rotation sensor subsystem 208 may comprise a gyroscope that monitors movement of the components of the downhole pumping system 100 in multiple degrees of freedom (e.g., nine degrees of freedom).

[0041] The sensor system 200 may include a processor subsystem 210 to receive data from the sensor subsystem 204 (e.g., the axial motion sensor subsystem 206 and/or the rotation sensor subsystem 208). The processor subsystem 210 may include one or more processors 212 for processing the data. In some embodiments, the processor subsystem 210 may be part of (e.g., physically located with) the movable sensors 175, 185, may be part of (e.g., physically located with) the base unit 195, or may be part of both the movable sensors 175, 185 and the base unit 195.

[0042] The processor subsystem 210 may determine axial movement of the polished rod 135 and/or the tubing rotator 190 of the downhole pumping system 100 with data from the axial motion sensor subsystem 204. The processor subsystem 210 may determine rotational velocity of the polished rod 135 and/or the tubing rotator 190 of the downhole pumping system 100 with data from the rotation sensor subsystem 208.

[0043] In some embodiments, data from the axial motion sensor subsystem 206 and the rotation sensor subsystem 208 may be used together (e.g., interrelated) to determine a condition of the downhole pumping system 100. For example, the processor subsystem 210 may use data from the axial motion sensor subsystem 206 to determine a direction change in the polished rod 135 (e.g., to determine when one part of a stroke of the polished rod 135 has been completed and/or to determine that a new stroke is beginning). Once the change in direction is noted, the angular velocity data detected the rotation sensor subsystem 208 may be sampled at relatively high frequency (e.g., 10 to 10,000 samples per second) to measure rotational velocity of the polished rod 135. When a second direction change of the polished rod 135 is determined, the sampling is continued. When the third direction change is noted (e.g., noting the completion of a complete up and down stroke), the sampling may be ceased.

[0044] In some embodiments, the sensor system 200 may only selectively detect the motion of the downhole pumping system 100 (e.g., in order to conserve battery life of the sensor system 200). The sensor system 200 may generally reside in a standby or sleep mode while only waking occasionally to detect movement of the downhole pumping system 100. For example, the sensor system 200 may selectively (e.g., periodically, based on an event, etc.) wake to detect the motion of the polished rod 135 during an entire stroke. Once the stroke is completed, the sensor system 200 may return to a sleep or standby mode.

[0045] The processor subsystem 210 may sum both positive and negative angular velocity measurements during the completed stroke to determine (e.g., to approximate) the overall net rotation of the polished rod 135 during the completed stroke. In some embodiments, the processor subsystem 210 may convert the overall net rotation to degrees of rotation per minute of the polished rod 135. If the angular velocity calculation yields a value above a preselected limit (e.g., a minimum amount of expected rotation), then confirmation of rotation may be indicted by the processor subsystem 210. Otherwise, rotation a failure in rotation may be noted. As noted above, similar monitoring and calculation may be utilized when monitoring rotation of the tubing rotator 190 and/or tubing 145 itself.

[0046] In such embodiments, verifying that the polished rod 135 is being moved (e.g., translated) by the downhole pumping system 100 may be useful to determine that the rod rotator 180 has actually failed to operate. For example, the sensor system 200 may continue to sample angular velocity only if it is determined that axial motion exists (e.g., with the axial

motion sensor subsystem 206). Otherwise, the sensor system 200 may recognize no angular velocity or angular velocity under a certain threshold and incorrectly report that rod rotation has ceased when the polished rod 135 is not actually moving in the axial direction. The magnetic change near the axial motion sensor subsystem 206 will be substantially zero when there is no vertical motion of the polished rod 135. If little to no changes are noted in magnetic fields with the axial motion sensor subsystem 206, the sampling of the angular velocity may be aborted or discontinued when no vertical motion is reported.

[0047] In some embodiments, through the monitoring and reporting of the angular velocity, the number of rotations of the polished rod 135 during a selected period of time may be determined and used to evaluate the operation of the rod rotator 180. Components of the rod rotator 180 may degrade in performance over time, which often manifests in reduced velocity and reduced rotation over time. A reduced velocity of the rod rotator 180 may indicate an improper installation of the rod rotator 180, where a full stroke of the rotation mechanism of the rod rotator 180 may not be adequately occurring because of the installation orientation.

[0048] As noted above, velocity data the from rotation sensor subsystem 208 may be used to determine that the rod rotator 180 or other component is not properly rotating and/or may also be used to monitor for changes in the velocity data from a baseline or threshold amount and/or changes over time. For example, a detected decrease in velocity and/or one or more detected velocities that are below a selected threshold may be detected by the sensor system 200. Such data may be used to determine a performance characteristic of the downhole pumping system 100, such as, for example, if the rod rotator 180 is underperforming and/or showing signs of impending failure.

[0049] In some embodiments, the data from the axial motion sensor subsystem 206 may be used to determine the stroke period of the polished rod 135. Such a determination may be used to detect a condition of the well, for example, to detect a pumped-off condition.

[0050] In some embodiments, data from the rotation sensor subsystem 208 may be used to detect bridal oscillations caused by a fluid pound condition. The determination of the fluid pound condition may then be used to estimate the amount of pump fillage in the pumping operation.

[0051] In some embodiments, the sensor system 200 may include a vibration sensor subsystem 214 (e.g., load sensors, strain gauges, magnet sensors, accelerometers, gyroscopes,

etc.) used to detect rod string vibration or vibration in other components of the downhole pumping system 100. As noted above, such vibration may be used to detect fluid pound/tagging, high friction, and/or other rod motion anomalies. The processor subsystem 210 may be used to establish a vibrational baseline during the stroke of the polished rod 135 under normal operational conditions. Detected deviation from this baseline may be monitored and reported to an operator of the downhole pumping system 100. In some embodiments, the vibrational baseline may be derived from the vibration sensor subsystem 214 in more than one axis (e.g., three axes) during the stroke of the downhole pumping system 100. A configurable limit may be established to alert the operator when the current vibrations exceed such a limit.

[0052] FIG. 3 illustrates a flow chart of a method 300 of detecting motion of one or more components of the downhole pumping system (e.g., the polished rod 135 and/or the tubing 145 of the downhole pumping system 100 of FIG. 1). As shown in FIG. 3, and with further reference to FIG. 1, at act 302, axial motion of the component (e.g., the polished rod 135) may be detected based on variations detected by an axial motion sensor (e.g., rod sensor 175) coupled to the polished rod 135 of the downhole pumping system 100 generated by translation of the polished rod 135. At act 304, rotational movement of the (e.g., the polished rod 135 and/or the tubing 145) may be detected with a rotational sensor (e.g., the rod sensor 175 and/or tubing sensor 185) generated by rotation of the polished rod 135 and/or the tubing 145. At act 306, axial movement of the polished rod 135 may be verified with the rod sensor 175 before detecting (e.g., beginning to detect and/or continuing to detect) the rotational movement of the polished rod 135 and/or the tubing 145 with the rod sensor 175 and/or tubing sensor 185.

[0053] Terms of degree (e.g., “about,” “substantially,” “generally,” etc.) indicate structurally or functionally insignificant variations, such as within acceptable manufacturing tolerances. In an example, when the term of degree is included with a term indicating quantity, the term of degree is interpreted to mean $\pm 10\%$, $\pm 5\%$, or $\pm 2\%$ of the term indicating quantity. In an example, when the term of degree is used to modify a shape, the term of degree indicates that the shape being modified by the term of degree has the appearance of the disclosed shape. For instance, the term of degree may be used to indicate that the shape may have rounded corners instead of sharp corners, curved edges instead of straight edges, one or more protrusions extending therefrom, is oblong, is the same as the disclosed shape, et cetera.

[0054] While the present disclosure has been described herein with respect to certain illustrated embodiments, those of ordinary skill in the art will recognize and appreciate that it is not so limited. Rather, many additions, deletions, and modifications to the illustrated embodiments may be made without departing from the scope of the disclosure as hereinafter claimed, including legal equivalents thereof. Further, the words “including,” “having,” and variants thereof (e.g., “includes” and “has”) as used herein, including the claims, shall be open-ended and have the same meaning as the word “comprising” and variants thereof (e.g., “comprise” and “comprises”). In addition, features from one embodiment may be combined with features of another embodiment while still being encompassed within the scope of the disclosure as contemplated by the inventors.

Electronic Acknowledgement Receipt

EFS ID:	44503538
Application Number:	17549519
International Application Number:	
Confirmation Number:	4428
Title of Invention:	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE
First Named Inventor/Applicant Name:	Terry Treiberg
Customer Number:	102983
Filer:	Gregory C. Baker
Filer Authorized By:	
Attorney Docket Number:	CHX.1002US
Receipt Date:	13-DEC-2021
Filing Date:	
Time Stamp:	17:56:22
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$ 1820
RAM confirmation Number	E2021BCH56510081
Deposit Account	
Authorized User	

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File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	WebADS.pdf	203266	no	8
			32efba9482d0757cb4f28e3f20f01c18cbcb d8d2		
Warnings:					
Information:					
2	Drawings-only black and white line drawings	2021-12-13_Drawings.pdf	147465	no	3
			4446162e00013bfa61971d280a57167a837 02af3		
Warnings:					
Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	2021-12-13_IDS.pdf	1034550	no	4
			5f47b5b38b1990b7bb94abcc8795e0a34bc e755e		
Warnings:					
Information:					
4	Power of Attorney	2021-12-13_POA_.pdf	1624649	no	2
			92e1e0de1511002ab72a8db5c3f2f3bf7a5 3374		
Warnings:					
Information:					
5	Oath or Declaration filed	2021-12-13_DECs.pdf	730713	no	3
			1a91a18380536964d136e8084cd8414ad0d 65b43		
Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	43868	no	2
			3fa4694f4109ea981992140ef755e1f3ee481 11d		
Warnings:					
Information:					

7	Abstract	2021_12_13_17_44_26_0643_3383bf9b-2062-465f-b47d-fbff6640119d.docx	36645 fec937f7135729480d0ea4a302cf3b98edc9cac76792f976856e82028dcd30e024b05c11def5c09c9959f2b273d7bc9964a000a8693475c9b1b708a618d68cc8	no	1
Warnings:					
Information:					
8	Claims	2021_12_13_17_44_27_0567_16cb876b-9e75-40b4-92c1-9feb5e4b503.docx	41787 a03d256bc49e7ebd16c76c45bf6a5d1a230ab044c9a4a1f0bbcd54df4138331cc277df7f85c7849155782a915045759f334fe02fbdff30b96cf0e1bc5d9d74d1b	no	-
Warnings:					
Information:					
9	Specification	2021_12_13_17_55_55_0554_4443181b-e88f-4026-bcc4-a68d6fb50dc8.docx	58117 9208ecb52378bf652a908a55b4c81e2b25876b7d1e7653ac901eb0212e16726b07a1c01858bbe16daac1f2057cee6f1f3552108e75bf913e5e5ff54e3cc28c1b	no	-
Warnings:					
Text decorations were found and have been removed.					
Information:					
Total Files Size (in bytes):			4223708		
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. <u>New Applications Under 35 U.S.C. 111</u> 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. <u>National Stage of an International Application under 35 U.S.C. 371</u> 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. <u>New International Application Filed with the USPTO as a Receiving Office</u> 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.					

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		
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.)
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Inventor Information:

Inventor 1					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Terry		Treiberg		
Residence Information (Select One)		☒ US Residency ☐ Non US Residency ☐ Active US Military Service			
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City	Bakersfield	State/Province	CA		
Postal Code	93308	Country ⁱ	US		
Inventor 2					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Terry		Wright		
Residence Information (Select One)		☒ US Residency ☐ Non US Residency ☐ Active US Military Service			
City	Lequire	State/Province	OK	Country of Residence ⁱ	US
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Address 2					
City	Lequire	State/Province	OK		
Postal Code	74943	Country ⁱ	US		
Inventor 3					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Eric	EX-1002, p. 39 of 378	Larson		

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

Residence Information (Select One)		☒ US Residency	☐ Non US Residency	☐ Active US Military Service
City	Johnstown	State/Province	CO	Country of Residence ⁱ
US				
Mailing Address of Inventor:				
Address 1	326 Glenroy Dr.			
Address 2				
City	Johnstown	State/Province	CO	
Postal Code	80534	Country ⁱ	US	
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	102983
Email Address	
	Add Email Remove Email

Application Information:

Title of the Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		
Attorney Docket Number	CHX.1002US	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	3	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

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

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	102983		
Prefix	Given Name	Middle Name	Family Name Suffix Remove
Registration Number			
Prefix	Given Name	Middle Name	Family Name Suffix Remove
Registration Number			

Additional Representative Information blocks may be generated within this form by selecting the **Add** button.

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		Remove
Application Number	Continuity Type	Prior Application Number Filing or 371(c) Date (YYYY-MM-DD)

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Foreign Priority Information:

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

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) 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).

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.

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

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.

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

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			
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.			
			Clear
☒ Assignee	☐ Legal Representative under 35 U.S.C. 117	☐ Joint Inventor	
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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	THETA OILFIELD SERVICES, INC.		
Mailing Address Information For Applicant:			
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Address 2			
City	BAKERSFIELD	State/Province	CA
Country ⁱ	US	Postal Code	93309
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button.			

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

Assignee Information including Non-Applicant Assignee 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.

Assignee 1				
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.				
If the Assignee or Non-Applicant Assignee is an Organization check here. ☐				
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Mailing Address Information For Assignee including Non-Applicant Assignee:				
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Address 2				
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

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	/GCB/			Date (YYYY-MM-DD)	
First Name	Gregory	Last Name	Baker	Registration Number	61335
Additional Signature may be generated within this form by selecting the Add button.					

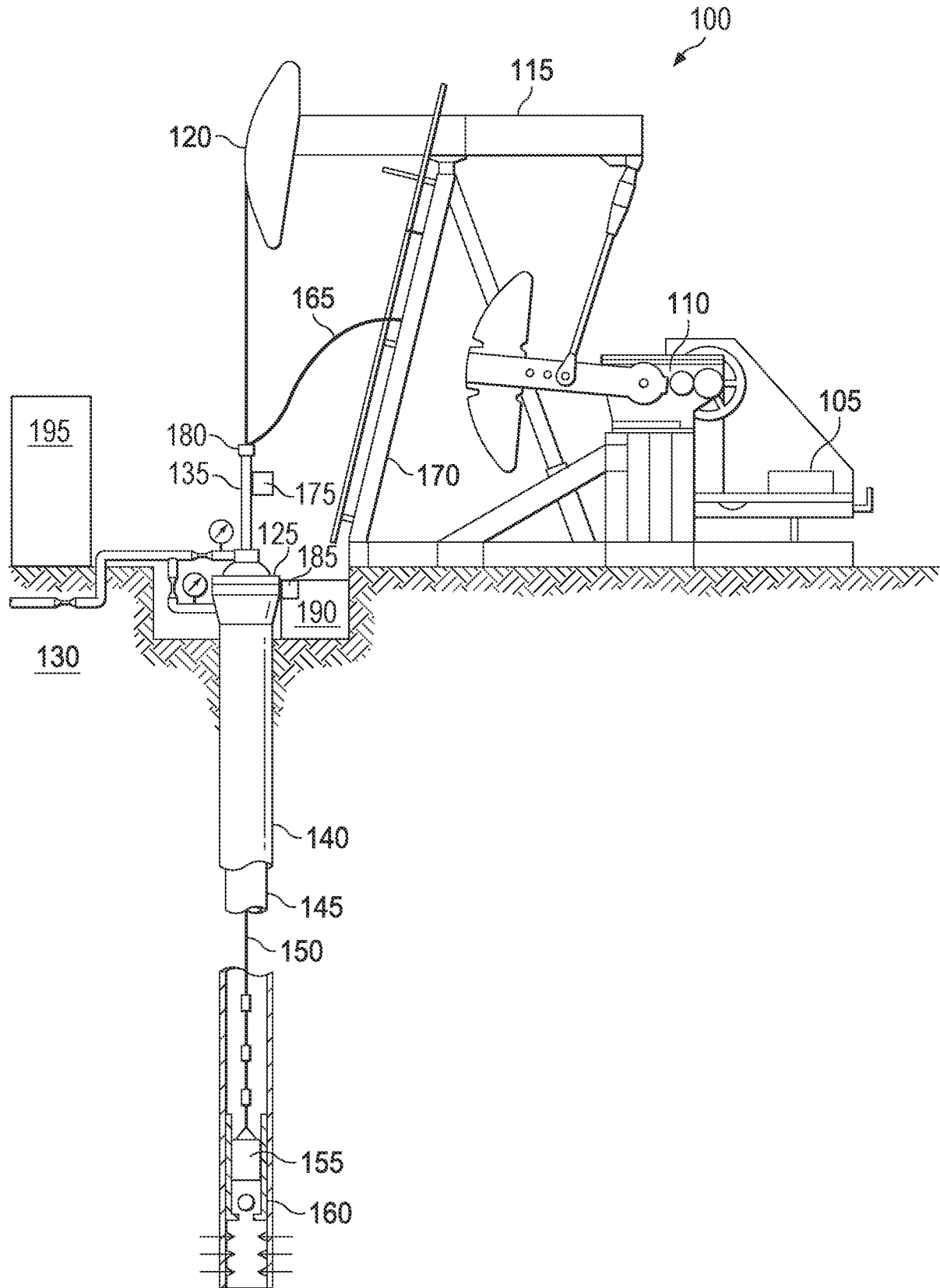


FIG. 1

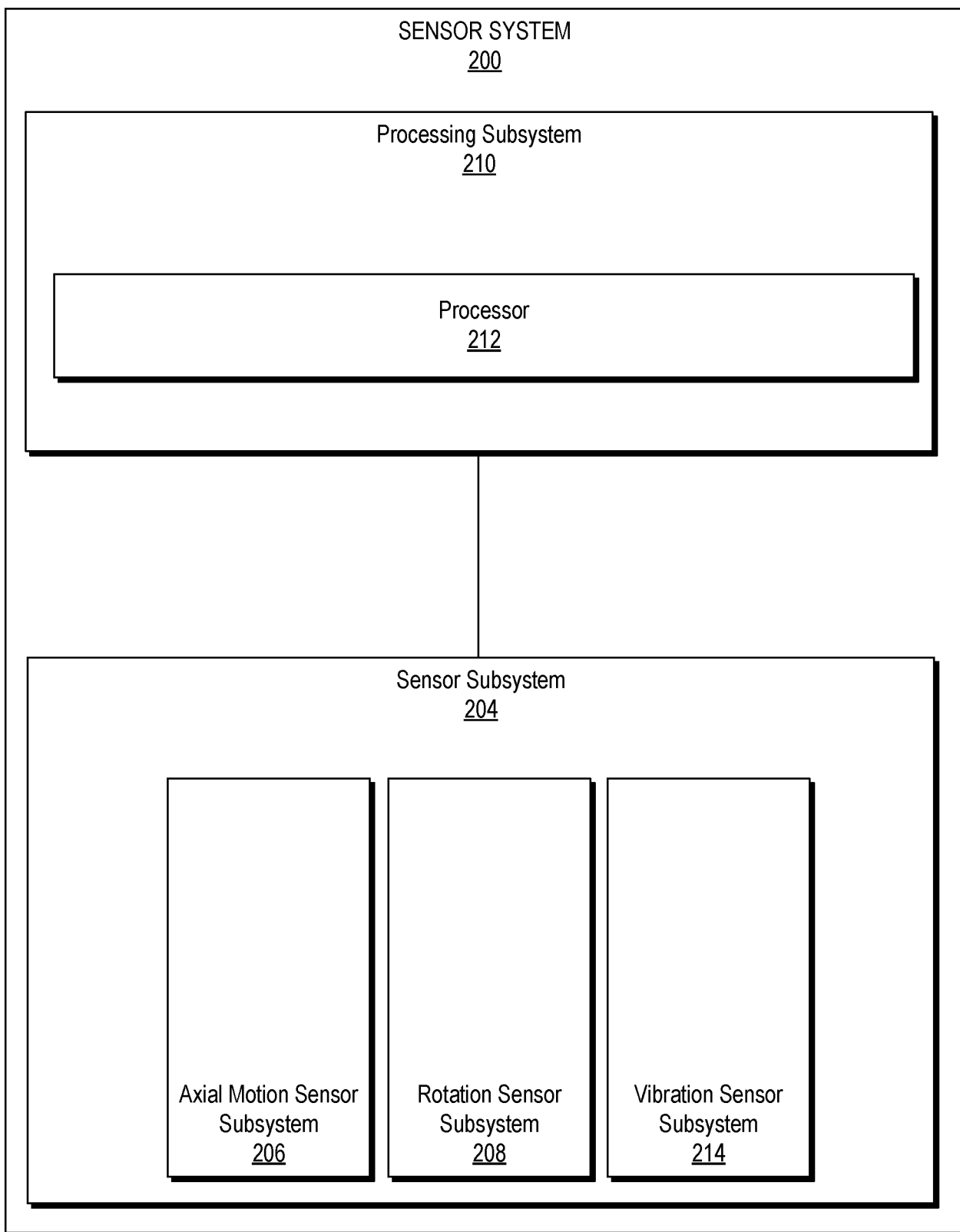


FIG. 2

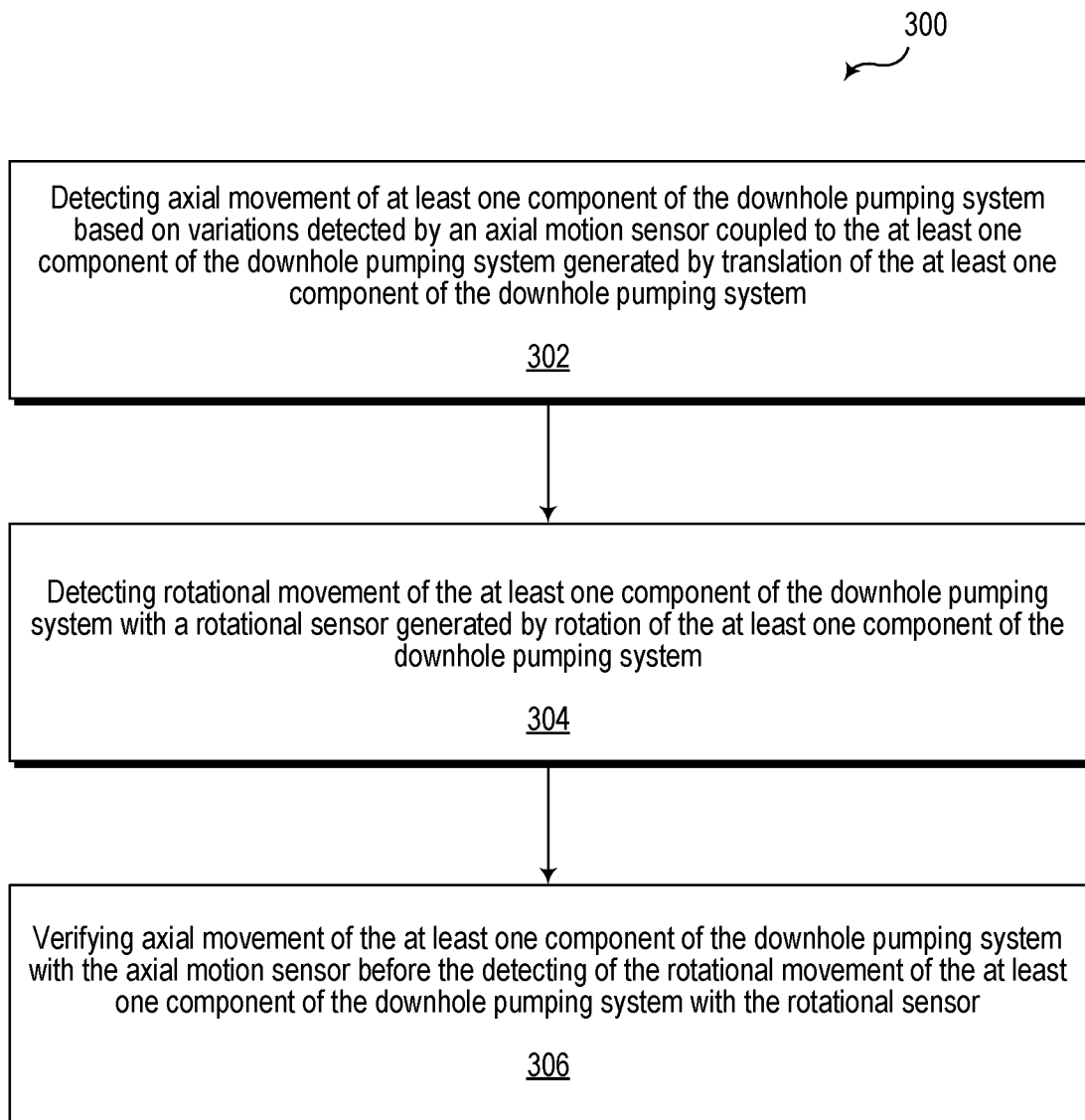


FIG. 3



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United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
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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
17/549,519	12/13/2021	3676	1820	CHX.1002US	20	4

CONFIRMATION NO. 4428

FILING RECEIPT

102983
Phillips Winchester
4001 South 700 East, Suite 500
Salt Lake City, UT 84107



Date Mailed: 12/28/2021

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)

Terry Treiberg, Bakersfield, CA;
Terry Wright, Lequire, OK;
Eric Larson, Johnstown, CO;

Applicant(s)

THETA OILFIELD SERVICES, INC., BAKERSFIELD, CA;

Power of Attorney: The patent practitioners associated with Customer Number 102983

Domestic Applications for which benefit is claimed - None.

A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

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

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: 12/27/2021

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/549,519**

Projected Publication Date: 06/15/2023

Non-Publication Request: No

Early Publication Request: No

Title

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Preliminary Class

166

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.

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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).

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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.

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 Assets Control, 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).

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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.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 17/549,519				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)			
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	320			
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	700			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	800			
TOTAL CLAIMS (37 CFR 1.16(j))	20	minus 20 = *				x 100 =	0.00			
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4	minus 3 = *	1			x 480 =	480			
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	2300			
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=		x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=		x	=
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))									
						TOTAL ADD'L FEE			TOTAL ADD'L FEE	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=		x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=		x	=
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))									
						TOTAL ADD'L FEE			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.										



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US

CONFIRMATION NO. 4428

FORMALITIES LETTER



OC000000130704947

102983
Phillips Winchester
4001 South 700 East, Suite 500
Salt Lake City, UT 84107

Date Mailed: 12/28/2021

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing.

Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- Additional claim fees of \$ **480** as an undiscounted entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. No entity status discount is in effect. If applicant is qualified for small entity status, a written assertion of small entity status must be submitted to establish small entity status. (See 37 CFR 1.27). If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- \$ **480** for **1** independent claims over 3.
- \$(**0**) previous unapplied payment amount.
- \$ **480** TOTAL FEE BALANCE DUE.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

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Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice".
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If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

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**.

/thaile/

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Trelberg et al.

Serial No.: 17/549,519

Filed: December 13, 2021

For: DEVICES, SYSTEMS, AND
METHODS FOR DETECTING THE
ROTATION OF ONE OR MORE
COMPONENTS FOR USE WITH A
WELLBORE

Confirmation No.: 4428

Examiner: TBD

Group Art Unit: 3676

Attorney Docket No.: CHX.1002US

VIA ELECTRONIC FILING

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

TO THE COMMISSIONER FOR PATENTS:

In response to the Notice to File Corrected Papers mailed December 28, 2021, appended hereto, the additional fees are paid herewith.

Respectfully submitted,

/Gregory C. Baker/
Gregory C. Baker
Registration No. 61,335
Attorney for Applicant
PHILLIPS WINCHESTER
4001 South 700 East, Suite 500
Salt Lake City, Utah 84107
Telephone: 801-935-4935

Date: December 28, 2021



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US

CONFIRMATION NO. 4428

FORMALITIES LETTER



OC000000130704947

102983
Phillips Winchester
4001 South 700 East, Suite 500
Salt Lake City, UT 84107

Date Mailed: 12/28/2021

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

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/thaile/

Electronic Patent Application Fee Transmittal

Application Number:	17549519			
Filing Date:	13-Dec-2021			
Title of Invention:	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE			
First Named Inventor/Applicant Name:	Terry Treiberg			
Filer:	Gregory C. Baker			
Attorney Docket Number:	CHX.1002US			
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:				
INDEPENDENT CLAIMS IN EXCESS OF 3	1201	1	480	480
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 (\$)				480

Electronic Acknowledgement Receipt

EFS ID:	44649274
Application Number:	17549519
International Application Number:	
Confirmation Number:	4428
Title of Invention:	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE
First Named Inventor/Applicant Name:	Terry Treiberg
Customer Number:	102983
Filer:	Gregory C. Baker
Filer Authorized By:	
Attorney Docket Number:	CHX.1002US
Receipt Date:	01-JAN-2022
Filing Date:	13-DEC-2021
Time Stamp:	11:12:27
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$480
RAM confirmation Number	E202211B13111251
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	Applicant Response to Pre-Exam Formalities Notice	2021-12-28_XFees.pdf	129307	no	1
			c13df3563393c1267cd561b9360eb099c32f99c4		
Warnings:					
Information:					
2	Applicant Response to Pre-Exam Formalities Notice	2021-12-28_Noticefeesdue.pdf	64358	no	2
			86890cc70043dccc04031d02958fa8429fc7fe96a		
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	38240	no	2
			18646274c53eb91ccad3185b92bffd6b5710c8bd		
Warnings:					
Information:					
Total Files Size (in bytes):			231905		
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. <u>New Applications Under 35 U.S.C. 111</u> 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. <u>National Stage of an International Application under 35 U.S.C. 371</u> 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. <u>New International Application Filed with the USPTO as a Receiving Office</u> 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.					



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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
17/549,519	12/13/2021	3676	2300	CHX.1002US	20	4

CONFIRMATION NO. 4428

UPDATED FILING RECEIPT

102983
Phillips Winchester
4001 South 700 East, Suite 500
Salt Lake City, UT 84107



Date Mailed: 01/04/2022

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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Terry Wright, Lequire, OK;
Eric Larson, Johnstown, CO;

Applicant(s)

THETA OILFIELD SERVICES, INC., BAKERSFIELD, CA;

Power of Attorney: The patent practitioners associated with Customer Number 102983

Domestic Applications for which benefit is claimed - None.

A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

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.

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Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

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: 12/27/2021

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/549,519**

Projected Publication Date: 06/15/2023

Non-Publication Request: No

Early Publication Request: No

Title

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Preliminary Class

166

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

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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 Assets Control, 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).

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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.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 17/549,519				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)			
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	320			
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	700			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	800			
TOTAL CLAIMS (37 CFR 1.16(j))	20	minus 20 = *			OR	x 100 =	0.00			
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4	minus 3 = *	1			x 480 =	480			
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	2300			
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	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))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	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))							OR		
	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.										



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	PATENT NUMBER	GROUP ART UNIT	REQUEST ID
17/549,519		3676	155692

PAIR Correspondence Address/Fee Address Change

The following fields have been changed to Customer Number 184959 on 01/05/2022 via Private PAIR in view of the certification copied below that authorized the change.

- Correspondence Address

The address for Customer Number 184959 is:

184959

ChampionX/Phillips Winchester

4001 S. 700 E. Suite 500

Salt Lake City, UT 84107

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

An attorney or Agent of Record registered to practice before the Patent and Trademark Office who has been given power of attorney in this application

Signature:	/GCB/
Name:	Gregory Baker
Registration Number:	61335



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
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- Maintenance Fee Address

The address for Customer Number 184959 is:

184959

ChampionX/Phillips Winchester

4001 S. 700 E. Suite 500

Salt Lake City, UT 84107

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

An attorney or Agent of Record registered to practice before the Patent and Trademark Office who has been given power of attorney in this application

Signature:	/GCB/
Name:	Gregory Baker
Registration Number:	61335

PATENT ASSIGNMENT COVER SHEET

Electronic Version v1.1
 Stylesheet Version v1.2

EPAS ID: PAT7372417

SUBMISSION TYPE:	NEW ASSIGNMENT
NATURE OF CONVEYANCE:	SECURITY INTEREST

CONVEYING PARTY DATA

Name	Execution Date
APERGY BMCS ACQUISITION CORP.	06/07/2022
APERGY ESP SYSTEMS, LLC	06/07/2022
CHAMPIONX USA INC.	06/07/2022
HARBISON-FISCHER, INC.	06/07/2022
NORRIS-RODS, INC.	06/07/2022
PCS FERGUSON, INC.	06/07/2022
THETA OILFIELD SERVICES, INC.	06/07/2022
US SYNTHETIC CORPORATION	06/07/2022

RECEIVING PARTY DATA

Name:	JPMORGAN CHASE BANK, N.A.
Street Address:	500 STANTON CHRISTIANA ROAD, NCC5, 1ST FLOOR
Internal Address:	LOAN AND AGENCY SERVICES GROUP
City:	NEWARK
State/Country:	DELAWARE
Postal Code:	19713

PROPERTY NUMBERS Total: 66

Property Type	Number
Application Number:	17448813
Application Number:	17507763
Application Number:	14804973
Application Number:	17484547
Application Number:	17167314
Application Number:	17552858
Application Number:	17139539
Application Number:	17234601
Application Number:	17305069
Application Number:	17483753
Application Number:	16826029
Application Number:	17483430

Property Type	Number
Application Number:	17156765
Application Number:	17479553
Application Number:	17244755
Application Number:	17234400
Application Number:	17237017
Application Number:	17148145
Application Number:	17238472
Application Number:	16249824
Application Number:	16787214
Application Number:	29723823
Application Number:	29723822
Application Number:	29786961
Application Number:	15190364
Application Number:	17455804
Application Number:	17306704
Application Number:	17691051
Application Number:	17550221
Application Number:	17589765
Application Number:	17549628
Application Number:	17549519
Application Number:	16993055
Application Number:	17592388
Application Number:	17451535
Application Number:	16909838
Application Number:	17061419
Application Number:	17518100
Application Number:	17360704
Application Number:	17323537
Application Number:	29734635
Application Number:	29734689
Application Number:	29830851
Application Number:	17587734
Application Number:	17550864
Application Number:	17678819
Application Number:	17707569
Application Number:	17713161
Application Number:	17713170
Application Number:	16935475

Property Type	Number
Application Number:	17021752
Application Number:	17034257
Application Number:	29760765
Application Number:	29769089
Application Number:	17680729
Application Number:	17401112
Application Number:	17401030
Application Number:	17363410
Application Number:	17318365
Application Number:	63309936
Application Number:	63320914
Application Number:	63318663
PCT Number:	US2021013627
PCT Number:	US2021031561
PCT Number:	US2021038902
PCT Number:	US2021063349

CORRESPONDENCE DATA

Fax Number: (214)746-7777

Correspondence will be sent to the e-mail address first; if that is unsuccessful, it will be sent using a fax number, if provided; if that is unsuccessful, it will be sent via US Mail.

Phone: 2147467700

Email: brian.lee@weil.com

Correspondent Name: ANGELA ESTRADA

Address Line 1: 200 CRESCENT COURT, SUITE 300

Address Line 4: DALLAS, TEXAS 75201

ATTORNEY DOCKET NUMBER:	15474.0007
NAME OF SUBMITTER:	ANGELA ESTRADA
SIGNATURE:	/Angela Estrada/
DATE SIGNED:	06/08/2022
	This document serves as an Oath/Declaration (37 CFR 1.63).

Total Attachments: 13

source=ChampionX.2022 - Tab 06 - Patent Security Agreement Supplement [Executed]#page1.tif
source=ChampionX.2022 - Tab 06 - Patent Security Agreement Supplement [Executed]#page2.tif
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source=ChampionX.2022 - Tab 06 - Patent Security Agreement Supplement [Executed]#page13.tif

PATENT SECURITY AGREEMENT SUPPLEMENT dated as of June 7, 2022 (this “*Agreement*”), between APERGY BMCS ACQUISITION CORP., APERGY ESP SYSTEMS, LLC, CHAMPIONX USA INC., HARBISON-FISCHER, INC., NORRIS-RODS, INC., PCS FERGUSON, INC., THETA OILFIELD SERVICES, INC. and US SYNTHETIC CORPORATION (the “*Grantors*”) and JPMorgan Chase Bank, N.A. (“*JPMCB*”), as Administrative Agent.

Reference is made to (a) that certain Amended and Restated Credit Agreement, dated as of June 7, 2022 (as amended, restated, amended and restated, supplemented or otherwise modified from time to time, the “*Credit Agreement*”), by and among, *inter alios*, ChampionX Corporation, a Delaware corporation (the “*Borrower*”), the Lenders from time to time party thereto, the Issuing Banks from time to time party thereto and the Administrative Agent and (b) that certain Guarantee and Collateral Agreement, dated as of May 9, 2018 (as amended, restated, amended and restated, supplemented or otherwise modified from time to time, the “*Collateral Agreement*”), between the Borrower, the Guarantors from time to time party thereto and the Administrative Agent. The Lenders and the Issuing Banks have extended, and have agreed to extend, credit to the Borrower subject to the terms and conditions set forth in the Credit Agreement. The Grantors are Affiliates of the Borrower, will derive substantial benefits from the extension of credit to the Borrower under the Credit Agreement and are willing to execute and deliver this Agreement in order to induce the Lenders and the Issuing Banks to extend such credit. Accordingly, the parties hereto agree as follows:

SECTION 1. Terms. Each capitalized term used but not otherwise defined herein shall have the meaning specified in the Credit Agreement or the Collateral Agreement, as applicable. The rules of construction specified in Section 1.03 of the Credit Agreement also apply to this Agreement, *mutatis mutandis*.

SECTION 2. Grant of Security Interest. As security for the payment or performance, as the case may be, in full of the Obligations, each Grantor, pursuant to the Collateral Agreement, did and hereby does grant to the Administrative Agent and its permitted successors and assigns, for the benefit of the Secured Parties, a security interest in all of such Grantor’s right, title and interest in, to and under the portion of the Article 9 Collateral constituting Patents (including those listed on Schedule I hereto), subject to the exclusions set forth in Section 4.01(d) of the Collateral Agreement (collectively, the “*Patent Collateral*”).

SECTION 3. Collateral Agreement. This Agreement has been executed and delivered by the Grantors for the purpose of recording the grant of security interest herein with the United States Patent and Trademark Office. The security interest granted hereby has been granted to the Administrative Agent for the benefit of the Lenders in connection with the Collateral Agreement and is expressly subject to the terms and conditions thereof. Each Grantor hereby acknowledges and affirms that the rights and remedies of the Administrative Agent with respect to the Patent Collateral are more fully set forth in the Collateral Agreement, the terms and provisions of which are hereby incorporated herein by reference as if fully set forth herein. In the event of any conflict between the terms of this Agreement and the Collateral Agreement, the terms of the Collateral Agreement shall govern.

SECTION 4. Counterparts. This Agreement may be executed in counterparts (and by different parties hereto on different counterparts), each of which shall constitute an original, but all of which when taken together shall constitute a single contract. Delivery of an executed counterpart of a signature page of this Agreement by facsimile or other electronic imaging shall be effective as delivery of a manually executed counterpart of this Agreement.

SECTION 5. CHOICE OF LAW. THIS AGREEMENT AND ANY CLAIM, CONTROVERSY, DISPUTE OR CAUSE OF ACTION (WHETHER IN CONTRACT OR TORT OR OTHERWISE) BASED UPON, ARISING OUT OF OR RELATING TO THIS AGREEMENT SHALL

BE GOVERNED BY, AND CONSTRUED IN ACCORDANCE WITH, THE LAW OF THE STATE OF NEW YORK.

[SIGNATURE PAGES FOLLOW]

IN WITNESS WHEREOF, the parties hereto have duly executed this Agreement as of the day and year first above written.

APERGY BMCS ACQUISITION CORP.,
as Grantor



By: _____
Name: Curtis Stucki
Title: Vice President, Chief Financial Officer
and Treasurer

APERGY ESP SYSTEMS, LLC,
HARBISON-FISCHER, INC.,
NORRIS RODS, INC.,
PCS FERGUSON, INC.,
as Grantors

By: _____
Name: Daniel T. Erdman
Title: Vice President and Treasurer

CHAMPIONX USA INC.,
as Grantor

By: _____
Name: Antoine Marcos
Title: Vice President, Chief Financial Officer
and Treasurer

US SYNTHETIC CORPORATION,
as Grantor

By: _____
Name: Robert Galloway
Title: President

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CHAMPIONX USA INC.,
as Grantor

By: _____
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US SYNTHETIC CORPORATION,
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as Grantors

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Title: Vice President and Treasurer

CHAMPIONX USA INC.,
as Grantor

Antoine Marcos

By: _____
Name: Antoine Marcos
Title: Vice President, Chief Financial Officer
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US SYNTHETIC CORPORATION,
as Grantor

By: _____
Name: Robert Galloway
Title: President

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as Grantor

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Title: Vice President, Chief Financial Officer
and Treasurer

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HARBISON-FISCHER, INC.,
NORRIS RODS, INC.,
PCS FERGUSON, INC.,
as Grantors

By: _____
Name: Daniel T. Erdman
Title: Vice President and Treasurer

CHAMPIONX USA INC.,
as Grantor

By: _____
Name: Antoine Marcos
Title: Vice President, Chief Financial Officer
and Treasurer

US SYNTHETIC CORPORATION,
as Grantor

By: Rob Galloway
Name: Robert Galloway
Title: President

By:

Name: Daniel T. Erdman

Title: Vice President and Treasurer

JPMORGAN CHASE BANK, N.A.,
as Administrative Agent

By: 

Name: Arina Mavilian
Title: Executive Director

SCHEDULE I

Patents

Registered Owner	Title	Pat. No./ Publ. No. / Appl. No.	Issue Date Pub. Date App. Date
Apergy BMCS Acquisition Corporation	PICK INCLUDING POLYCRYSTALLINE DIAMOND COMPACT	{20220120180} 17/448813	{4/21/2022} 9/24/2021
Apergy ESP Systems, LLC	DOWNHOLE CENTRIFUGAL PUMP DIFFUSER WITH PROTUBERANT VANES AND RELATED PUMPS AND METHODS	{20220065266} 17/507763	{3/3/2022} 10/21/2021
ChampionX USA Inc.	COMPOSITION AND METHOD FOR RECOVERING HYDROCARBON FLUIDS FROM A SUBTERRANEAN RESERVOIR	10214679 14/804973	2/26/2019 7/21/2015
ChampionX USA Inc.	METHODS OF MAKING ACRYLAMIDE-ACRYLIC ACID COPOLYMERS	10501625 15/190364	12/10/2019 6/23/2016
ChampionX USA Inc.	FLUORESCENT WATER TREATMENT COMPOUNDS AND METHOD OF USE	{20220024788} 17/484547	{1/27/2022} 9/24/2021
ChampionX USA Inc.	COMPOSITIONS AND METHODS FOR CORROSION INHIBITOR MONITORING	{20210163818} 17/167314	{6/3/2021} 2/4/2021
ChampionX USA Inc.	COMPOSITIONS FOR ENHANCED OIL RECOVERY	{20220106515} 17/552858	{4/7/2022} 12/16/2021
ChampionX USA Inc.	FLUID DIVERSION COMPOSITION IN WELL STIMULATION	{20210122967} 17/139539	{4/29/2021} 12/31/2020
ChampionX USA Inc.	ALKYL LACTONE-DERIVED CORROSION INHIBITORS	{20210246360} 17/234601	{8/12/2021} 4/19/2021
ChampionX USA Inc.	USE OF MULTIPLE CHARGED CATIONIC COMPOUNDS DERIVED FROM POLYAMINES FOR CLAY STABILIZATION IN OIL AND GAS OPERATIONS	{20210332288} 17/305069	{10/28/2021} 6/30/2021
Harbison-Fisher, Inc.	BALL CHECK-VALVE FOR LINEAR RECIPROCATING DOWNHOLE PUMPS	{20220090470} 17/483753	{3/24/2022} 9/23/2021
Harbison-Fisher, Inc.	PARTICULATE SEPARATOR FOR PRODUCTION WELLS	{20200308950} 16/826029	{10/1/2020} 3/20/2020
PCS Ferguson, Inc.	TORPEDO PLUNGER	{20220112792}	{4/14/2022}

Registered Owner	Title	Pat. No./ Publ. No. / Appl. No.	Issue Date Pub. Date App. Date
		17/483430	9/23/2021
PCS Ferguson, Inc.	GAS LIFT VALVE AGING PROCESS AND APPARATUS	{20210246769} 17/156765	{8/12/2021} 1/25/2021
US Synthetic Corporation	POLYCRYSTALLINE DIAMOND TABLES AND COMPACTS AND RELATED METHODS	{20220001348} 17/479553	{1/6/2022} 9/20/2021
US Synthetic Corporation	BEARING APPARATUS	{20210355991} 17/244755	{11/18/2021} 4/29/2021
US Synthetic Corporation	SHEAR CUTTER PICK MILLING SYSTEM	{20210262179} 17/234400	{8/26/2021} 4/19/2021
US Synthetic Corporation	ASSEMBLIES AND APPARATUSES INCLUDING SUPERHARD ELEMENTS	{20210239159} 17/237017	{8/5/2021} 4/21/2021
US Synthetic Corporation	CORROSION RESISTANT BEARING ELEMENTS, BEARING ASSEMBLIES, BEARING APPARATUSES, AND MOTOR ASSEMBLIES USING THE SAME	{20210131488} 17/148145	{5/6/2021} 1/13/2021
US Synthetic Corporation	BEARING ASSEMBLIES, RELATED BEARING APPARATUSES, AND RELATED METHODS	{20210381549} 17/238472	{12/9/2021} 4/23/2021
US Synthetic Corporation Ulterra Drilling Technologies, L.P.	SHAPED CUTTERS	11255129 16/249824	2/22/2022 1/16/2019
US Synthetic Corporation	SUPERABRASIVE COMPACTS, METHODS OF MAKING THE SAME, AND APPARATUSES USING THE SAME	{20200256133} 16/787214	{8/13/2020} 2/11/2020
US Synthetic Corporation	CUTTING TOOL	D908753 29/723823	1/26/2021 2/11/2020
US Synthetic Corporation	CUTTING TOOL	D914070 29/723822	3/23/2021 2/11/2020
US Synthetic Corporation	DRILL BIT	D947910 29/786961	4/5/2022 6/3/2021

Patent Applications

Registered Owner	Title	Appl. No.	App. Date
Apergy BMCS Acquisition Corporation	PERCUSSION DRILL BIT WITH AT LEAST ONE WEAR INSERT, RELATED SYSTEMS, AND METHODS	17/455804	11/19/2021
Apergy BMCS Acquisition Corporation	MATERIAL-REMOVAL SYSTEMS, CUTTING TOOLS THEREFOR, AND RELATED METHODS	17/306704	5/3/2021
Harbison-Fisher, Inc.	BALL CHECK-VALVE FOR LINEAR RECIPROCATING DOWNHOLE PUMPS	17/691051	3/9/2022
Harbison-Fisher, Inc.	SHEAR COUPLING FOR SUCKER ROD STRING	17/550221	12/14/2021
Norris Rods, Inc.	GEAR ROD ROTATOR SYSTEMS	17/589765	1/31/2022
PCS-Ferguson, Inc.	BEARING ASSEMBLIES, APPARATUSES, DEVICES, SYSTEMS, AND METHODS INCLUDING BEARINGS	17/549628	12/13/2021
Theta Oilfield Services, Inc.	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE	17/549519	12/13/2021
US Synthetic Corporation	LEACHED SUPERABRASIVE ELEMENTS AND SYSTEMS, METHODS AND ASSEMBLIES FOR PROCESSING SUPERABRASIVE MATERIALS	16/993055	8/13/2020
US Synthetic Corporation	LEACHED SUPERABRASIVE ELEMENTS AND SYSTEMS, METHODS AND ASSEMBLIES FOR PROCESSING SUPERABRASIVE MATERIALS	17/592388	2/3/2022
US Synthetic Corporation	MULTI-PART SUPERABRASIVE COMPACTS, ROTARY DRILL BITS INCLUDING MULTI-PART SUPERABRASIVE COMPACTS, AND RELATED METHODS	17/451535	10/20/2021
US Synthetic Corporation	LEACHED SUPERABRASIVE ELEMENTS AND SYSTEMS, METHODS AND ASSEMBLIES FOR PROCESSING SUPERABRASIVE MATERIALS	16/909838	6/23/2020
US Synthetic Corporation	LEACHED SUPERABRASIVE ELEMENTS AND LEACHING SYSTEMS METHODS AND ASSEMBLIES FOR PROCESSING SUPERABRASIVE ELEMENTS	17/061419	10/1/2020

Registered Owner	Title	Appl. No.	App. Date
US Synthetic Corporation	METHODS OF PROCESSING A POLYCRYSTALLINE DIAMOND ELEMENT	17/518100	11/3/2021
US Synthetic Corporation	SYSTEMS AND METHODS FOR MOUNTING A CUTTER IN A DRILL BIT	17/360704	6/28/2021
US Synthetic Corporation	POLYCRYSTALLINE DIAMOND COMPACT AND APPLICATIONS THEREFOR	17/323537	5/18/2021
US Synthetic Corporation	RADIAL BEARING	29/734635	5/14/2020
US Synthetic Corporation	RADIAL BEARING	29/734689	5/14/2020
US Synthetic Corporation	DRILL BIT	29/830851	3/15/2022
US Synthetic Corporation	BEARING ASSEMBLIES, RELATED BEARING APPARATUSES AND RELATED METHODS	17/587734	1/28/2022
US Synthetic Corporation	POLYCRYSTALLINE DIAMOND COMPACTS, METHODS OF MAKING SAME, AND APPLICATIONS THEREFOR	17/550864	12/14/2021
US Synthetic Corporation	CUTTING TOOL WITH PCD INSERTS, SYSTEMS INCORPORATING SAME AND RELATED METHODS	17/678819	2/23/2022
US Synthetic Corporation	METHODS OF LEACHING A SUPERABRASIVE BODY AND APPARATUSES AND SYSTEMS FOR THE SAME	17/707569	3/29/2022
US Synthetic Corporation	NOZZLES, NOZZLE ASSEMBLIES INCLUDING THE SAME, AND METHODS OF USING THE SAME	17/713161	4/4/2022
US Synthetic Corporation	NOZZLES INCLUDING POLYCRYSTALLINE DIAMOND OR POLYCRYSTALLINE CUBIC BORON NITRIDE	17/713170	4/4/2022
US Synthetic Corporation	POLYCRYSTALLINE DIAMOND COMPACTS AND METHODS OF FABRICATING SAME	16/935475	7/22/2020
US Synthetic Corporation	SUPERHARD COMPACTS, ASSEMBLIES INCLUDING THE SAME, AND METHODS INCLUDING THE SAME	17/021752	9/15/2020
US Synthetic Corporation	MATERIAL-REMOVAL SYSTEMS, CUTTING TOOLS, THEREFOR, AND RELATED METHODS	17/034257	9/28/2020
US Synthetic Corporation	CUTTING TOOL	29/760765	12/3/2020
US Synthetic Corporation	PICK	29/769089	2/3/2021
US Synthetic Corporation	POLYCRYSTALLINE DIAMOND	17/680729	2/25/2022

Registered Owner	Title	Appl. No.	App. Date
	BODIES INCLUDING ONE OR MORE THREADS, APPARATUSES INCLUDING THE SAME, AND METHODS OF FORMING AND USING THE SAME		
US Synthetic Corporation	BEARING ASSEMBLIES, APPARATUSES, AND METHODS INCLUDING BEARING ELEMENTS	17/401112	8/12/2021
US Synthetic Corporation	TORQUE COUPLING ASSEMBLIES AND RELATED SYSTEMS AND METHODS	17/401030	8/12/2021
US Synthetic Corporation	ASSEMBLIES AND METHODS OF FORMING POLYCRYSTALLINE DIAMOND USING SUCH ASSEMBLIES	17/363410	6/30/2021
US Synthetic Corporation	BEARING ASSEMBLIES, APPARATUSES, AND METHODS INCLUDING BEARING ELEMENTS	17/318365	5/12/2021
US Synthetic Corporation	RADIALLY ADJUSTABLE RADIAL PDC BEARINGS	US2021/013627	01/15/2021
US Synthetic Corporation	ATTACHMENT OF PDC BEARING MEMBERS, BEARING ASSEMBLIES INCORPORATING SAME AND RELATED METHODS	US2021/031561	5/10/2021
ChampionX USA Inc.	IMIDAZOLINE-DERIVED COMPOUNDS AND USE AS NATURAL GAS HYDRATE INHIBITORS	US2021/038902	6/24/2021
Harbison-Fischer, Inc.	SHEAR COUPLING FOR SUCKER ROD STRING	US2021/063349	1/7/2022
PCS Ferguson, Inc.	SINGLE PILOT FLUID LINE ACTUATION GAS LIFT VALVE AND RELATED SYSTEMS AND METHODS (Gas Lift Valve Patent Application)	63/309936	2/14/2022
US Synthetic Corporation	SUPERHARD CUTTING ELEMENTS, CUTTING TOOLS INCLUDING THE SAME, AND METHODS OF USING THE SAME	63/320914	3/17/2022
US Synthetic Corporation	POLYCRYSTALLINE DIAMOND ELEMENT INCLUDING AT LEAST ONE LEACHING FEATURE, CUTTING TOOL INSERTS AND SYSTEMS INCORPORATING SAME, AND RELATED METHODS	63/318663	3/11/2022

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		17549519
	Filing Date		2021-12-13
	First Named Inventor	Terry Treiberg	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	CHX.1002US	

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS						Remove
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20030236627	A1	2003-12-25	Robert Estes	
	2	20080035376	A1	2008-02-14	Carsten Freyer	
	3	20190203579	A1	2019-07-04	Walter Phillips	
	4	20200123892	A1	2020-04-23	Eduardo N. Picon	
	5	20200392834	A1	2020-12-17	Mahmut Sengul	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS						Remove
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**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number		17549519
Filing Date		2021-12-13
First Named Inventor	Terry Treiberg	
Art Unit		
Examiner Name		
Attorney Docket Number	CHX.1002US	

Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ² i	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1							

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	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, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1	International Search Report and Written Opinion for PCT/US2022/049624, 16 February 2023, 10 pages	

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	
--------------------	--	-----------------	--

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

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	17549519
Filing Date	2021-12-13
First Named Inventor	Terry Treiberg
Art Unit	
Examiner Name	
Attorney Docket Number	CHX.1002US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/GCB/	Date (YYYY-MM-DD)	2023-02-27
Name/Print	Gregory C. Baker	Registration Number	61,335

This collection of information is required by 37 CFR 1.97 and 1.98. 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 1 hour 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.**

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 the Freedom of Information Act requires disclosure of these records.
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 inspections 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.

Electronic Acknowledgement Receipt

EFS ID:	47599810
Application Number:	17549519
International Application Number:	
Confirmation Number:	4428
Title of Invention:	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE
First Named Inventor/Applicant Name:	Terry Treiberg
Customer Number:	184959
Filer:	Gregory C. Baker
Filer Authorized By:	
Attorney Docket Number:	CHX.1002US
Receipt Date:	27-FEB-2023
Filing Date:	13-DEC-2021
Time Stamp:	21:10:50
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	2023-02-27_ISRWO.pdf	2356746	no	10
			d0e9d3cfc6e557bae65868da29e9c2722d83df1		

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	2023-02-27_IDS.pdf	1263430	no	4
			8a88b483fd8b58634ff53bb52ba56af7f87f911f		
Warnings:					
Information:					
Total Files Size (in bytes):			3620176		
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. <u>New Applications Under 35 U.S.C. 111</u> 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. <u>National Stage of an International Application under 35 U.S.C. 371</u> 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. <u>New International Application Filed with the USPTO as a Receiving Office</u> 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.					

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To: GREGORY BAKER
PCFB LLC
4001 S. 700 E. SUITE 500
SALT LAKE CITY, UT 84107

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL SEARCH REPORT AND
THE WRITTEN OPINION OF THE INTERNATIONAL
SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Date of mailing
(day/month/year)

FEB 16 2023

Applicant's or agent's file reference

CHX-1002PC

FOR FURTHER ACTION See paragraphs 1 and 4 below

International application No.

PCT/US2022/049624

International filing date
(day/month/year)

10 November 2022

Applicant

THETA OILFIELD SERVICES, INC.

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46).

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

How? Directly to the International Bureau preferably through ePCT, or on paper to:
The International Bureau of WIPO, 34, chemin des Colombettes, 1211 Geneva 20, Switzerland
(Facsimile No.: +41 22 338 82 70)

For more detailed instructions, see the *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ With regard to any protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest, the applicant will be notified as soon as a decision is made.

4. Reminders

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

Shortly after the expiration of 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90bis 1 and 90bis 3).

Within 19 months from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later); otherwise, the applicant must, within 20 months from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices. In respect of other designated Offices, the time limit of 30 months (or later) will apply even if no demand is filed within 19 months. For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Within 22 months from the priority date, the applicant may request that a supplementary international search be carried out by a different International Searching Authority that offers this service (Rule 45bis 1). The procedure for requesting supplementary international search is described in the *PCT Applicant's Guide*, International Phase, paragraphs 8.006–8.032.

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450, Alexandria, VA 22313-1450
Facsimile No. 571-273-8300

Authorized officer

Taina Matos

Telephone No. PCT Helpdesk: 571-272-4300

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference CHX-1002PC		FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/US2022/049624	International filing date (day/month/year) 19 November 2022	(Earliest) Priority Date (day/month/year) 13 December 2021	
Applicant THETA OILFIELD SERVICES, INC.			

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 1 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the language, the international search was carried out on the basis of:

- ☒ the international application in the language in which it was filed.
☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 43.6bis(a)).

c. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, see Box No. I.

2. ☐ Certain claims were found unsearchable (see Box No. II).

3. ☐ Unity of invention is lacking (see Box No. III).

4. With regard to the title,

- ☒ the text is approved as submitted by the applicant.
☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

- ☒ the text is approved as submitted by the applicant.
☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the drawings,

a. the figure of the drawings to be published with the abstract is Figure No. 1

- ☒ as suggested by the applicant.
☐ as selected by this Authority, because the applicant failed to suggest a figure.
☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2022/049624

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - INV. - E21B 47/009 (2023.01)

ADD. - E21B 47/022; E21B 47/092; E21B 47/095; F01D 21/00; F04B 49/06 (2023.01)

CPC - INV. - E21B 47/009 (2023.01)

ADD. - E21B 47/022; E21B 47/092; F01D 21/003; F04B 49/065; G01D 5/145 (2023.01)

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)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History document

Electronic database consulted during the international search (name of database and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2003/0236627 A1 (ESTES) 25 December 2003 (25.12.2003) entire document	1-20
A	US 2019/0203579 A1 (PHILLIPS) 04 July 2019 (04.07.2019) entire document	1-20
A	US 2008/0035376 A1 (FREYER) 14 February 2008 (14.02.2008) entire document	1-20
A	US 2020/0392634 A1 (NOVEN INC.) 17 December 2020 (17.12.2020) entire document	1-20
A	US 2020/0123892 A1 (PICON) 23 April 2020 (23.04.2020) entire document	1-20

☐ 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

"D" document cited by the applicant in the international application

"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

17 January 2023

Date of mailing of the international search report

FEB 16 2023

Name and mailing address of the ISA/

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, VA 22313-1450

Facsimile No. 571-273-8300

Authorized officer

Taina Matos

Telephone No. PCT Helpdesk: 571-272-4300

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

To: GREGORY BAKER PCFB LLC 4001 S. 700 E. SUITE 500 SALT LAKE CITY, UT 84107
--

Date of mailing (day/month/year)	FEB 16 2023
-------------------------------------	--------------------

Applicant's or agent's file reference CHX-1002PC		FOR FURTHER ACTION See paragraph 2 below
International application No. PCT/US2022/049624	International filing date (day/month/year) 10 November 2022	Priority date (day/month/year) 13 December 2021
International Patent Classification (IPC) or both national classification and IPC IPC(8) - INV. - E21B 47/009 (2023.01) ADD. - E21B 47/022; E21B 47/092; E21B 47/095; F01D 21/00; F04B 49/06 (2023.01) CPC - INV. - E21B 47/009 (2023.01) ADD. - E21B 47/022; E21B 47/092; F01D 21/003; F04B 49/065; G01D 5/145 (2023.01)		
Applicant THETA OILFIELD SERVICES, INC.		

1. This opinion contains indications relating to the following items:	
☒ Box No. I	Basis of the opinion
☐ Box No. II	Priority
☐ Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐ Box No. IV	Lack of unity of invention
☒ Box No. V	Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
☐ Box No. VI	Certain documents cited
☐ Box No. VII	Certain defects in the international application
☐ Box No. VIII	Certain observations on the international application
2. FURTHER ACTION	
If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered. If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later. For further options, see Form PCT/ISA/220.	

Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/IS Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Date of completion of this opinion 17 January 2023	Authorized officer Taina Matos PCT Helpdesk: 571-272-4300 Telephone No. 571-272-4300
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Form PCT/ISA/237 (cover sheet) (July 2022)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/US2022/049624

Box No. 1 Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:
☒ the international application in the language in which it was filed.
☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
2. ☐ This opinion has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(b)).
3. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, this opinion has been established on the basis of a sequence listing:
 - a. ☐ forming part of the international application as filed.
 - b. ☐ furnished subsequent to the international filing date for the purposes of international search (Rule 13ter.1(a)),
☐ accompanied by a statement to the effect that the sequence listing does not go beyond the disclosure in the international application as filed.
4. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, this opinion has been established to the extent that a meaningful opinion could be formed without a WIPO Standard ST.26 compliant sequence listing.
5. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/US2022/049624

Box No. V	Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement			
1. Statement				
Novelty (N)	Claims	1-20	YES	
	Claims	None	NO	
Inventive step (IS)	Claims	1-20	YES	
	Claims	None	NO	
Industrial applicability (IA)	Claims	1-20	YES	
	Claims	None	NO	
2. Citations and explanations:				
Claims 1-20 meet the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest: Regarding claim 1, the prior art of record, individually or in combination, does not teach or fairly suggest a sensor system for a downhole pumping system, comprising: a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising: an axial motion sensor subsystem comprising a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system; and a rotation sensor subsystem comprising a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system; and a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to: determine axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and determine rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system with the gyroscope. Claims 2-12 depend from claim 1, and therefore meet the criteria set out in PCT Article 33(2)-(3) for at least the same reasons as claim 1. The following prior art is made of record to support and further define the reasons that claim 1 meets the criteria set out in PCT Article 33(2)-(3): (i) US 2003/0236627 to Estes is in the art of measurement while drilling downhole assembly (abstract) and teaches a sensor system (Para. [0075], sensor section 400 at Fig. 4) for a downhole pumping system (Para. [0042], drilling system 10 at Fig. 1), comprising: a sensor subsystem (Para. [0075], sensor section 400 at Fig. 4) for detecting movement of at least one component (Para. [0075], housing 430 at Fig. 4) of the downhole pumping system (drilling system 10), the sensor subsystem (sensor section 400) comprising: an axial motion sensor subsystem (Para. [0075], [0076], axial motion sensor subsystem [unlabeled] comprises magnetometers 426a, 426b, 426c at Fig. 4) comprising a magnetometer (Para. [0075], [0076], magnetometers 426a, 426b, 426c at Fig. 4), the magnetometer (magnetometers 426a, 426b, 426c) to be coupled to the at least one component (Para. [0075], housing 430 at Fig. 4) of the downhole pumping system (drilling system 10) and to detect axial movement (Para. [0075], magnetometers 426a, 426b, 426c detect axial movement) of the at least one component (housing 430) of the downhole pumping system (drilling system 10) based on variations in a magnet field (Para. [0076], "magnetic field disturbances") detected by the magnetometer (magnetometers 426a, 426b, 426c) generated by movement of the at least one component (housing 430) of the downhole pumping system (Para. [0075], [0076], drilling system 10), and a rotation sensor subsystem (Para. [0075], rotation sensor subsystem [unlabeled] comprises gyroscopes 404, 412 at Fig. 4) comprising a gyroscope (Para. [0075], gyroscopes 404, 412 at Fig. 4), the gyroscope (gyroscopes 404, 412) to be coupled to the at least one component (gyroscopes 404, 412 are coupled to housing 430 at Fig. 4) of the downhole pumping system (drilling system 10) and to detect rotational movement (Para. [0077], gyroscopes 404, 412 can measure different angles) of the at least one component (housing 430) of the downhole pumping system (drilling system 10); and a processor subsystem (Para. [0046], processor 40 at Fig. 1). Estes fails to explicitly disclose wherein the gyroscope detects rotational movement by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system; wherein the processor subsystem receives data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to: determine axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and determine rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system with the gyroscope. (ii) US 2019/0203879 to Phillips is in the art of apparatus for monitoring rod rotation in a rod lift system (abstract) and teaches a sensor system (Para. [0074], rod rotator system 200 at Fig. 2) for a downhole pumping system (Para. [0065], rod pumping system 100 at Fig. 1), comprising: a sensor subsystem (Para. [0078], rotational sensing device 201 at Fig. 2) for detecting movement of at least one component (Para. [0066], polished rod 101 at Fig. 2) of the downhole pumping system (Para. [0078], rod pumping system 100), the sensor subsystem (rotational sensing device 201) comprising: a magnetometer (Para. [0066], rotational sensing device 201 may comprise a magnetometer, not shown in figures), the magnetometer (said magnetometer) to be coupled to the at least one component (Para. [0066], polished rod 101 at Fig. 2) of the downhole pumping system (rod pumping system 100) and to detect axial movement (Para. [0067], rotational sensing device 201 detects vertical motion) of the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100); and comprising a gyroscope (Para. [0066], rotational sensing device 201 may comprise a gyroscope), the gyroscope (said gyroscope) to be coupled to the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100) and to detect rotational movement (Para. [0078], rotational sensing device 201 senses rotation) of the at least one component (polished				

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/US2022/049624

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

rod 101) of the downhole pumping system (rod pumping system 100) by detecting rotational velocity values (Para. [0110], rotational acceleration, velocity are detected) with the gyroscope (Para. [0110], said gyroscope detects rotational acceleration and velocity) generated by rotation of the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100); and a processor subsystem (Para. [0150], processor 901 at Fig. 9), the processor subsystem (processor 901) to: determine axial movement (processor 901 is coupled to said magnetometer as shown at Fig. 9) of the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100); and determine rotational velocity (processor 901 is coupled to said gyroscope as shown at Fig. 9) of the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100). Phillips fails to explicitly disclose an axial motion sensor subsystem; wherein in detection is based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system; a rotation sensor subsystem; wherein the processor is configured to receive data from the axial motion sensor subsystem and the rotation sensor subsystem; with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system with the gyroscope.

None of the cited prior art teaches or fairly suggests wherein the processor is configured to receive data from the axial motion sensor subsystem and the rotation sensor subsystem; with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system with the gyroscope.

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:

Regarding claim 13, the prior art of record, individually or in combination, does not teach or fairly suggest a sensor system for a downhole pumping system, comprising: a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising: an axial motion sensor subsystem comprising an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations detected by the axial motion sensor generated by movement of the at least one component of the downhole pumping system; and a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system; and a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to: verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and when the axial movement has been verified, determine rotational velocity of the at least one component of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

Claims 14 and 15 depend from claim 13, and therefore meet the criteria set out in PCT Article 33(2)-(3) for at least the same reasons as claim 13.

The following prior art is made of record to support and further define the reasons that claim 13 meets the criteria set out in PCT Article 33(2)-(3):

(i) Estes is in the art of measurement while drilling downhole assembly (abstract) and teaches a sensor system (Para. [0075], sensor section 400 at Fig. 4) for a downhole pumping system (Para. [0042], drilling system 10 at Fig. 1), comprising: a sensor subsystem (Para. [0075], sensor section 400 at Fig. 4) for detecting movement of at least one component (Para. [0075], housing 430 at Fig. 4) of the downhole pumping system (drilling system 10), the sensor subsystem (sensor section 400) comprising: an axial motion sensor subsystem (Para. [0075];[0076], axial motion sensor subsystem [unlabeled]) comprising magnetometers 426a, 426b, 426c at Fig. 4) comprising an axial motion sensor (Para. [0075];[0076], magnetometers 426a, 426b, 426c at Fig. 4), the axial motion sensor (magnetometers 426a, 426b, 426c) to be coupled to the at least one component (Para. [0075], housing 430 at Fig. 4) of the downhole pumping system (drilling system 10) and to detect axial movement (Para. [0076], magnetometers 426a, 426b, 426c detect axial movement) of the at least one component (housing 430) of the downhole pumping system (drilling system 10) based on variations detected by the axial motion sensor (magnetometers 426a, 426b, 426c) generated by movement of the at least one component (housing 430) of the downhole pumping system (Para. [0075];[0076], drilling system 10); and a rotation sensor subsystem (Para. [0075], rotation sensor subsystem [unlabeled]) comprising gyroscopes 404, 412 at Fig. 4) comprising a rotational sensor (Para. [0075], gyroscopes 404, 412 at Fig. 4), the rotational sensor (gyroscopes 404, 412) to be coupled to the at least one component (gyroscopes 404, 412 are coupled to housing 430 at Fig. 4) of the downhole pumping system (drilling system 10) and to detect rotational movement (Para. [0077], gyroscopes 404, 412 can measure different angles) of the at least one component (housing 430) of the downhole pumping system (drilling system 10); and a processor subsystem (Para. [0046], processor 40 at Fig. 1). Estes fails to explicitly disclose wherein the rotational sensor detects rotational movement by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system; wherein the processor subsystem receives data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to: verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and when the axial movement has been verified, determine rotational velocity of the at least one component of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

(ii) Phillips is in the art of apparatus for monitoring rod rotation in a rod lift system (abstract) and teaches a sensor system (Para. [0074], rod rotator system 200 at Fig. 2) for a downhole pumping system (Para. [0065], rod pumping system 100 at Fig. 1), comprising: a sensor subsystem (Para. [0078], rotational sensing device 201 at Fig. 2) for detecting movement of at least one component (Para. [0098], polished rod 101 at Fig. 2) of the downhole pumping system (Para. [0078], rod pumping system 100), the sensor subsystem (rotational sensing device 201) comprising: an axial motion sensor (Para. [0086], rotational sensing device 201 may comprise a magnetometer, not shown in figures), the axial motion sensor (said magnetometer) to be coupled to the at least one component (Para. [0098], polished rod 101 at Fig. 2) of the downhole pumping system (rod pumping system 100) and to detect axial movement (Para. [0087], rotational sensing device 201 detects vertical motion) of the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100); and comprising a rotational sensor (Para. [0086], rotational sensing device 201 may comprise a gyroscope), the rotational sensor (said gyroscope) to be coupled to the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100) and to detect rotational movement (Para. [0078], rotational sensing device 201 senses rotation) of the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100) by sampling rotational velocity values (Para. [0110], rotational acceleration, velocity are detected) with the rotational sensor (Para. [0110], said gyroscope detects rotational acceleration and velocity) generated by rotation of the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100); and a processor subsystem (Para. [0150], processor 901 at Fig. 9), the processor subsystem (processor 901) to: verify the axial movement (processor 901 is coupled to said magnetometer as shown at Fig. 9) of the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100); and determine rotational velocity (processor 901 is coupled to said gyroscope as shown at Fig. 9) of the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100). Phillips fails to explicitly disclose an axial motion sensor subsystem; wherein in detection is based on variations detected by the axial motion sensor generated by movement of the at least one component of the downhole pumping system; a rotation sensor subsystem; wherein the processor is configured to receive data from the axial motion sensor subsystem and the rotation sensor subsystem; when the axial movement has been verified determines rotational velocity with the rotational velocity values detected by the rotation sensor subsystem.

None of the cited prior art teaches or fairly suggests wherein the processor is configured to receive data from the axial motion sensor subsystem and the rotation sensor subsystem; when the axial movement has been verified determine rotational velocity with the rotational velocity values detected by the rotation sensor subsystem.

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/US2022/049624

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:

Regarding claim 16, the prior art of record, individually or in combination, does not teach or fairly suggest a sensor system for a downhole pumping system, comprising: a sensor subsystem for detecting movement of a tubing rotator of the downhole pumping system, the sensor subsystem comprising a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the tubing rotator of the downhole pumping system and to detect rotational movement of the tubing rotator of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the tubing rotator of the downhole pumping system; and a processor subsystem to receive data from the rotation sensor subsystem, the processor subsystem to determine rotational velocity of the tubing rotator of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

Claims 17 and 18 depend from claim 16, and therefore meet the criteria set out in PCT Article 33(2)-(3) for at least the same reasons as claim 16.

The following prior art is made of record to support and further define the reasons that claim 16 meets the criteria set out in PCT Article 33(2)-(3):

(i) Estes is in the art of measurement while drilling downhole assembly (abstract) and teaches a sensor system (Para. [0075], sensor section 400 at Fig. 4) for a downhole pumping system (Para. [0042], drilling system 10 at Fig. 1), comprising: a sensor subsystem (Para. [0075], sensor section 400 at Fig. 4) for detecting movement (Para. [0075], housing 430 at Fig. 4) of the downhole pumping system (drilling system 10), the sensor subsystem (sensor section 400) comprising a rotation sensor subsystem (Para. [0075], rotation sensor subsystem [unlabeled] comprises gyroscopes 404, 412 at Fig. 4) comprising a rotational sensor (Para. [0075], gyroscopes 404, 412 at Fig. 4), the rotational sensor (gyroscopes 404, 412) to be coupled to the downhole pumping system (Para. [0075];[0076], drilling system 10) and to detect rotational movement (Para. [0077], gyroscopes 404, 412 can measure different angles) of the downhole pumping system (drilling system 10); and a processor subsystem (Para. [0046], processor 40 at Fig. 1).

Estes fails to explicitly disclose a tubing rotator; wherein the rotational sensor is coupled to the tubing rotator; to detect rotational movement of the tubing rotator; by sampling rotational velocity values with the rotational sensor generated by rotation of the tubing rotator of the downhole pumping system; wherein to receive data from the rotation sensor subsystem, the processor subsystem to determine rotational velocity of the tubing rotator of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

(ii) Phillips is in the art of apparatus for monitoring rod rotation in a rod lift system (abstract) and teaches a sensor system (Para. [0074], rod rotator system 200 at Fig. 2) for a downhole pumping system (Para. [0065], rod pumping system 100 at Fig. 1), comprising: a sensor subsystem (Para. [0078], rotational sensing device 201 at Fig. 2) for detecting movement of the downhole pumping system (Para. [0078], rod pumping system 100), the sensor subsystem (rotational sensing device 201) comprising a rotational sensor (Para. [0086], rotational sensing device 201 may comprise a gyroscope), the rotational sensor (said gyroscope) to be coupled to the downhole pumping system (rod pumping system 100) and to detect rotational movement (Para. [0078], rotational sensing device 201 senses rotation) of the downhole pumping system (rod pumping system 100) by sampling rotational velocity values (Para. [0110], rotational acceleration, velocity are detected) with the rotational sensor (Para. [0110], said gyroscope detects rotational acceleration and velocity) generated by rotation of the downhole pumping system (rod pumping system 100); and a processor subsystem (Para. [0150], processor 901 at Fig. 9), the processor subsystem (processor 901) to determine rotational velocity (processor 901 is coupled to said gyroscope as shown at Fig. 9) of the downhole pumping system (rod pumping system 100).

Phillips fails to explicitly disclose a tubing rotator; a rotation sensor subsystem; the rotational sensor coupled to the tubing rotator; detecting rotational movement of the tubing rotator; generated by rotation of the tubing rotator; the processor subsystem to receive data from: the rotation sensor subsystem; determining rotational velocity of the tubing rotator with the rotational velocity values detected by the rotation sensor subsystem.

None of the cited prior art teaches or fairly suggests a tubing rotator; the rotational sensor coupled to the tubing rotator; detecting rotational movement of the tubing rotator; generated by rotation of the tubing rotator; the processor subsystem to receive data from: the rotation sensor subsystem; determining rotational velocity of the tubing rotator with the rotational velocity values detected by the rotation sensor subsystem.

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/US2022/049624

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:

Regarding claim 19, the prior art of record, individually or in combination, does not teach or fairly suggest a method of detecting motion of at least one component of a downhole pumping system, the method comprising: detecting axial movement of at least one component of the downhole pumping system based on variations detected by an axial motion sensor coupled to the at least one component of the downhole pumping system generated by translation of the at least one component of the downhole pumping system; detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system; and verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the at least one component of the downhole pumping system with the rotational sensor.

Claim 20 depends from claim 19, and therefore meets the criteria set out in PCT Article 33(2)-(3) for at least the same reasons as claim 19.

The following prior art is made of record to support and further define the reasons that claim 19 meets the criteria set out in PCT Article 33(2)-(3):

(i) Estes is in the art of measurement while drilling downhole assembly (abstract) and teaches a method of detecting motion of at least one component (Para. [0075], housing 430 at Fig. 4) of a downhole pumping system (Para. [0042], drilling system 10 at Fig. 1), the method comprising: detecting axial movement (Para. [0076], magnetometers 426a, 426b, 426c detect axial movement) of at least one component (housing 430) of the downhole pumping system (drilling system 10) based on variations detected by an axial motion sensor (magnetometers 426a, 426b, 426c) coupled to the at least one component (Para. [0075], housing 430 at Fig. 4) of the downhole pumping system (drilling system 10) generated by translation of the at least one component (housing 430) of the downhole pumping system (drilling system 10); detecting rotational movement (Para. [0077], gyroscopes 404, 412 can measure different angles) of the at least one component (housing 430) of the downhole pumping system (drilling system 10) with a rotational sensor (Para. [0075], gyroscopes 404, 412 at Fig. 4) generated by rotation of the at least one component (housing 430) of the downhole pumping system (drilling system 10). Estes fails to explicitly disclose the method of verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the at least one component of the downhole pumping system with the rotational sensor.

(ii) Phillips is in the art of apparatus for monitoring rod rotation in a rod lift system (abstract) and teaches a method of detecting motion of at least one component (Para. [0088], polished rod 101 at Fig. 2) of a downhole pumping system (Para. [0065], rod pumping system 100 at Fig. 1), the method comprising: detecting axial movement (Para. [0087], rotational sensing device 201 detects vertical motion) of at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100) based on variations detected by an axial motion sensor (Para. [0086], rotational sensing device 201 may comprise a magnetometer, not shown in figures) coupled to the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100) generated by translation of the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100); detecting rotational movement (Para. [0078], rotational sensing device 201 senses rotation) of the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100) with a rotational sensor (Para. [0086], rotational sensing device 201 may comprise a gyroscope) generated by rotation of the at least one component (polished rod 101) of the downhole pumping system (rod pumping system 100). Phillips fails to explicitly disclose the method of verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the at least one component of the downhole pumping system with the rotational sensor.

None of the cited prior art teaches or fairly suggests the method of verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the at least one component of the downhole pumping system with the rotational sensor.

Claims 1-20 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US

CONFIRMATION NO. 4428

PUBLICATION NOTICE



0000000138076598

184959
ChampionX/PCFB
4001 S. 700 E. Suite 500
Salt Lake City, UT 84107

Date Mailed: 06/15/2023

Title:DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Publication No.US-2023-0184089-A1

Publication Date:06/15/2023

NOTICE OF PUBLICATION OF APPLICATION

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.

The publication may be accessed through the USPTO's publicly available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to the applicant. A copy of the publication may be obtained from the Office upon payment of the application fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571)272-3150 or (800)972-6382, by facsimile at (571)273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

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3rd Party Submission pursuant to 37 CFR §1.290

This submission is in regard to application US 17/549,519 titled “Devices, systems, and methods for detecting the rotation of one or more components for use with a wellbore”, dated December 13th, 2021.

REMARKS

A description of the cited documents and their relevance is provided.

A claim chart is also provided to illustrate the prior art regarding the specific claims.

Brief description of cited documents:

The claimed priority date of US 17/549,519 is December 13, 2021. The following documents should be considered as prior art.

- US 9,140,113 Hurst et al. – “Instrumented rod rotator”
 - This is the primary disclosure of the need to monitor rods for rotation in a rod lift system. It utilizes a discrete switch to count revolutions.
 - In addition to monitoring the rod-string, this also discloses the monitoring of a tubing string.
- US 16/228,233 Phillips – “Apparatus and Method for Detecting the Rotation of a Rod-String in a Wellbore”
 - Discloses a rotation sensor for monitoring rotation including a linear component and a rotational component.
 - This further discloses utilizing a magnetometer and/or a gyro for the purpose of collectively monitoring both linear motion and rotational motion.
 - See Figure 6-9, claims 1, 8-10, 12, and discussion below.
- US 11,319,794 Fyfe et al. – “Oil-Well Pump Instrumentation Device and Method”
 - Discloses rotation sensing; “*rate-gyro sensors to sense rotational accelerations of the polished rod 224 resulting from each yank of the handle*” col 13, lines 40-42.
 - And determining the ends of the stroke with a magnetic sensor “*identifying a reference tick in each stroke uses readings of a magnetic sensor of the polished - rod dynamometer*” col 30, lines 28-30. This discloses the axial motion subsystem, as described by US 17/549,519.
 - And discloses the use of a gyro in conjunction with a magnetometer “*further includes sensing rotation of the polished rod with an accelerometer and a gyroscopic sensor in addition to sensing a magnetic field with a magnetometer*” col 32, lines 61-63
 - Further discloses monitoring a tubing rotator. See the sections “*Rod Rotator Monitor*” and “*Tubing Rotation Monitoring*” (columns 12-14).
- US 9,903,193 Harding et al. – “Systems and Methods for Sucker Rod Pump Jack Visualizations and Analytics”
 - Discloses using a gyro on the polished rod; col 5, line 60-62 “*At least one 6-Axis IMU (accelerometer plus gyroscope) may be attached to the polished rod and is referred to as the bridle sensor.*”
- US 11,339,643 Robison et al. – “Pumping unit inspection sensor assembly, system and method”
 - This relates to the vibration monitoring aspects presented in US 17/549,519.

- Discloses a gyroscope; col 4, line 19-20 “*The gyroscope 68 in this example is a sensor configured to measure a rate of rotation about at least one gyroscope axis 88*” in reference to the pumping unit crank. It further discloses a means for detecting points within the stroke of the pumping unit; figure 7 shows a 360-degree plot of crankarm vs. acceleration. This application discusses rotation, but specifically rotation of the crank arm of the pumping unit, not of the rod-string. While these are different types of rotation, this disclosure demonstrates that a gyro can be used for the purpose of monitoring at least one type of rotation.
- US 3,343,409 Gibbs – “Method of determining sucker rod pump performance”.
 - Discloses monitoring the rod lift system. Of particular relevance is the linear displacement (or “axial motion”). Further it discloses the process of summing sensor data.
- US 11,542,938 Zhao – “Polished Rod Rotation Sensor”
 - This discloses a sensor similar to that of the Hurst disclosure in that it utilizes a discrete switch to determine rotation.
 - Further discloses a means to determine position using an accelerometer.
- US 17/586,292 Navar et al. – “Rotation monitoring assembly for an artificial lift system”
 - This discloses a sensor similar to that of the Hurst disclosure in that it utilizes a discrete switch to determine rotation.
- US 10,167,707 Trapan et al. – “Rod string rotation during well pumping operations”
 - Discusses magnetic sensing of stroke position using a discrete magnet. It is noted that the use of a magnet to determine stroke position dates back to US 3,343,409 Gibbs and is a well-known method of determining position. The use of a continuous magnetometer for this purpose was introduced in US 16/228,233.
- US 11,572,770 Sengul et al. – “System and method for determining load and displacement of a polished rod”
 - Discloses a gyroscope coupled to the polished rod. Col 4, lines 50-53 “*the integrated sensor 200 includes a strain gauge 202, gyroscope 204, and accelerometer 206 which may be positioned on the polished rod 124*”.
 - See claim 1 “*a gyroscope configured to measure an orientation, an angular velocity, or both of the beam pump unit as the beam pump unit operates*”.

Concise description of relevancy:

Claims from US 17/549,519	Discussion and relative citations
1. <i>A sensor system for a downhole pumping system, comprising: a sensor subsystem for <u>detecting movement of at least one component of the downhole pumping system</u>, the sensor subsystem comprising:</i> <i><u>an axial motion sensor subsystem comprising a magnetometer</u>, the magnetometer to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system <u>based on variations in a magnet field</u> detected by the magnetometer generated by movement of the at least one component of the downhole pumping system; and</i> <i><u>a rotation sensor subsystem comprising a gyroscope</u>, the gyroscope to be coupled to the at least one component of the downhole pumping system and to <u>detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values</u> with the gyroscope generated by rotation of the at least one</i>	See US 16/228,233 claim 1: “<i>the sensor is configured to generate a signal indicative of instantaneous radial orientation of <u>a rod-string extending down into the well from a polished rod</u></i>”. See US 16/228,233 Claim 1 “<i>generate an alarm if the <u>rod lift system is operational</u> but invalid rotation of the rod-string is detected</i>”. The term “operational” is indicative of linear, or “axial” motion of the rod-string. See claim 8 “<i>the sensor comprises a <u>magnetometer</u></i>”. See US 16/228,233 paragraph [00126]; “<i>As the pumping unit strokes, the sensor sees increasing <u>field distortions</u> as it nears these components.</i>” And “<i>observing historical readings and detecting <u>changes in the variation of the historical magnetometer samples</u></i>”. See US 16/228,233 claim 1 “<i>the sensor is configured to generate a signal indicative of instantaneous <u>radial orientation</u> of a rod-string extending down into the well from a polished rod</i>”. See claim 12 “<i>the sensor further comprises an accelerometer, a barometer, a <u>gyroscope</u>, or combinations thereof</i>”. See US 16/228,233 paragraph [00110] “<i>The magnitude of the <u>rotational acceleration, velocity, and finally displacement</u> can be measured through the use of an accelerometer and a <u>gyroscope over a single stroke</u>.</i>”

<i>component of the downhole pumping system; and</i> <i><u>a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:</u></i> <i><u>determine axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and</u></i> <i><u>determine rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem by <u>sampling rotational velocity values</u> generated by the rotation of the at least one component of the downhole pumping system with the gyroscope.</u></i>	See US 16/228,233 claim 1 “<i><u>a processor configured to: receive electrical signals from the sensor</u></i>”. US 16/228,233 discloses both “<i><u>determine axial movement</u></i>” and “<i><u>determine rotational velocity</u></i>”. See paragraph [0021] “<i><u>The processor is configured to receive signals from the sensing components that are indicative of at least partial radial position of the rod-string, or changing vertical position that is indicative of stroking action.</u></i>” US 16/228,233 paragraph [0026]: “Rotation during idle periods is not expected and therefore does not need to be considered. <u>Indicating non-rotation</u> during idle periods would be considered a false alarm as the functionality of the rotation system is indeterminate during that period.” US 16/228,233 paragraph [0029] “<i><u>The sensing components may comprise a magnetometer, accelerometer and/or a gyroscope. In this instance, the accelerometer and gyroscope are configured to determine immediate rotational deflection of the bridle assembly during the course of a single stroke by way of an inertial reference.</u></i>” US 11,319,794 (Fyfe) also discloses this claim; “<i><u>In an alternative embodiment, a stand-alone wireless polished-rod rotation monitor has at least one polished-rod rotation sensor including a magnetometer, an accelerometer, or a gyroscopic sensor; a processor; a real-time clock; a wireless communicator; and a memory</u></i>” US 11,572,770 (Sengul) Claim 1: “<i><u>a gyroscope configured to measure an orientation, an angular velocity, or both of the beam pump unit as the beam pump unit operates</u></i>”
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Figure 6 from US 16/228,233 discloses the contents of Claim 1 and is replicated below for convenience:

6/9

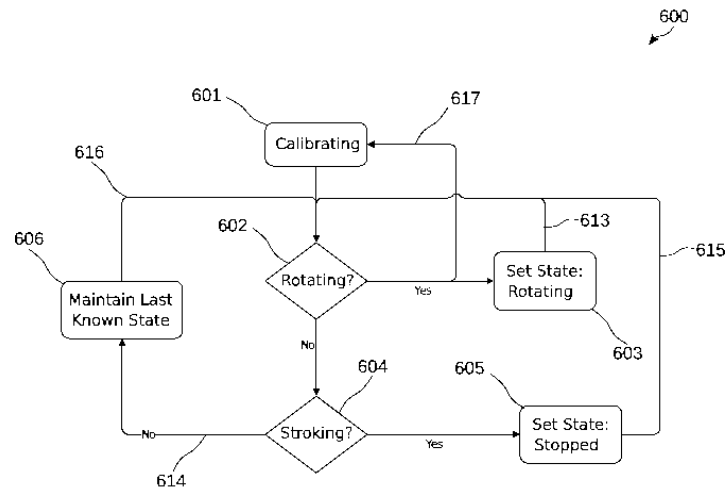


FIG. 6

This figure shows there is a “rotating” determination (or “rotation sensor subsystem”) and a “stroking” determination (or “axial motion sensor subsystem”). The order of operations is clarified in US 16/228,233 paragraph [00134] *“The order of detecting rotating and stroking in Query 602 is not critical, but for power consumption purposes it is preferable to sense rotation first as that is a discrete and low frequency operation”*. 605 is a fault condition in the rotation status (see paragraph [00138]).

US 11,319,794 (Fyfe) also provides relevant disclosures regarding claim 1. See the section titled “Rod Rotator Monitor” beginning at the bottom of column 12.

Both Fyfe and Phillips provide extensive details regarding how one would process the sensor data, and the challenges in determining both rotation and axial position using inertial sensors (magnetometer, accelerometer, gyro).

2. The sensor system of claim 1, wherein the sensor subsystem is configured to <u>detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore.</u>	See US 16/228,233 claim 1 “<u>rod-string extending down into the well from a polished rod</u>”. See US 16/228,233 claim 13: “the processor is further configured to receive signals advising as to <u>whether the rod lift system is stroking</u>”.
3. The sensor system of claim 2, wherein the processor subsystem is configured to <u>verify the axial movement of the at least one rod before determining the rotation.</u>	See US 16/228,233 (Phillips) paragraph [0027] “<u>Stroking action can be indicated by the barometer, accelerometer, or magnetometer individually</u>”. The terms “operational”, “stroking” and “axial movement” refer to the same concept. Phillips claim 11: “generate the alarm if a <u>revolution of the polished rod is not achieved in a given period of time, where the time period is active only while the rod lift system is stroking</u>”. Phillips discloses “<u>before determining the rotation</u>”: see paragraph [00134] “<u>The order of detecting rotating and stroking in Query 602 is not critical, but for power consumption purposes it is preferable to sense rotation first as that is a discrete and low frequency operation</u>”. Further, the flow chart depicted in Figure 6 (Phillips) shows a cyclic dependence on the determination of rotation and stroking. In otherwards, the two determinations alternate, each naturally occurring “before” the other in a steady state.
4. The sensor system of claim 2, wherein the processor subsystem is configured to determine a <u>change in direction</u> the at least one rod.	See US 16/228,233 paragraph [0020]; “In one aspect, the sensor is also configured to <u>determine vertical motion. This indicates whether the rod lift system is stroking or whether it has stopped.</u>” See US 16/228,233 [00133] “Furthermore, the sensing device may incorporate a number of

	<i>other sensors that can help <u>identify whether the unit is stroking</u></i>". Fyfe discloses using a magnetic sensor to determine a change in direction. See col 30, lines 26-30: "<i>wherein the firmware for identifying a <u>reference tick</u> in each stroke uses a <u>magnetic sensor</u> of the polished-rod dynamometer.</i>" And Fyfe claim 1: "<i>identify, for each polished-rod stroke of a plurality of polished-rod strokes, a <u>reference tick</u> of said <u>each</u> polished-rod stroke to determine a duration of said each polished-rod stroke; and estimate <u>polished-rod position</u> throughout each polished-rod stroke</i>". Further examples of detecting a change in the linear direction for the purpose of determining the ends of a discrete stroke can also be found in Gibbs, Harding, Zhao, Trapan, and Sengul.
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5. The sensor system of claim 4, wherein the processor subsystem is configured to <u>begin sampling the rotational velocity after determining the change in direction</u> the at least one rod.	US 11,319,794 (Fyfe) col 7, lines 1-3; "<i>We use this tick knowing the polished-rod velocity should be the same at the <u>beginning and end of each identified stroke</u></i>". Velocity at the beginning and end of the stroke is known to be zero, indicating a change in direction. See US 16/228,233 paragraph [0133] (in regards to calibrating the sensors); "<i>This could only be done if one knew the <u>exact position in the stroke</u>, and could ensure the sensor is always <u>read in the same position, which is possible but not practical</u></i>". This paragraph identifies the determination of the exact position is possible. The term "not practical" in reference to the preferred embodiment and the desire to minimize power consumption. See US 16/228,233 paragraph [0029] "<i>In this instance, the accelerometer and gyroscope are configured to determine immediate rotational deflection of the bridle assembly <u>during the course of a single stroke</u> by way of an inertial</i>
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	<i>reference.” Paragraph [0029] describes this as a single stroke which is well understood in the field of the invention to begin at a change of direction of the polished rod.</i>
6. <i>The sensor system of claim 5, wherein the processor subsystem is configured to <u>continue sampling the rotational velocity until another change in direction</u> the at least one rod is detected.</i>	See US 16/228,233 paragraph [00158]; “<i>Also, the sensor requires no knowledge of the <u>rotation angle per stroke</u>, or likewise strokes per rotation. In fact, the sensor can provide these measured values.</i>” In other words, US 16/228,233 discloses measuring a rotational change during a stroke. Fyfe identifies in col 7 lines 43-47: “<i>In an alternative embodiment, both minima and maxima are identified within each stroke so that <u>the stroke is separated into two pieces</u>, such as time from minima to maxima and from maxima to minima. Scaling is then applied to <u>each half of the stroke independently</u>”</i>
7. <i>The sensor system of claim 5, wherein the processor subsystem is configured to <u>continue sampling the rotational velocity along substantially an entire stroke</u> of the at least one rod, the sampling beginning at a <u>first change of direction</u> of the at least one rod, continuing through a <u>second change of direction</u> of the at least one rod, and ceasing at a <u>third change of direction</u> of the at least one rod.</i>	See US 16/228,233 [0029]; “<i>In this instance, the accelerometer and gyroscope are configured to determine immediate rotational deflection of the bridle assembly during the <u>course of a single stroke</u> by way of an inertial reference.</i>” Fyfe col 7 lines 43-47 (discussed above) describe splitting the stroke. It is well understood in the field of the invention that a “<i>stroke</i>” is defined by a “<u>first</u>” (bottom of stroke), “<u>second</u>” (top of stroke), and “<u>third</u>” (return to bottom of stroke) “<u>change of direction</u>”. The stroke could alternatively start at the top of stroke and continue to the next top of stroke. Further, the sampling of sensor data “<u>along substantially an entire stroke</u>” is commonly done with load and position for the purpose of drawing

	a dynamometer card. Sampling accelerometer data, for example, is commonly performed in this manner. Fyfe, Harding, Zhao, and Sengul disclose this process.
8. <i>The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising a <u>tubing rotator</u> of the downhole pumping system.</i>	US 9,140,113 (Hurst) discloses a tubing rotator and sensing rotation of the tubing string. See Hurst claim 2: “<i>The method of claim 1, wherein the monitoring is performed by a mechanism incorporated in at least one of a load cell, a rod rotator, or a <u>tubing rotator</u>.</i>” US 11,319,794 (Fyfe) discloses a tubing rotator sensor in addition to sensing using inertial sensors. See the section titled “<i>Tubing Rotation Monitoring</i>”, column 14.
9. <i>The sensor system of claim 8, wherein the sensor subsystem is configured to detect rotation of the <u>tubing rotator while detecting axial movement of a polished of the downhole pumping system.</u></i>	US 16/228,233 (Phillips) discloses the correlation between stroking motion and rotational motion. See Figure 6 and claim 1 “<i>generate an <u>alarm if the rod lift system is operational but invalid rotation</u></i>”. Rod rotators and tubing rotators may be used on the same well. The rotational drive mechanism is mechanically similar (actuated by the stroking action of the pumping unit via a cable and ratchet arm mechanism). US 11,319,794 (Fyfe) discloses a sensor capable of detecting both tubing rotation as well as axial motion of the polished rod. Col 5, line 46-47; “<i>Sensor 291 may be configured to <u>monitor displacement of the polished rod</u></i>” and the section titled “<i>Tubing Rotation Monitoring</i>”, column 14.

10. <i>The sensor system of claim 1, wherein the processor subsystem is configured to determine the <u>rotational velocity</u> of the at least one component of the downhole pumping system by <u>summing both positive and negative samples of the rotational velocity values</u> sensed by the rotation sensor subsystem.</i>	US 16/228,233 paragraph [0029] discloses “<i>In this instance, the accelerometer and gyroscope are configured to <u>determine immediate rotational deflection of the bridle assembly during the course of a single stroke</u> by way of an inertial reference.</i>” Velocity and position (or deflection) are related in that velocity is a change in position over time. US 3,343,409 (Gibbs), discloses (col 12, line 40-42) “<i>The signal generator contains the necessary operational amplifiers to both shape the signals and <u>sum the signals</u>.</i>” The mathematical process of converting accelerometer measurements from acceleration to velocity to position is common in the field, and involves “<i><u>summing both positive and negative samples of the rotational velocity values</u>.</i>” See US 11,319,794 (Fyfe) col 6, lines 61-63 “<i>To improve position determined by <u>double integration</u> from accelerometer readings taken within the polished-rod dynamometer</i>”. Fyfe col 6, lines 1-2; “<i><u>gyroscope</u> to measure <u>angular velocity</u> and angular acceleration with <u>differentiation</u></i>”. The mathematical terms “<i>integration</i>” and “<i>differentiation</i>” are inverse operations, both of which involve summation. Gyros inherently measure a rotational velocity, typically in terms of degrees per second. See US 9,903,193 (Harding) col 4, lines 41-46: “<i>Time series data on the crank angle (theta in radians, θ in rad), the crank <u>angular velocity</u> (in rad/sec), and the crank angular acceleration (in rad/sec²) may be generated, with a corresponding timestamp, as the crank's phase “cycle” may be estimated using a 6-axis IMU sensor.</i>” The IMU contains a gyroscope sensor.
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11. The sensor system of claim 10, wherein the processor subsystem is configured to <u>compare the determined rotational velocity</u> of the at least one component of the downhole pumping system with an expected amount of rotational velocity to <u>determine a failure in the rotation</u> of the at least one component of the downhole pumping system.	See US 16/228,233 claim 1: “<u>generate an alarm if the rod lift system is operational but <u>invalid rotation of the rod-string is detected</u></u>” and claim 10: “The apparatus of claim 9, wherein the expected value is based on a <u>historic rotation rate during periods of active rotation.</u>” Rate and velocity are interchangeable terms in this context as velocity is fundamentally a rate of change in position over time. See US 16/228,233 paragraph [0138] (in regard to Figure 6); “This is considered to be a fault condition”. US 11,319,794 (Fyfe) also discloses “<u>determine a failure in the rotation</u>” using a rotational velocity. See col 2 line 52-54; “This may include setting an alarm when data differs from previously recorded data from the same pumpjack by more than a configurable threshold.” and col 6, line 1; “gyroscope to measure <u>angular velocity</u>”.
12. The sensor system of claim 1, further comprising a <u>vibration sensor</u> subsystem for <u>monitoring vibration</u> of the at least one component of the downhole pumping system over a <u>vibrational baseline</u>.	US 11,339,643 (Robison) discloses a vibration. Robison col 3 line 41-42 “The principles described below can be used to monitor <u>vibration produced during operation of the pumping unit</u>”. US 11,319,794 (Fyfe) discloses a vibration sensor placed on the polished rod; col 2 line 14-18 “In an embodiment, a polished-rod dynamometer has at least one accelerometer <u>adapted to measure acceleration and vibration of the polished rod</u>”. And further defines vibration relative to a baseline; Fyfe col 12, line 65-67: “<u>A change in vibration levels or other sensor inputs such as flows and pressures may indicate a change of state or deterioration in performance</u>”

13. <i>A sensor system for a downhole pumping system, comprising:</i> <i>a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising:</i> <i>an axial motion sensor subsystem comprising an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations detected by the axial motion sensor generated by movement of the at least one component of the downhole pumping system; and</i> <i>a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system; and</i>	See remarks regarding claim 1 above. US 3,343,409 Gibbs discloses an axial motion sensor to detect axial movement. See Claim 1: “(c) measuring and recording the load and <u>displacement of the polished rod as functions of time</u>”. The term “displacement” here refers to the linear position within the stroke, or “axial motion”. US 16/228,233 paragraph [0077] “<u>Short term variation in the magnetometer readings can therefore also be indicative of stroking action</u>.”. More generally, “variations” in position may be used to determine axial motion by other methods: Gibbs US 3,343,409: col 2, line 53: “a displacement transducer 37”. Fyfe US 11,319,794 col 2, lines 17-19: “firmware to double-integrate polished-rod acceleration to determine polished-rod position in a pumpjack cycle”. Zhao US 11,542,938 Col 4, lines 58-59: “In an example, the position sensor may be circuitry including an accelerometer”. Hurst, Phillips, Fyfe, as well as Zhao and Navar disclose a rotational sensor. See claim 1 discussion above. US 16/228,233 claim 1 “the sensor is configured to generate a signal indicative of instantaneous <u>radial orientation</u> of a rod-string extending down into the well from a polished rod”. Navar [0023]: “to identify whether the polish rods are not rotating or are <u>not rotating at a target rate</u>”. See Fyfe “Rod Rotator Monitor” section, columns 12-13.
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<i>a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:</i> <i><u>verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and</u></i> <i><u>when the axial movement has been verified, determine rotational velocity of the at least one component of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.</u></i>	US 16/228,233 discloses both the axial motion and rotational sensor subsystems. As does Fyfe. See “Rod Rotator Monitor” section (col 12-13) and Fyfe claim 1: “<i>estimate polished-rod position throughout each polished-rod stroke from readings from the accelerometer</i>”. See US 16/228,233 [0021] “<i>The processor is configured to receive signals from the sensing components that are indicative of at least partial radial position of the rod-string, or changing vertical position that is indicative of stroking action.</i>” US 16/228,233 figure 6 illustrates combining “<i>verify the axial movement</i>” and “<i>when the axial movement has been verified, determine rotational velocity</i>”. Further, claim 1 from US 16/228,233: “<i>generate an alarm if the rod lift system is operational but invalid rotation of the rod-string is detected</i>”.
14. <i>The sensor system of claim 13, wherein the <u>axial motion sensor subsystem comprises a magnetometer and the rotation sensor subsystem comprises a gyroscope.</u></i>	US 16/228,233 discloses both a magnetometer; see claim 8 “<i>the sensor comprises a magnetometer</i>” and a gyroscope; see claim 12 “<i>The apparatus of claim 8, wherein the sensor further comprises an accelerometer, a barometer, a gyroscope, or combinations thereof.</i>” Fyfe discloses a magnetometer for “axial motion”, see col 6 lines 61-68: “<i>To improve position determined by double integration from accelerometer ... with an external magnet and magnetometer</i>”. And further discloses a gyroscope, see col 13 lines 38-42 “<i>In an alternative embodiment, the polished-rod dynamometer 261 includes calibrated rotational accelerometers and rate-gyro sensors to sense rotational accelerations of the polished rod 224 resulting from each yank of the handle 219 of the rod rotator during each stroke of the polished rod</i>”.

15. The sensor system of claim 14, wherein the sensor subsystem is configured to <u>detect movement</u> of the at least one component of the downhole pumping system comprising at <u>least one rod</u> of the downhole pumping system extending from a surface location into a wellbore, and wherein the processor subsystem is configured to <u>continue sampling the rotational velocity values</u> of the at least one rod <u>over a stroke</u> of the at least one rod.	See US 16/228,233 paragraph [0029]; “In this instance, the accelerometer and <u>gyroscope</u> are configured to determine immediate <u>rotational deflection</u> of the bridle assembly <u>during the course of a single stroke</u> by way of an inertial reference.” Phillips paragraph [0042] “The accelerometer and <u>gyroscope</u> determine rotational deflection of the bridle assembly <u>during the course of a single stroke</u>”. Phillips paragraph [00103]: “The anti-rotation device 208 makes the entire bridle assembly 240 act as a single mass for the course of a given stroke. The bridle cables 102 are somewhat flexible and resist the rotation, but allow for some limited <u>rotational deflection during the stroke</u>.” Phillips paragraph [00110] “The magnitude of the rotational acceleration, <u>velocity</u>, and finally displacement can be measured through the use of an accelerometer and a <u>gyroscope over a single stroke</u>.”
16. A sensor system for a downhole pumping system, comprising: <u>a sensor subsystem</u> for detecting movement of a <u>tubing rotator</u> of the downhole pumping system, the sensor subsystem comprising a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the tubing rotator of the downhole pumping system and to detect rotational movement of the tubing rotator of the downhole pumping system by <u>sampling rotational velocity values</u> with the rotational sensor generated by	US 9,140,113 (Hurst) discloses a tubing rotator in claim 2: “The method of claim 1, wherein the monitoring is performed by a mechanism incorporated in at least one of a load cell, a rod rotator, or a <u>tubing rotator</u>.” Fyfe further discloses monitoring a tubing rotator. See Fyfe section titled “<u>Tubing Rotation Monitoring</u>” on column 14. Fyfe also discloses the means to monitor rotation using inertial sensors. Phillips discloses a processor for the purpose of determining rotational velocity. See paragraph [0030]; “The processor is configured to receive signals from the sensing components indicative of instantaneous torque induced rotational

<i>rotation of the tubing rotator of the downhole pumping system; and</i> <i>a processor subsystem to receive data from the rotation sensor subsystem, the processor subsystem to <u>determine rotational velocity of the tubing rotator of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.</u></i>	<i>deflection of the bridle assembly <u>during stroking</u>, and process those signals to <u>detect intra-stroke torsional deflection</u> over time, indicating a buildup of torque in the rod-string.”</i> Fyfe col 27 lines 15-18; “The same polished-rod dynamometer can optionally receive polished rod or tubing rotation information from <u>angular accelerometers</u> and/or <u>gyroscopes</u> or <u>magnetic sensors</u> within the dynamometer”
17. The sensor system of claim 16, wherein the <u>rotation sensor</u> subsystem comprises at <u>least one of a gyroscope or an accelerometer.</u>	Fyfe (which discloses monitoring both a rod rotator and a tubing rotator sensor) col 13, lines 51-53: “rotation monitor has at least one polished-rod rotation sensor including a magnetometer, an <u>accelerometer</u>, or a <u>gyroscopic sensor</u>; a processor”. See US 16/228,233 (Phillips) claim 12 “The apparatus of claim 8, wherein the sensor further comprises an <u>accelerometer</u>, a barometer, a <u>gyroscope</u>, or combinations thereof.” Phillips paragraph [0043] clarifies the selection of sensors is independent. “The processor periodically receives signals from a magnetometer, <u>accelerometer</u> and/or <u>gyroscope</u>, and processes those signals to detect intra-stroke torsional deflection”.

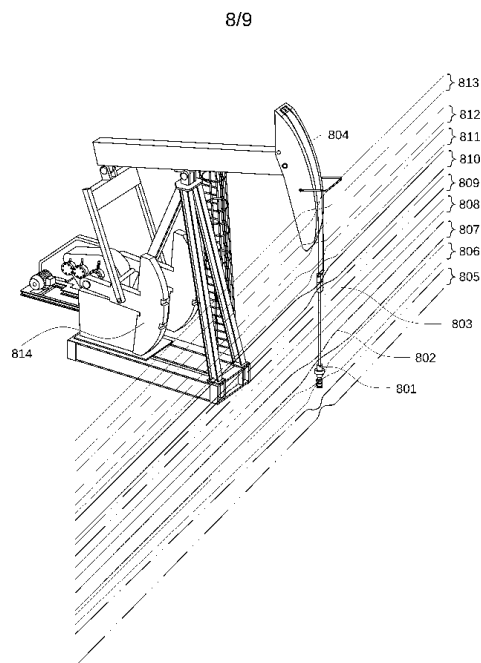
18. <i>The sensor system of claim 16, wherein the rotation sensor subsystem is configured to <u>monitor the rotation of the tubing rotator along a path that extends in a direction substantially perpendicular to a surface upon which the downhole pumping system is positioned.</u></i>	See US 11,319,794 (Fyfe) col 7 line 66 to col 8 line 2: “<i>The sensor pod is coupled to monitor rotation of the crank of the pumpjack or <u>monitor rotation of an output shaft of the gearbox of the pumpjack</u></i>”. While the rotation of the gearbox and crank of the pumping unit is a different mechanism from a tubing rotator, both drive shafts are horizontal. Placing a sensor on the crank arm of the pumping unit, to monitor rotation in a vertical plane (about a horizontal axis), is demonstrated by Fyfe using an accelerometer or gyro.
19. <i>A method of detecting motion of at least one component of a downhole pumping system, the method comprising:</i> <i>detecting axial movement of at least one component of the downhole pumping system <u>based on variations detected by an axial motion sensor coupled to the at least one component of the downhole pumping system generated by translation of the at least one component of the downhole pumping system;</u></i> <i><u>detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system; and</u></i> <i><u>verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor <u>before the detecting of the rotational movement of the</u></u></i>	For “<i>variations</i>” in the magnetic field, see US 16/228,233 paragraph [0077] “<i>Short term <u>variation in the magnetometer readings can therefore also be indicative of stroking action.</u></i>”. For “<i>variations</i>” in linear motion, see Gibbs, Zhao, Harding, Sengul. “<i>Stroking</i>”, “<i>linear movement</i>”, “<i>displacement</i>” in the cited documents are equivalent terms of “<i>translation</i>”. Hurst, Phillips, Fyfe, Navar, and Zhao disclose a rotational sensor. Phillips and Fyfe disclose the combination of both the axial motion and rotational sensor subsystems. Figure 6 (Phillips) illustrates the combination of both, for the purpose of combining “<i>verifying axial movement</i>” and “<i>before the detecting of the rotational</i>

<i>at least one component of the downhole pumping system with the rotational sensor.</i>	<i>movement</i>". See further, US 16/228,233 claim 1: <u>"generate an alarm if the rod lift system is operational but invalid rotation of the rod-string is detected"</u>.
20. <i>The method of claim 19, further comprising <u>comparing a rotational velocity detected with the rotational sensor with a threshold value to determine a performance characteristic of the at least one component of the downhole pumping system.</u></i>	See US 16/228,233 claim 9: <u>"generate the alarm if rotational travel of the polished rod over a given period of time is different than an expected value."</u> The term "rotational travel" from US 16/228,233 is <u>"a performance characteristic"</u>. Further performance characteristics are provided in, paragraph [00158] <u>"the sensor requires no knowledge of the rotation angle per stroke, or likewise strokes per rotation. In fact, the sensor can provide these measured values"</u>. Paragraph [0026] <u>"the processor is able to determine a rate of rotation at any given point. If this rate effectively falls to zero, the processor can determine this lack of rotation without knowledge of the associated angle per stroke"</u>. The threshold value in this case would be any value greater than zero. It should be understood that other values may be used for this purpose. Fyfe col 2 lines 51-54: <u>"This may include setting an alarm when data differs from previously recorded data from the same pumpjack by more than a configurable threshold"</u>

Further discussion:

Axial Motion Subsystem:

Figure 8 (US 16/228,233) is replicated below for convenience. Field variations are illustrated along the vertical traveling path. 802 moves up and down. This is “linear motion”, “stroking action”, or “axial motion” is relevant to the magnetic field variations discussed in US 17/549,519



Paragraph [00127] (US 16/228,233) identifies and attributes the magnetic field variations to specific components of the pumping system and their location along the stroking path: “*The magnitude of the distortions can dominate the reading depending on the proximity of the sensor to the ferrous material present in the pumping system. The wellhead 801, horsehead 804, counterweights 814, etc. all create distortions and act at different longitudinal positions during the motion of the sensor. Magnetic field lines are shown at various elevations (805-813) along the vertical path of the sensor 803*”.

US 16/228,233, paragraph [00126] discloses how a magnetic field would be interpreted in a complex and dynamic environment, for the purpose of determining a location within the stroke:

In some pumping unit configurations such as a Mark-II unit (not shown), the counterweights 814 come very close to the polished rod and can accordingly

create a very dynamic field distortion which affects the sensor reading. As the pumping unit strokes, the sensor sees increasing field distortions as it nears these components.

Rotation sensor subsystem:

Claim 1 from US 16/228,233 recites “*indicative of an instantaneous status of rotation*”. A gyroscope is a sensor for measuring angular velocity. Velocity is an instantaneous measure of a change in position over time, or a rate of change in position. Claim 12 from US 16/228,233 discloses the use of a gyroscope.

US 16/228,233 discloses the use of an accelerometer or a gyro in paragraph [0029] “*The sensing components may comprise a magnetometer, accelerometer and/or a gyroscope. In this instance, the accelerometer and gyroscope are configured to determine immediate rotational deflection of the bridle assembly during the course of a single stroke by way of an inertial reference.*”

US 9,903,193 B2, titled “Systems and Methods for Sucker Rod Pump Jack Visualizations and Analytics” issued Feb. 27th, 2018, discloses the use of a gyro, primarily on the crank arm to determine rotation in terms of an angle and velocity. This disclosure also provides a very specific description of a gyroscope placed directly on the polished rod. Relevant lines from US 9,903,193 B2 are replicated below for convenience.

Column 5, lines 60-62:

At least one 6-Axis IMU (accelerometer plus gyroscope) may be attached to the polished rod and is referred to as the bridle sensor.

Column 9, lines 62-64:

The final result provides accurate crank angle and crank angle velocity time series data, which may be used in further pumping unit analytics.

Additional observations from the specification:

US 17/549,519, paragraphs [0027], [0037-38] and [0044] discuss wireless communication and a battery powered device. This is disclosed in US 16/228,233:

[0089] *The preferred embodiment of the sensing device 201 is a self-contained, battery-powered device which is installed on the polished rod. This necessarily requires any external signal to be transmitted wirelessly, and*

then converted to a useable output or to a visual indicator. Thus, in one aspect the wireless I/O module 250 provides the output signals in a convenient location, preferably with access to external power. This allows the sensing device 201 to operate in an extremely low power mode, thus conserving battery life.

US 16/228,233 paragraph [00152] “It is preferred to keep the sensor asleep as much as possible to conserve battery life.” And:

[00159] *Power consumption of the sensing device is reduced because it does not need to be on all the time. Sensing the orientation within a gravity or magnetic field can be done independently from any previous state. This means the device can be powered down between readings. The readings can be scheduled at regular intervals irrespective of any external positioning. This can be optimized to historical rotational rates, deducting idle periods to help conserve battery life.*

US 17/549,519, paragraph [0038] discusses a self-calibrating sensor. This is disclosed in US 16/228,233 paragraph [00131] “The inherent rotation of the system also presents an opportunity to automatically calibrate the sensor.”

CONCLUSION

A small entity filing fee of \$72 is set forth in accordance with 37 CFR §1.17(o). Should the examiner have any questions regarding this submission, please feel free to contact me at wp@wansco.com.

/Walter Phillips/
Walter Phillips
10/29/2023



ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
17/549,519

RECEIPT DATE / TIME
10/30/2023 11:59:50 AM ET

ATTORNEY DOCKET #

Title of Invention

Application Information

APPLICATION TYPE

PATENT #

CONFIRMATION #

FILED BY walter phillips

PATENT CENTER # 63108951

FILING DATE 12/13/2021

CUSTOMER # -

FIRST NAMED
INVENTOR

CORRESPONDENCE
ADDRESS -

AUTHORIZED BY -

Documents

TOTAL DOCUMENTS: 4

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
Third-party-notification-request.pdf	1	Request for Notification of Non-compliant Third-Party Submission	14 KB
third-party-preissuance-submission.pdf	2	Third-Party Submission Under 37 CFR 1.290	63 KB
Concise-description-generated.pdf	2	Concise Description of Relevance	41 KB
3rdPartyObservation2.pdf	21	-	352 KB
3rdPartyObservation2-3P.RELEVANCE.pdf	(1-21) 21	Concise Description of Relevance	350 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
Third-party-notification-request.pdf	78C7E04A90027CD2A31E4546F2A46979A46B9EB1413B3D806874E067F416CD4D7FB0F39BFBADF5483664D57E70AAD8BAF903BEF52902A0122FCF885CE37B5A2D
third-party-preissuance-submission.pdf	1496A3C5F6DABE0370970000F32C2C416546226CC6ACDF6AA8C64A487540678A3D140E2CF966EAE227D5C1A7D3B8899FEF8755A86FC80A29E66AAB1C8C080425
Concise-description-generated.pdf	CB91DCCE4BA4A0FEF816821C00EF19B79743C004585D71460C66E0F6655BEF75F7A35A7B58C84A9B94B69FDE7CF5D765968D7344291577C355D7330838CD5AC3
3rdPartyObservation2.pdf	58B22C6658AFEA21C347D13708037939C1E49873F348099D255537670DB16A2DB17F3BFC350A49B5577B462A014311E337E814DC58AD7C98BF700B156B56D384
3rdPartyObservation2-3P.RELEVANCE.pdf	549862179D14895944E7C5802B5FBB49214AA620C676314563575E448D0A28E6DB7DF08ACEBB95B7DEA9BE059DB3991B2DDDEE0833074214F5751B232021FC36

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for 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.

3rd Party Submission pursuant to 37 CFR §1.290

This submission is in regard to application US 17/549,519 titled “Devices, systems, and methods for detecting the rotation of one or more components for use with a wellbore”, dated December 13th, 2021.

REMARKS

A description of the cited documents and their relevance is provided.

A claim chart is also provided to illustrate the prior art regarding the specific claims.

Brief description of cited documents:

The claimed priority date of US 17/549,519 is December 13, 2021. The following documents should be considered as prior art.

- US 9,140,113 Hurst et al. – “Instrumented rod rotator”
 - This is the primary disclosure of the need to monitor rods for rotation in a rod lift system. It utilizes a discrete switch to count revolutions.
 - In addition to monitoring the rod-string, this also discloses the monitoring of a tubing string.
- US 16/228,233 Phillips – “Apparatus and Method for Detecting the Rotation of a Rod-String in a Wellbore”
 - Discloses a rotation sensor for monitoring rotation including a linear component and a rotational component.
 - This further discloses utilizing a magnetometer and/or a gyro for the purpose of collectively monitoring both linear motion and rotational motion.
 - See Figure 6-9, claims 1, 8-10, 12, and discussion below.
- US 11,319,794 Fyfe et al. – “Oil-Well Pump Instrumentation Device and Method”
 - Discloses rotation sensing; *“rate-gyro sensors to sense rotational accelerations of the polished rod 224 resulting from each yank of the handle”* col 13, lines 40-42.
 - And determining the ends of the stroke with a magnetic sensor *“identifying a reference tick in each stroke uses readings of a magnetic sensor of the polished - rod dynamometer”* col 30, lines 28-30. This discloses the axial motion subsystem, as described by US 17/549,519.
 - And discloses the use of a gyro in conjunction with a magnetometer *“further includes sensing rotation of the polished rod with an accelerometer and a gyroscopic sensor in addition to sensing a magnetic field with a magnetometer”* col 32, lines 61-63
 - Further discloses monitoring a tubing rotator. See the sections “Rod Rotator Monitor” and “Tubing Rotation Monitoring” (columns 12-14).
- US 9,903,193 Harding et al. – “Systems and Methods for Sucker Rod Pump Jack Visualizations and Analytics”
 - Discloses using a gyro on the polished rod; col 5, line 60-62 *“At least one 6-Axis IMU (accelerometer plus gyroscope) may be attached to the polished rod and is referred to as the bridle sensor.”*
- US 11,339,643 Robison et al. – “Pumping unit inspection sensor assembly, system and method”
 - This relates to the vibration monitoring aspects presented in US 17/549,519.

- Discloses a gyroscope; col 4, line 19-20 “*The gyroscope 68 in this example is a sensor configured to measure a rate of rotation about at least one gyroscope axis 88*” in reference to the pumping unit crank. It further discloses a means for detecting points within the stroke of the pumping unit; figure 7 shows a 360-degree plot of crankarm vs. acceleration. This application discusses rotation, but specifically rotation of the crank arm of the pumping unit, not of the rod-string. While these are different types of rotation, this disclosure demonstrates that a gyro can be used for the purpose of monitoring at least one type of rotation.
- US 3,343,409 Gibbs – “Method of determining sucker rod pump performance”.
 - Discloses monitoring the rod lift system. Of particular relevance is the linear displacement (or “axial motion”). Further it discloses the process of summing sensor data.
- US 11,542,938 Zhao – “Polished Rod Rotation Sensor”
 - This discloses a sensor similar to that of the Hurst disclosure in that it utilizes a discrete switch to determine rotation.
 - Further discloses a means to determine position using an accelerometer.
- US 17/586,292 Navar et al. – “Rotation monitoring assembly for an artificial lift system”
 - This discloses a sensor similar to that of the Hurst disclosure in that it utilizes a discrete switch to determine rotation.
- US 10,167,707 Trapan et al. – “Rod string rotation during well pumping operations”
 - Discusses magnetic sensing of stroke position using a discrete magnet. It is noted that the use of a magnet to determine stroke position dates back to US 3,343,409 Gibbs and is a well-known method of determining position. The use of a continuous magnetometer for this purpose was introduced in US 16/228,233.
- US 11,572,770 Sengul et al. – “System and method for determining load and displacement of a polished rod”
 - Discloses a gyroscope coupled to the polished rod. Col 4, lines 50-53 “*the integrated sensor 200 includes a strain gauge 202, gyroscope 204, and accelerometer 206 which may be positioned on the polished rod 124*”.
 - See claim 1 “*a gyroscope configured to measure an orientation, an angular velocity, or both of the beam pump unit as the beam pump unit operates*”.

Concise description of relevancy:

Claims from US 17/549,519	Discussion and relative citations
1. <i>A sensor system for a downhole pumping system, comprising: a sensor subsystem for <u>detecting movement of at least one component of the downhole pumping system</u>, the sensor subsystem comprising:</i> <i><u>an axial motion sensor subsystem comprising a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system; and</u></i> <i><u>a rotation sensor subsystem comprising a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one</u></i>	See US 16/228,233 claim 1: “<i>the sensor is configured to generate a signal indicative of instantaneous radial orientation of a rod-string extending down into the well from a polished rod</i>”. See US 16/228,233 Claim 1 “<i>generate an alarm if the rod lift system is operational but invalid rotation of the rod-string is detected</i>”. The term “operational” is indicative of linear, or “axial” motion of the rod-string. See claim 8 “<i>the sensor comprises a magnetometer</i>”. See US 16/228,233 paragraph [00126]; “<i>As the pumping unit strokes, the sensor sees increasing field distortions as it nears these components.</i>” And “<i>observing historical readings and detecting changes in the variation of the historical magnetometer samples</i>”. See US 16/228,233 claim 1 “<i>the sensor is configured to generate a signal indicative of instantaneous radial orientation of a rod-string extending down into the well from a polished rod</i>”. See claim 12 “<i>the sensor further comprises an accelerometer, a barometer, a gyroscope, or combinations thereof</i>”. See US 16/228,233 paragraph [00110] “<i>The magnitude of the rotational acceleration, velocity, and finally displacement can be measured through the use of an accelerometer and a gyroscope over a single stroke.</i>”

<i>component of the downhole pumping system; and</i> <i>a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:</i> <i>determine axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and</i> <i>determine rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system with the gyroscope.</i>	See US 16/228,233 claim 1 “<u>a processor configured to: receive electrical signals from the sensor</u>”. US 16/228,233 discloses both “<u>determine axial movement</u>” and “<u>determine rotational velocity</u>”. See paragraph [0021] “<u>The processor is configured to receive signals from the sensing components that are indicative of at least partial radial position of the rod-string, or changing vertical position that is indicative of stroking action.</u>” US 16/228,233 paragraph [0026]: “Rotation during idle periods is not expected and therefore does not need to be considered. <u>Indicating non-rotation during idle periods would be considered a false alarm as the functionality of the rotation system is indeterminate during that period.</u>” US 16/228,233 paragraph [0029] “<u>The sensing components may comprise a magnetometer, accelerometer and/or a gyroscope. In this instance, the accelerometer and gyroscope are configured to determine immediate rotational deflection of the bridle assembly during the course of a single stroke by way of an inertial reference.</u>” US 11,319,794 (Fyfe) also discloses this claim; “<u>In an alternative embodiment, a stand-alone wireless polished-rod rotation monitor has at least one polished-rod rotation sensor including a magnetometer, an accelerometer, or a gyroscopic sensor; a processor; a real-time clock; a wireless communicator; and a memory</u>” US 11,572,770 (Sengul) Claim 1: “<u>a gyroscope configured to measure an orientation, an angular velocity, or both of the beam pump unit as the beam pump unit operates</u>”
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Figure 6 from US 16/228,233 discloses the contents of Claim 1 and is replicated below for convenience:

6/9

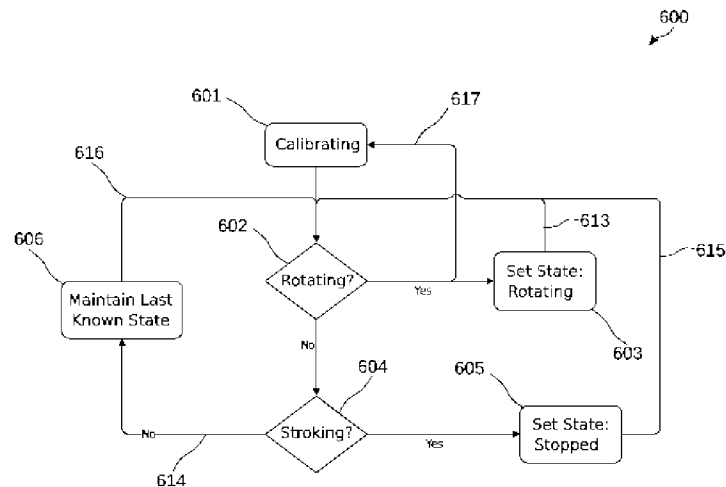


FIG. 6

This figure shows there is a “rotating” determination (or “rotation sensor subsystem”) and a “stroking” determination (or “axial motion sensor subsystem”). The order of operations is clarified in US 16/228,233 paragraph [00134] *“The order of detecting rotating and stroking in Query 602 is not critical, but for power consumption purposes it is preferable to sense rotation first as that is a discrete and low frequency operation”*. 605 is a fault condition in the rotation status (see paragraph [00138]).

US 11,319,794 (Fyfe) also provides relevant disclosures regarding claim 1. See the section titled “Rod Rotator Monitor” beginning at the bottom of column 12.

Both Fyfe and Phillips provide extensive details regarding how one would process the sensor data, and the challenges in determining both rotation and axial position using inertial sensors (magnetometer, accelerometer, gyro).

2. <i>The sensor system of claim 1, wherein the sensor subsystem is configured to <u>detect movement of the at least one component</u> of the downhole pumping system comprising at least one rod of the downhole pumping system <u>extending from a surface location into a wellbore</u>.</i>	See US 16/228,233 claim 1 “<u>rod-string extending down into the well from a polished rod</u>”. See US 16/228,233 claim 13: “<i>the processor is further configured to receive signals advising as to <u>whether the rod lift system is stroking</u></i>”.
3. <i>The sensor system of claim 2, wherein the processor subsystem is configured to <u>verify the axial movement of the at least one rod before determining the rotation</u>.</i>	See US 16/228,233 (Phillips) paragraph [0027] “<u>Stroking action can be indicated by the barometer, accelerometer, or magnetometer individually</u>”. The terms “operational”, “stroking” and “axial movement” refer to the same concept. Phillips claim 11: “<i>generate the alarm if a <u>revolution of the polished rod is not achieved in a given period of time, where the time period is active only while the rod lift system is stroking</u></i>”. Phillips discloses “<u>before determining the rotation</u>”: see paragraph [00134] “<i>The <u>order of detecting rotating and stroking in Query 602 is not critical</u>, but for power consumption purposes it is preferable to sense rotation first as that is a discrete and low frequency operation</i>”. Further, the flow chart depicted in Figure 6 (Phillips) shows a cyclic dependence on the determination of rotation and stroking. In otherwords, the two determinations alternate, each naturally occurring “before” the other in a steady state.
4. <i>The sensor system of claim 2, wherein the processor subsystem is configured to determine a <u>change in direction</u> the at least one rod.</i>	See US 16/228,233 paragraph [0020]; “<i>In one aspect, the sensor is also configured to <u>determine vertical motion</u>. This indicates whether the rod lift system is stroking or whether it has stopped.</i>” See US 16/228,233 [00133] “<i>Furthermore, the sensing device may incorporate a number of</i>

	<i>other sensors that can help <u>identify whether the unit is stroking</u></i>". Fyfe discloses using a magnetic sensor to determine a change in direction. See col 30, lines 26-30: "<i>wherein the firmware for identifying a <u>reference tick in each stroke uses a magnetic sensor of the polished-rod dynamometer.</u></i>" And Fyfe claim 1: "<i>identify, for each polished-rod stroke of a plurality of polished-rod strokes, a <u>reference tick of said each polished-rod stroke to determine a duration of said each polished-rod stroke; and estimate polished-rod position throughout each polished-rod stroke</u></i>". Further examples of detecting a change in the linear direction for the purpose of determining the ends of a discrete stroke can also be found in Gibbs, Harding, Zhao, Trapan, and Sengul.
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5. <i>The sensor system of claim 4, wherein the processor subsystem is configured to <u>begin sampling the rotational velocity after determining the change in direction the at least one rod.</u></i>	US 11,319,794 (Fyfe) col 7, lines 1-3; "<i>We use this tick knowing the polished-rod velocity should be the same at the <u>beginning and end of each identified stroke</u></i>". Velocity at the beginning and end of the stroke is known to be zero, indicating a change in direction. See US 16/228,233 paragraph [0133] (in regards to calibrating the sensors); "<i>This could only be done if one knew the <u>exact position in the stroke, and could ensure the sensor is always read in the same position, which is possible but not practical</u></i>". This paragraph identifies the determination of the exact position is possible. The term "not practical" in reference to the preferred embodiment and the desire to minimize power consumption. See US 16/228,233 paragraph [0029] "<i>In this instance, the accelerometer and gyroscope are configured to determine immediate rotational deflection of the bridle assembly <u>during the course of a single stroke by way of an inertial</u></i>
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	<i>reference.” Paragraph [0029] describes this as a single stroke which is well understood in the field of the invention to begin at a change of direction of the polished rod.</i>
6. <i>The sensor system of claim 5, wherein the processor subsystem is configured to <u>continue sampling the rotational velocity until another change in direction</u> the at least one rod is detected.</i>	See US 16/228,233 paragraph [00158]; “<i>Also, the sensor requires no knowledge of the <u>rotation angle per stroke</u>, or likewise strokes per rotation. In fact, the sensor can provide these measured values.</i>” In other words, US 16/228,233 discloses measuring a rotational change during a stroke. Fyfe identifies in col 7 lines 43-47: “<i>In an alternative embodiment, both minima and maxima are identified within each stroke so that <u>the stroke is separated into two pieces</u>, such as time from minima to maxima and from maxima to minima. Scaling is then applied to <u>each half of the stroke independently</u>”</i>
7. <i>The sensor system of claim 5, wherein the processor subsystem is configured to <u>continue sampling the rotational velocity along substantially an entire stroke of the at least one rod, the sampling beginning at a <u>first change of direction of the at least one rod</u>, continuing through a <u>second change of direction of the at least one rod</u>, and ceasing at a <u>third change of direction of the at least one rod</u>.</u></i>	See US 16/228,233 [0029]; “<i>In this instance, the accelerometer and gyroscope are configured to determine immediate rotational deflection of the bridle assembly during the <u>course of a single stroke</u> by way of an inertial reference.</i>” Fyfe col 7 lines 43-47 (discussed above) describe splitting the stroke. It is well understood in the field of the invention that a “<i>stroke</i>” is defined by a “<i><u>first</u></i>” (bottom of stroke), “<i><u>second</u></i>” (top of stroke), and “<i><u>third</u></i>” (return to bottom of stroke) “<i><u>change of direction</u></i>”. The stroke could alternatively start at the top of stroke and continue to the next top of stroke. Further, the sampling of sensor data “<i><u>along substantially an entire stroke</u></i>” is commonly done with load and position for the purpose of drawing

	a dynamometer card. Sampling accelerometer data, for example, is commonly performed in this manner. Fyfe, Harding, Zhao, and Sengul disclose this process.
8. <i>The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising a <u>tubing rotator</u> of the downhole pumping system.</i>	US 9,140,113 (Hurst) discloses a tubing rotator and sensing rotation of the tubing string. See Hurst claim 2: “<i>The method of claim 1, wherein the monitoring is performed by a mechanism incorporated in at least one of a load cell, a rod rotator, or a <u>tubing rotator</u>.</i>” US 11,319,794 (Fyfe) discloses a tubing rotator sensor in addition to sensing using inertial sensors. See the section titled “<i>Tubing Rotation Monitoring</i>”, column 14.
9. <i>The sensor system of claim 8, wherein the sensor subsystem is configured to detect rotation of the <u>tubing rotator while detecting axial movement of a polished of the downhole pumping system.</u></i>	US 16/228,233 (Phillips) discloses the correlation between stroking motion and rotational motion. See Figure 6 and claim 1 “<i>generate an <u>alarm if the rod lift system is operational but invalid rotation</u></i>”. Rod rotators and tubing rotators may be used on the same well. The rotational drive mechanism is mechanically similar (actuated by the stroking action of the pumping unit via a cable and ratchet arm mechanism). US 11,319,794 (Fyfe) discloses a sensor capable of detecting both tubing rotation as well as axial motion of the polished rod. Col 5, line 46-47; “<i>Sensor 291 may be configured to <u>monitor displacement of the polished rod</u></i>” and the section titled “<i>Tubing Rotation Monitoring</i>”, column 14.

10. <i>The sensor system of claim 1, wherein the processor subsystem is configured to determine the <u>rotational velocity</u> of the at least one component of the downhole pumping system by <u>summing both positive and negative samples of the rotational velocity values</u> sensed by the rotation sensor subsystem.</i>	US 16/228,233 paragraph [0029] discloses “<i>In this instance, the accelerometer and gyroscope are configured to <u>determine immediate rotational deflection of the bridle assembly during the course of a single stroke</u> by way of an inertial reference.</i>” Velocity and position (or deflection) are related in that velocity is a change in position over time. US 3,343,409 (Gibbs), discloses (col 12, line 40-42) “<i>The signal generator contains the necessary operational amplifiers to both shape the signals and <u>sum the signals.</u></i>” The mathematical process of converting accelerometer measurements from acceleration to velocity to position is common in the field, and involves “<i><u>summing both positive and negative samples of the rotational velocity values.</u></i>” See US 11,319,794 (Fyfe) col 6, lines 61-63 “<i>To improve position determined by <u>double integration</u> from accelerometer readings taken within the polished-rod dynamometer</i>”. Fyfe col 6, lines 1-2; “<i><u>gyroscope to measure angular velocity and angular acceleration with differentiation</u></i>”. The mathematical terms “<i>integration</i>” and “<i>differentiation</i>” are inverse operations, both of which involve summation. Gyros inherently measure a rotational velocity, typically in terms of degrees per second. See US 9,903,193 (Harding) col 4, lines 41-46: “<i>Time series data on the crank angle (theta in radians, θ in rad), the crank <u>angular velocity</u> (in rad/sec), and the crank angular acceleration (in rad/sec²) may be generated, with a corresponding timestamp, as the crank's phase “cycle” may be estimated using a 6-axis IMU sensor.</i>” The IMU contains a gyroscope sensor.
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11. <i>The sensor system of claim 10, wherein the processor subsystem is configured to <u>compare the determined rotational velocity</u> of the at least one component of the downhole pumping system with an expected amount of rotational velocity to <u>determine a failure in the rotation</u> of the at least one component of the downhole pumping system.</i>	See US 16/228,233 claim 1: “<u>generate an alarm if the rod lift system is operational but <u>invalid rotation of the rod-string is detected</u></u>” and claim 10: “<u>The apparatus of claim 9, wherein the expected value is based on a historic rotation rate during periods of active rotation.</u>” Rate and velocity are interchangeable terms in this context as velocity is fundamentally a rate of change in position over time. See US 16/228,233 paragraph [0138] (in regard to Figure 6); “<u>This is considered to be a fault condition</u>”. US 11,319,794 (Fyfe) also discloses “<u>determine a failure in the rotation</u>” using a rotational velocity. See col 2 line 52-54; “<u>This may include setting an alarm when data differs from previously recorded data from the same pumpjack by more than a configurable threshold.</u>” and col 6, line 1; “<u>gyroscope to measure angular velocity</u>”
12. <i>The sensor system of claim 1, further comprising a <u>vibration sensor</u> subsystem for <u>monitoring vibration</u> of the at least one component of the downhole pumping system over a <u>vibrational baseline</u>.</i>	US 11,339,643 (Robison) discloses a vibration. Robison col 3 line 41-42 “<u>The principles described below can be used to monitor vibration produced during operation of the pumping unit</u>”. US 11,319,794 (Fyfe) discloses a vibration sensor placed on the polished rod; col 2 line 14-18 “<u>In an embodiment, a polished-rod dynamometer has at least one accelerometer adapted to measure acceleration and vibration of the polished rod</u>”. And further defines vibration relative to a baseline; Fyfe col 12, line 65-67: “<u>A change in vibration levels or other sensor inputs such as flows and pressures may indicate a change of state or deterioration in performance</u>”

13. <i>A sensor system for a downhole pumping system, comprising:</i> <i>a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising:</i> <i>an axial motion sensor subsystem comprising an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations detected by the axial motion sensor generated by movement of the at least one component of the downhole pumping system; and</i> <i>a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system; and</i>	See remarks regarding claim 1 above. US 3,343,409 Gibbs discloses an axial motion sensor to detect axial movement. See Claim 1: “(c) <u>measuring and recording the load and displacement of the polished rod as functions of time</u>”. The term “displacement” here refers to the linear position within the stroke, or “axial motion”. US 16/228,233 paragraph [0077] “<u>Short term variation in the magnetometer readings can therefore also be indicative of stroking action.</u>”. More generally, “variations” in position may be used to determine axial motion by other methods: Gibbs US 3,343,409: col 2, line 53: “a <u>displacement transducer 37</u>”. Fyfe US 11,319,794 col 2, lines 17-19: “<u>firmware to double-integrate polished-rod acceleration to determine polished-rod position in a pumpjack cycle</u>”. Zhao US 11,542,938 Col 4, lines 58-59: “<u>In an example, the position sensor may be circuitry including an accelerometer</u>”. Hurst, Phillips, Fyfe, as well as Zhao and Navar disclose a rotational sensor. See claim 1 discussion above. US 16/228,233 claim 1 “<u>the sensor is configured to generate a signal indicative of instantaneous radial orientation of a rod-string extending down into the well from a polished rod</u>”. Navar [0023]: “<u>to identify whether the polish rods are not rotating or are not rotating at a target rate</u>”. See Fyfe “Rod Rotator Monitor” section, columns 12-13.
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<i>a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:</i> <i><u>verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and</u></i> <i><u>when the axial movement has been verified, determine rotational velocity of the at least one component of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.</u></i>	US 16/228,233 discloses both the axial motion and rotational sensor subsystems. As does Fyfe. See “Rod Rotator Monitor” section (col 12-13) and Fyfe claim 1: “<i>estimate polished-rod position throughout each polished-rod stroke from readings from the accelerometer</i>”. See US 16/228,233 [0021] “<i>The processor is configured to receive signals from the sensing components that are indicative of at least partial radial position of the rod-string, or changing vertical position that is indicative of stroking action.</i>” US 16/228,233 figure 6 illustrates combining “<i>verify the axial movement</i>” and “<i>when the axial movement has been verified, determine rotational velocity</i>”. Further, claim 1 from US 16/228,233: “<i>generate an alarm if the rod lift system is operational but invalid rotation of the rod-string is detected</i>”.
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14. <i>The sensor system of claim 13, wherein the <u>axial motion sensor subsystem comprises a magnetometer and the rotation sensor subsystem comprises a gyroscope.</u></i>	US 16/228,233 discloses both a magnetometer; see claim 8 “<i>the sensor comprises a magnetometer</i>” and a gyroscope; see claim 12 “<i>The apparatus of claim 8, wherein the sensor further comprises an accelerometer, a barometer, a gyroscope, or combinations thereof.</i>” Fyfe discloses a magnetometer for “axial motion”, see col 6 lines 61-68: “<i>To improve position determined by double integration from accelerometer ... with an external magnet and magnetometer</i>”. And further discloses a gyroscope, see col 13 lines 38-42 “<i>In an alternative embodiment, the polished-rod dynamometer 261 includes calibrated rotational accelerometers and rate-gyro sensors to sense rotational accelerations of the polished rod 224 resulting from each yank of the handle 219 of the rod rotator during each stroke of the polished rod</i>”.
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15. <i>The sensor system of claim 14, wherein the sensor subsystem is configured to <u>detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore, and wherein the processor subsystem is configured to <u>continue sampling the rotational velocity values of the at least one rod over a stroke of the at least one rod.</u></u></i>	See US 16/228,233 paragraph [0029]; “<i>In this instance, the accelerometer and gyroscope are configured to determine immediate <u>rotational deflection of the bridle assembly during the course of a single stroke</u> by way of an inertial reference.</i>” Phillips paragraph [0042] “<i>The accelerometer and gyroscope determine rotational deflection of the bridle assembly <u>during the course of a single stroke</u></i>”. Phillips paragraph [00103]: “<i>The anti-rotation device 208 makes the entire bridle assembly 240 act as a single mass for the course of a given stroke. The bridle cables 102 are somewhat flexible and resist the rotation, but allow for some limited <u>rotational deflection during the stroke.</u></i>” Phillips paragraph [00110] “<i>The magnitude of the rotational acceleration, <u>velocity</u>, and finally displacement can be measured through the use of an accelerometer and a gyroscope <u>over a single stroke.</u></i>”
16. <i>A sensor system for a downhole pumping system, comprising:</i> <i><u>a sensor subsystem for detecting movement of a tubing rotator of the downhole pumping system, the sensor subsystem comprising a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the tubing rotator of the downhole pumping system and to detect rotational movement of the tubing rotator of the downhole pumping system by <u>sampling rotational velocity values with the rotational sensor generated by</u></u></i>	US 9,140,113 (Hurst) discloses a tubing rotator in claim 2: “<i>The method of claim 1, wherein the monitoring is performed by a mechanism incorporated in at least one of a load cell, a rod rotator, or a <u>tubing rotator.</u></i>” Fyfe further discloses monitoring a tubing rotator. See Fyfe section titled “<i>Tubing Rotation Monitoring</i>” on column 14. Fyfe also discloses the means to monitor rotation using inertial sensors. Phillips discloses a processor for the purpose of determining rotational velocity. See paragraph [0030]; “<i>The processor is configured to receive signals from the sensing components indicative of instantaneous torque induced rotational</i>

<i>rotation of the tubing rotator of the downhole pumping system; and</i> <i>a processor subsystem to receive data from the rotation sensor subsystem, the processor subsystem to <u>determine rotational velocity of the tubing rotator of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.</u></i>	<i>deflection of the bridle assembly <u>during stroking</u>, and process those signals to <u>detect intra-stroke torsional deflection over time</u>, indicating a buildup of torque in the rod-string.”</i> Fyfe col 27 lines 15-18; “<i>The same polished-rod dynamometer can optionally receive polished rod or tubing rotation information from <u>angular accelerometers and/or gyroscopes or magnetic sensors within the dynamometer</u></i>”
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17. <i>The sensor system of claim 16, wherein the <u>rotation sensor subsystem comprises at least one of a gyroscope or an accelerometer.</u></i>	Fyfe (which discloses monitoring both a rod rotator and a tubing rotator sensor) col 13, lines 51-53: “<i>rotation monitor has at least one polished-rod rotation sensor including a magnetometer, an <u>accelerometer</u>, or a <u>gyroscopic sensor</u>; a processor</i>”. See US 16/228,233 (Phillips) claim 12 “<i>The apparatus of claim 8, wherein the sensor further comprises an <u>accelerometer</u>, a <u>barometer</u>, a <u>gyroscope</u>, or combinations thereof.</i>” Phillips paragraph [0043] clarifies the selection of sensors is independent. “<i>The processor periodically receives signals from a magnetometer, <u>accelerometer and/or gyroscope</u>, and processes those signals to detect intra-stroke torsional deflection</i>”.
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18. <i>The sensor system of claim 16, wherein the rotation sensor subsystem is configured to <u>monitor the rotation of the tubing rotator along a path that extends in a direction substantially perpendicular to a surface upon which the downhole pumping system is positioned.</u></i>	See US 11,319,794 (Fyfe) col 7 line 66 to col 8 line 2: “<i>The sensor pod is coupled to monitor rotation of the crank of the pumpjack or <u>monitor rotation of an output shaft of the gearbox of the pumpjack</u></i>”. While the rotation of the gearbox and crank of the pumping unit is a different mechanism from a tubing rotator, both drive shafts are horizontal. Placing a sensor on the crank arm of the pumping unit, to monitor rotation in a vertical plane (about a horizontal axis), is demonstrated by Fyfe using an accelerometer or gyro.
19. <i>A method of detecting motion of at least one component of a downhole pumping system, the method comprising:</i> <i>detecting axial movement of at least one component of the downhole pumping system <u>based on variations detected by an axial motion sensor coupled to the at least one component of the downhole pumping system generated by translation of the at least one component of the downhole pumping system;</u></i> <i><u>detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system; and</u></i> <i><u>verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the</u></i>	For “<i>variations</i>” in the magnetic field, see US 16/228,233 paragraph [0077] “<i>Short term <u>variation in the magnetometer readings can therefore also be indicative of stroking action.</u></i>”. For “<i>variations</i>” in linear motion, see Gibbs, Zhao, Harding, Sengul. “<i>Stroking</i>”, “<i>linear movement</i>”, “<i>displacement</i>” in the cited documents are equivalent terms of “<i>translation</i>”. Hurst, Phillips, Fyfe, Navar, and Zhao disclose a rotational sensor. Phillips and Fyfe disclose the combination of both the axial motion and rotational sensor subsystems. Figure 6 (Phillips) illustrates the combination of both, for the purpose of combining “<i>verifying axial movement</i>” and “<i>before the detecting of the rotational</i>

<i>at least one component of the downhole pumping system with the rotational sensor.</i>	<i>movement</i>". See further, US 16/228,233 claim 1: <u>"generate an alarm if the rod lift system is operational but invalid rotation of the rod-string is detected"</u>.
20. <i>The method of claim 19, further comprising <u>comparing a rotational velocity detected with the rotational sensor with a threshold value to determine a performance characteristic of the at least one component of the downhole pumping system.</u></i>	See US 16/228,233 claim 9: <u>"generate the alarm if rotational travel of the polished rod over a given period of time is different than an expected value."</u> The term "rotational travel" from US 16/228,233 is <u>"a performance characteristic"</u>. Further performance characteristics are provided in, paragraph [00158] <u>"the sensor requires no knowledge of the rotation angle per stroke, or likewise strokes per rotation. In fact, the sensor can provide these measured values"</u>. Paragraph [0026] <u>"the processor is able to determine a rate of rotation at any given point. If this rate effectively falls to zero, the processor can determine this lack of rotation without knowledge of the associated angle per stroke"</u>. The threshold value in this case would be any value greater than zero. It should be understood that other values may be used for this purpose. Fyfe col 2 lines 51-54: <u>"This may include setting an alarm when data differs from previously recorded data from the same pumpjack by more than a configurable threshold"</u>

Further discussion:

Axial Motion Subsystem:

Figure 8 (US 16/228,233) is replicated below for convenience. Field variations are illustrated along the vertical traveling path. 802 moves up and down. This is “*linear motion*”, “*stroking action*”, or “*axial motion*” is relevant to the magnetic field variations discussed in US 17/549,519

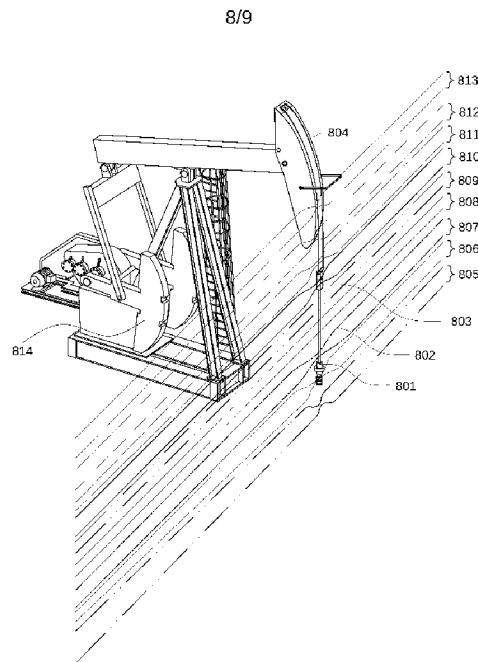


FIG. 8

Paragraph [00127] (US 16/228,233) identifies and attributes the magnetic field variations to specific components of the pumping system and their location along the stroking path: “*The magnitude of the distortions can dominate the reading depending on the proximity of the sensor to the ferrous material present in the pumping system. The wellhead 801, horsehead 804, counterweights 814, etc. all create distortions and act at different longitudinal positions during the motion of the sensor. Magnetic field lines are shown at various elevations (805-813) along the vertical path of the sensor 803*”.

US 16/228,233, paragraph [00126] discloses how a magnetic field would be interpreted in a complex and dynamic environment, for the purpose of determining a location within the stroke:

In some pumping unit configurations such as a Mark-II unit (not shown), the counterweights 814 come very close to the polished rod and can accordingly

create a very dynamic field distortion which affects the sensor reading. As the pumping unit strokes, the sensor sees increasing field distortions as it nears these components.

Rotation sensor subsystem:

Claim 1 from US 16/228,233 recites “*indicative of an instantaneous status of rotation*”. A gyroscope is a sensor for measuring angular velocity. Velocity is an instantaneous measure of a change in position over time, or a rate of change in position. Claim 12 from US 16/228,233 discloses the use of a gyroscope.

US 16/228,233 discloses the use of an accelerometer or a gyro in paragraph [0029] “*The sensing components may comprise a magnetometer, accelerometer and/or a gyroscope. In this instance, the accelerometer and gyroscope are configured to determine immediate rotational deflection of the bridle assembly during the course of a single stroke by way of an inertial reference.*”

US 9,903,193 B2, titled “Systems and Methods for Sucker Rod Pump Jack Visualizations and Analytics” issued Feb. 27th, 2018, discloses the use of a gyro, primarily on the crank arm to determine rotation in terms of an angle and velocity. This disclosure also provides a very specific description of a gyroscope placed directly on the polished rod. Relevant lines from US 9,903,193 B2 are replicated below for convenience.

Column 5, lines 60-62:

At least one 6-Axis IMU (accelerometer plus gyroscope) may be attached to the polished rod and is referred to as the bridle sensor.

Column 9, lines 62-64:

The final result provides accurate crank angle and crank angle velocity time series data, which may be used in further pumping unit analytics.

Additional observations from the specification:

US 17/549,519, paragraphs [0027], [0037-38] and [0044] discuss wireless communication and a battery powered device. This is disclosed in US 16/228,233:

[0089] *The preferred embodiment of the sensing device 201 is a self-contained, battery-powered device which is installed on the polished rod. This necessarily requires any external signal to be transmitted wirelessly, and*

then converted to a useable output or to a visual indicator. Thus, in one aspect the wireless I/O module 250 provides the output signals in a convenient location, preferably with access to external power. This allows the sensing device 201 to operate in an extremely low power mode, thus conserving battery life.

US 16/228,233 paragraph [00152] “It is preferred to keep the sensor asleep as much as possible to conserve battery life.” And:

[00159] *Power consumption of the sensing device is reduced because it does not need to be on all the time. Sensing the orientation within a gravity or magnetic field can be done independently from any previous state. This means the device can be powered down between readings. The readings can be scheduled at regular intervals irrespective of any external positioning. This can be optimized to historical rotational rates, deducting idle periods to help conserve battery life.*

US 17/549,519, paragraph [0038] discusses a self-calibrating sensor. This is disclosed in US 16/228,233 paragraph [00131] “The inherent rotation of the system also presents an opportunity to automatically calibrate the sensor.”

CONCLUSION

A small entity filing fee of \$72 is set forth in accordance with 37 CFR §1.17(o). Should the examiner have any questions regarding this submission, please feel free to contact me at wp@wansco.com.

/Walter Phillips/
Walter Phillips
10/29/2023



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THIRD-PARTY SUBMISSION UNDER 37 CFR 1.290

APPLICATION #
17549519

U.S. Patents

Cite #	Patent #	Kind Code ¹	Issue Date (YYYY/MM/DD)	First Named Inventor
1	9140113		2015/09/22	Gregg W. Hurst
2	11319794		2022/05/03	Kelly Fyfe
3	9903193		2018/02/27	Peter HARDING
4	11339643		2022/05/24	Clark E. ROBISON
5	3343409		1967/09/26	Gibbs
6	11542938		2023/01/03	Min ZHAO
7	10167707		2019/01/01	James S. TRAPANI
8	11572770		2023/02/07	Mahmut Sengul

U.S. patent application publications

Cite #	Publication #	Kind Code ¹	Publication Date (YYYY/MM/DD)	First Named Inventor
1	US 2022- 0236082		2022/07/28	Jose Navar
2	US 2019- 0203579		2019/07/04	Walter Phillips

Foreign patents and published foreign patent applications

Cite #	Foreign Document # ³	Country Code ²	Kind Code ¹	Publication Date (YYYY/MM/DD)	Applicant, patentee or first named inventor	T ⁵
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Non-patent publications

Cite #	Author (if any), title of the publication, page(s) being submitted, publication date, publisher (where available), place of publication (where available).	T ⁵	E ⁶
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Statements

The party making the submission is not an individual who has a duty to disclose information with respect to the above-identified application under 37 CFR 1.56.

This submission complies with the requirements of 35 U.S.C. 122(e) and 37 CFR 1.290.

Resubmission: This resubmission is being made responsive to a notification of non-compliance issued for an earlier filed third-party submission. The corrections in this resubmission are limited to addressing the non-compliance.

1. Fee previously paid: The party making this resubmission requests that the Office apply the previously-paid fee set forth in 37 CFR 1.290(f).

2. Fee exemption applies: The party making this resubmission states that no fee is required to accompany this resubmission as the undersigned is again making the fee exemption statement set forth in 37 CFR 1.290(g).

Signature

Name

Registration

/Walter Phillips/

walter phillips

—

Examiner Signature

Date considered

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*EXAMINER: Signature indicates all documents listed above have been considered, except for citations through which a line is drawn. Draw line through citation if not considered. Include a copy of this form with next communication to applicant. 1. If known, enter kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16. See MPEP 901.04(a). 2. Enter the country or patent office that issued the document, by two-letter code under WIPO standard ST.3. See MPEP 1851. 3. For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 4. If known, enter the kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16. See MPEP 901.04(a). 5. Check mark indicates translation attached. 6. Check mark indicates evidence of publication attached.



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THIRD-PARTY SUBMISSION UNDER 37 CFR 1.290 CONCISE DESCRIPTION OF RELEVANCE

APPLICATION #
17549519

U.S. Patents

Cite #	Patent #	Concise Description of Relevance
1	9140113	This is the primary disclosure of the need to monitor rods for rotation in a rod lift system. It utilizes a discrete switch to count revolutions. In addition to monitoring the rod-string, this also discloses the monitoring of a tubing string.
2	11319794	Discloses rotation sensing; "rate-gyro sensors to sense rotational accelerations of the polished rod 224 resulting from each yank of the handle" col 13, lines 40-42. And determining the ends of the stroke with a magnetic sensor "identifying a reference tick in each stroke uses readings of a magnetic sensor of the polished - rod dynamometer" col 30, lines 28-30. This discloses the axial motion subsystem, as described by US 17/549,519. And discloses the use of a gyro in conjunction with a magnetometer "further includes sensing rotation of the polished rod with an accelerometer and a gyroscopic sensor in addition to sensing a magnetic field with a magnetometer" col 32, lines 61-63 Further discloses monitoring a tubing rotator. See the sections "Rod Rotator Monitor" and "Tubing Rotation Monitoring" (columns 12-14).
3	9903193	Discloses using a gyro on the polished rod; col 5, line 60-62 "At least one 6-Axis IMU (accelerometer plus gyroscope) may be attached to the polished rod and is referred to as the bridle sensor."
4	11339643	This relates to the vibration monitoring aspects presented in US 17/549,519. Discloses a gyroscope; col 4, line 19-20 "The gyroscope 68 in this example is a sensor configured to measure a rate of rotation about at least one gyroscope axis 88" in reference to the pumping unit crank. It further discloses a means for detecting points within the stroke of the pumping unit; figure 7 shows a 360-degree plot of crankarm vs. acceleration. This application discusses rotation, but specifically rotation of the crank arm of the pumping unit, not of the rod-string. While these are

different types of rotation, this disclosure demonstrates that a gyro can be used for the purpose of monitoring at least one type of rotation.

5	3343409	Discloses monitoring the rod lift system. Of particular relevance is the linear displacement (or "axial motion"). Further it discloses the process of summing sensor data.
6	11542938	This discloses a sensor similar to that of the Hurst disclosure in that it utilizes a discrete switch to determine rotation. Further discloses a means to determine position using an accelerometer.
7	10167707	Discusses magnetic sensing of stroke position using a discrete magnet. It is noted that the use of a magnet to determine stroke position dates back to US 3,343,409 Gibbs and is a well-known method of determining position. The use of a continuous magnetometer for this purpose was introduced in US 16/228,233.
8	11572770	Discloses a gyroscope coupled to the polished rod. Col 4, lines 50-53 "the integrated sensor 200 includes a strain gauge 202, gyroscope 204, and accelerometer 206 which may be positioned on the polished rod 124". See claim 1 "a gyroscope configured to measure an orientation, an angular velocity, or both of the beam pump unit as the beam pump unit operates".

U.S. patent application publications

Cite #	Publication #	Concise Description of Relevance
1	US 2022-0236082	This discloses a sensor similar to that of the Hurst disclosure in that it utilizes a discrete switch to determine rotation.
2	US 2019-0203579	Attachment: 3rdPartyObservation2.pdf

Foreign patent documents

Cite #	Foreign Document #	Concise Description of Relevance
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Non-patent publications

Cite #	Reference	Concise Description of Relevance
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US	4428
184959	7590	11/01/2023		
ChampionX/PCFB			EXAMINER	
4001 S. 700 E. Suite 500			SINGLETON, MICHAEL J	
Salt Lake City, UT 84107				
			ART UNIT	PAPER NUMBER
			2863	
			NOTIFICATION DATE	DELIVERY MODE
			11/01/2023	ELECTRONIC

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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):

gcb.team@phillipswinchester.com
greg@pcfblaw.com
sarah.petersen@championx.com

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APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR/ PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
17/549,519	12/13/2021	Treiberg et al.	CHX.1002US

ChampionX/PCFB 4001 S. 700 E. Suite 500 Salt Lake City, UT 84107		EXAMINER	
		Karl I Tamai	
		ART UNIT	PAPER
		2800	20231031

DATE MAILED: _____

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Commissioner for Patents

A third-party submission under 37 CFR 1.290 has been filed on October 30, 2023 (10/30/2023), and is being entered in the above-identified application. Please allow a few days for the submission to be visible in the Patent Center (<https://patentcenter.uspto.gov>).

/KARL I TAMAI/
TQAS, TC 2800



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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
17/549,519

RECEIPT DATE / TIME
03/13/2024 11:15:52 PM Z ET

ATTORNEY DOCKET #
CHX.1002US

Title of Invention

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	4428	FILED BY	Autumn Lee
PATENT CENTER #	64676010	FILING DATE	12/13/2021
CUSTOMER #	184959	FIRST NAMED INVENTOR	Terry Treiberg
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Greg Baker

Documents

TOTAL DOCUMENTS: 3

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
POA ChampionX LLC.pdf	1	Power of Attorney	152 KB
184959_17549519_12-13-2021_ADS.pdf	8	Application Data Sheet	496 KB
Warning: This is not a USPTO supplied ADS fillable form. Data in the form cannot be automatically loaded to other USPTO systems.			
373_CHX.pdf	3	Assignee showing of ownership per 37 CFR 3.73	224 KB

Digest

DOCUMENT

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184959_17549519_12-13- 2021_ADS.pdf	DD36E3AFC23FA83F65EC03B71B1D0B4A97C8658DA2047122 60CBBD7F3F12E1721C17472280B2491BC0025389517B45EED F3F4784FBDA54304E8703AB644078BC
373_CHX.pdf	81F4983B52FD1B331B39EE7EF2F67FB4FD870CA7F5D325622 C06E2C5EBABD43EDCBEDAE689E46A0AA99A84E7CB0AF820 430A04F38767FEB99C142C1F629E7CDD

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 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.

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.

STATEMENT UNDER 37 CFR 3.73(c)First Named Inventor/Patent Owner: CHAMPIONX LLCApplication No./Patent No.: 17/549,519 Filed/Issue Date: 12/13/2021Titled: DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORECHAMPIONX LLC, a Company

(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 _____, Frame _____, 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: Inventors To: THETA OILFIELD SERVICES, INC.The document was recorded in the United States Patent and Trademark Office at
Reel 058690, Frame 0839, or for which a copy thereof is attached*.2. From: THETA OILFIELD SERVICES, INC. To: CHAMPIONX LLCThe document was recorded in the United States Patent and Trademark Office at
Reel 063966, Frame 0350, or for which a copy thereof is attached*.

[Page 1 of 2]

A Federal agency may not conduct or sponsor, and a person is not required to respond to, nor shall a person be subject to a penalty for failure to comply with an information collection subject to the requirements of the Paperwork Reduction Act of 1995, unless the information collection has a currently valid OMB Control Number. The OMB Control Number for this information collection is 0651-0031. Public burden for this form is estimated to average 12 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection. Send comments regarding this burden estimate or any other aspect of this information collection, including suggestions for reducing this burden to the Chief Administrative Officer, United States Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450 or email InformationCollection@uspto.gov. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

EX-1002, p. 157 of 378

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

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.

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.

/GCB/

3/13/2024

Signature

Date

Greg Baker

61335

Printed or Typed Name

Title or Registration 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. The United States Patent and Trademark Office (USPTO) collects the information in this record under authority of 35 U.S.C. 2. The USPTO's system of records is used to manage all applicant and owner information including name, citizenship, residence, post office address, and other information with respect to inventors and their legal representatives pertaining to the applicant's/owner's activities in connection with the invention for which a patent is sought or has been granted. The applicable Privacy Act System of Records Notice for the information collected in this form is COMMERCE/PAT-TM-7 Patent Application Files, available in the Federal Register at 78 FR 19243 (March 29, 2013). <https://www.govinfo.gov/content/pkg/FR-2013-03-29/pdf/2013-07341.pdf>

Routine uses of the information in this record may include disclosure to:

- 1) law enforcement, in the event that the system of records indicates a violation or potential violation of law;
- 2) a federal, state, local, or international agency, in response to its request;
- 3) a contractor of the USPTO having need for the information in order to perform a contract;
- 4) the Department of Justice for determination of whether the Freedom of Information Act (FOIA) requires disclosure of the record;
- 5) a Member of Congress submitting a request involving an individual to whom the record pertains, when the individual has requested the Member's assistance with respect to the subject matter of the record;
- 6) a court, magistrate, or administrative tribunal, in the course of presenting evidence, including disclosures to opposing counsel in the course of settlement negotiations;
- 7) the Administrator, General Services Administration (GSA), or their designee, during an inspection of records conducted by GSA under authority of 44 U.S.C. 2904 and 2906, in accordance with the GSA regulations and any other relevant (i.e., GSA or Commerce) directive, where such disclosure shall not be used to make determinations about individuals;
- 8) 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));
- 9) the Office of Personnel Management (OPM) for personnel research purposes; and
- 10) the Office of Management and Budget (OMB) for legislative coordination and clearance.

If you do not furnish the information requested on this form, the USPTO may not be able to process and/or examine your submission, which may result in termination of proceedings, abandonment of the application, and/or expiration of the patent.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number

Filing Date

17/549,519

12/13/2021

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)



I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

184959

OR



I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:



The address associated with the above-mentioned Customer Number

OR



The address associated with Customer Number:

OR



Firm or
Individual Name

Address

City

State

Zip

Country

Telephone

Email

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

CHAMPIONX LLC



Inventor or Joint Inventor (title not required below)



Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)



Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)



Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature

Date (Optional)

Name

Julia Wright

Title

Senior Vice President and General Counsel

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



Total of 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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		
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					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Terry		Treiberg		
Residence Information (Select One)		☒ US Residency ☐ Non US Residency ☐ Active US Military Service			
City	Bakersfield	State/Province	CA	Country of Residence ⁱ	US
Mailing Address of Inventor:					
Address 1		4511 Palisades Circle			
Address 2					
City	Bakersfield	State/Province	CA		
Postal Code	93308	Country ⁱ	US		
Inventor 2					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Terry		Wright		
Residence Information (Select One)		☒ US Residency ☐ Non US Residency ☐ Active US Military Service			
City	Lequire	State/Province	OK	Country of Residence ⁱ	US
Mailing Address of Inventor:					
Address 1		PO BOX 7			
Address 2					
City	Lequire	State/Province	OK		
Postal Code	74943	Country ⁱ	US		
Inventor 3					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Eric	EX-1002, p. 161 of 378	Larson		

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	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

Residence Information (Select One)		☒ US Residency	☐ Non US Residency	☐ Active US Military Service
City	Johnstown	State/Province	CO	Country of Residence ⁱ
US				
Mailing Address of Inventor:				
Address 1	326 Glenroy Dr.			
Address 2				
City	Johnstown	State/Province	CO	
Postal Code	80534	Country ⁱ	US	
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.				

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	102983
Email Address	Add Email Remove Email

Application Information:

Title of the Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		
Attorney Docket Number	CHX.1002US	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	3	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

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	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

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	102983				
Prefix	Given Name	Middle Name	Family Name	Suffix	Remove
Registration Number					
Prefix	Given Name	Middle Name	Family Name	Suffix	Remove
Registration Number					
Additional Representative Information blocks may be generated within this form by selecting the Add button.					

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		Remove
Application Number	Continuity Type	Prior Application Number
Filing or 371(c) Date (YYYY-MM-DD)		
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.		

Foreign Priority Information:

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	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

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) 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).

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.

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	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

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.

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	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

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

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

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 ~~THETA OILFIELD SERVICES, INC.~~ CHAMPIONX LLC

Mailing Address Information For Applicant:

Address 1	5201 CALIFORNIA AVE., SUITE 370 11177 S. STADIUM DRIVE		
Address 2			
City	BAKERSFIELD SUGAR LAND	State/Province	CA TX
Country ⁱ	US	Postal Code	93309 77478
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

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	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

Assignee Information including Non-Applicant Assignee 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.

Assignee 1							
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.							
If the Assignee or Non-Applicant Assignee is an Organization check here.				☐			
Prefix	Given Name	Middle Name	Family Name	Suffix			
Mailing Address Information For Assignee including Non-Applicant Assignee:							
Address 1							
Address 2							
City			State/Province				
Country i			Postal Code				
Phone Number			Fax Number				
Email Address							
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.							

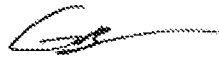
Application Data Sheet 37 CFR 1.76		Attorney Docket Number	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

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	/GCB/ 	Date (YYYY-MM-DD)	3/13/2024		
First Name	Gregory	Last Name	Baker	Registration Number	61335
Additional Signature may be generated within this form by selecting the Add button.					



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
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US

184959
ChampionX/BKRIP
1240B E Stringham Ave #1027
SALT LAKE CITY, UT 84106

CONFIRMATION NO. 4428
IMPROPER CPOA LETTER



OC00000069925914

Date Mailed: 03/20/2024

NOTICE REGARDING POWER OF ATTORNEY

This is in response to the power of attorney filed 03/13/2024. The power of attorney in this application is not accepted for the reason(s) listed below:

- The power of attorney has not been accepted because the party who is giving power has not been identified. Power of attorney may only be signed by the applicant for patent (37 CFR 1.42) or the patent owner. A party who is not the applicant must become the applicant in accordance with 37 CFR 1.46(c) and appoint any power of attorney in compliance with 37 CFR 3.71 and 3.73. For a reissue application, reexamination proceeding, or supplemental examination proceeding, a patent owner who was not the applicant under 37 CFR 1.46 must appoint any power of attorney in compliance with 37 CFR 3.71 and 3.73. See 37 CFR 1.32(b)(4).

The power of attorney filed 03/13/2024 has not been accepted because the power of attorney must be signed by the applicant for patent. See 37 CFR 1.32(b)(4).

- The request to change the applicant is not accepted because the ADS submitted on 03/13/2024 was not properly marked up to show the desired changes. For information being changed relative to the information already of record, the ADS must contain markings to show that the information is being changed with underlining for insertions and strike-through or brackets for text removed. See 37 CFR 1.76(c)(2). Information of record can generally be found on the latest filing receipt.

Because the request to change or update the applicant cannot be accepted, the power of attorney is not properly signed by the applicant and cannot be accepted. The change to applicant must be acceptable before the new applicant can appoint power of attorney.

In order to make changes to the information of record, an ADS must be properly signed and properly marked up relative to the current information of record.

Proper signature: The ADS must be signed with a handwritten signature or proper S-signature by:

- A patent practitioner, with the practitioner's registration number accompanying the signature (e.g., immediately below or adjacent to the signature), or
- The applicant, if the applicant is an individual other than the inventor(s) and no power of attorney has been appointed, or

184950
Maxwell Cole Watchmaker
10602 North Wood Crest Court
Mequon, WI 53092
UNITED STATES

- All of the inventors, if no other applicant has been established and no power of attorney has been appointed. A proper S-signature consists of only letters and/or Arabic numerals, with appropriate spaces and commas, periods, apostrophes, or hyphens for punctuation contained between a first single forward slash mark before, and a second single forward slash mark after, the S-signature.

Proper markings: The ADS must identify the changes being made with underlining for insertions and strike-through or brackets for text removed. No other markings or indications are acceptable. Where an ADS providing corrected or updated information does not contain all of the sections of the ADS, the entire section in which changes are being made must be included in the ADS. Information of record can generally be found on the latest filing receipt.

/atesfai/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number

Filing Date

17/549,519

12/13/2021

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)



I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

184959

OR



I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:



The address associated with the above-mentioned Customer Number

OR



The address associated with Customer Number:

OR



Firm or
Individual Name

Address

City

State

Zip

Country

Telephone

Email

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

CHAMPIONX LLC



Inventor or Joint Inventor (title not required below)



Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)



Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)



Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature

Date (Optional)

Name

Julia Wright

Title

Senior Vice President and General Counsel

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



Total of 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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		
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					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Terry		Treiberg		
Residence Information (Select One)		☒ US Residency ☐ Non US Residency ☐ Active US Military Service			
City	Bakersfield	State/Province	CA	Country of Residence ⁱ	US
Mailing Address of Inventor:					
Address 1		4511 Palisades Circle			
Address 2					
City	Bakersfield	State/Province	CA		
Postal Code	93308	Country ⁱ	US		
Inventor 2					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Terry		Wright		
Residence Information (Select One)		☒ US Residency ☐ Non US Residency ☐ Active US Military Service			
City	Lequire	State/Province	OK	Country of Residence ⁱ	US
Mailing Address of Inventor:					
Address 1		PO BOX 7			
Address 2					
City	Lequire	State/Province	OK		
Postal Code	74943	Country ⁱ	US		
Inventor 3					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Eric	EX-1002, p. 172 of 378	Larson		

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	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

Residence Information (Select One)		☒ US Residency	☐ Non US Residency	☐ Active US Military Service
City	Johnstown	State/Province	CO	Country of Residence ⁱ
US				

Mailing Address of Inventor:

Address 1	326 Glenroy Dr.			
Address 2				
City	Johnstown	State/Province	CO	
Postal Code	80534	Country ⁱ	US	

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	102983		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		
Attorney Docket Number	CHX.1002US	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	3	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

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	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

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	102983				
Prefix	Given Name	Middle Name	Family Name	Suffix	Remove
Registration Number					
Prefix	Given Name	Middle Name	Family Name	Suffix	Remove
Registration Number					

Additional Representative Information blocks may be generated within this form by selecting the **Add** button.

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		Remove
Application Number	Continuity Type	Prior Application Number
Filing or 371(c) Date (YYYY-MM-DD)		

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

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	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

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) 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).

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.

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	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

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.

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	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

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

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

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 ~~THETA OILFIELD SERVICES, INC.~~ CHAMPIONX LLC

Mailing Address Information For Applicant:

Address 1	5201 CALIFORNIA AVE., SUITE 370	<u>11177 S. STADIUM DRIVE</u>
Address 2		
City	BAKERSFIELD	<u>SUGAR LAND</u>
State/Province	CA	<u>TX</u>
Country ⁱ	US	
Postal Code	93309	<u>77478</u>
Phone Number		Fax Number
Email Address		

Additional Applicant Data may be generated within this form by selecting the Add button.

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	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

Assignee Information including Non-Applicant Assignee 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.

Assignee 1							
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.							
If the Assignee or Non-Applicant Assignee is an Organization check here.				☐			
Prefix	Given Name	Middle Name	Family Name	Suffix			
Mailing Address Information For Assignee including Non-Applicant Assignee:							
Address 1							
Address 2							
City			State/Province				
Country i			Postal Code				
Phone Number			Fax Number				
Email Address							
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.							

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.

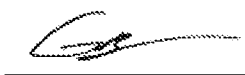
Application Data Sheet 37 CFR 1.76		Attorney Docket Number	CHX.1002US
		Application Number	
Title of Invention	DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE		

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

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	/GCB/ 			Date (YYYY-MM-DD)	3/13/2024
First Name	Gregory	Last Name	Baker	Registration Number	61335
Additional Signature may be generated within this form by selecting the Add button.					

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.

STATEMENT UNDER 37 CFR 3.73(c)First Named Inventor/Patent Owner: CHAMPIONX LLCApplication No./Patent No.: 17/549,519 Filed/Issue Date: 12/13/2021Titled: DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORECHAMPIONX LLC, a Company

(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 _____, Frame _____, 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: Inventors To: THETA OILFIELD SERVICES, INC.The document was recorded in the United States Patent and Trademark Office at
Reel 058690, Frame 0839, or for which a copy thereof is attached*.2. From: THETA OILFIELD SERVICES, INC. CHAMPIONX LLC To: CHAMPIONX LLCThe document was recorded in the United States Patent and Trademark Office at
Reel 063966, Frame 0350, or for which a copy thereof is attached*.

[Page 1 of 2]

A Federal agency may not conduct or sponsor, and a person is not required to respond to, nor shall a person be subject to a penalty for failure to comply with an information collection subject to the requirements of the Paperwork Reduction Act of 1995, unless the information collection has a currently valid OMB Control Number. The OMB Control Number for this information collection is 0651-0031. Public burden for this form is estimated to average 12 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection. Send comments regarding this burden estimate or any other aspect of this information collection, including suggestions for reducing this burden to the Chief Administrative Officer, United States Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450 or email InformationCollection@uspto.gov. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

EX-1002, p. 180 of 378

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

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.

/GCB/

3/20/2024

Signature

Date

Greg Baker

61335

Printed or Typed Name

Title or Registration 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. The United States Patent and Trademark Office (USPTO) collects the information in this record under authority of 35 U.S.C. 2. The USPTO's system of records is used to manage all applicant and owner information including name, citizenship, residence, post office address, and other information with respect to inventors and their legal representatives pertaining to the applicant's/owner's activities in connection with the invention for which a patent is sought or has been granted. The applicable Privacy Act System of Records Notice for the information collected in this form is COMMERCE/PAT-TM-7 Patent Application Files, available in the Federal Register at 78 FR 19243 (March 29, 2013). <https://www.govinfo.gov/content/pkg/FR-2013-03-29/pdf/2013-07341.pdf>

Routine uses of the information in this record may include disclosure to:

- 1) law enforcement, in the event that the system of records indicates a violation or potential violation of law;
- 2) a federal, state, local, or international agency, in response to its request;
- 3) a contractor of the USPTO having need for the information in order to perform a contract;
- 4) the Department of Justice for determination of whether the Freedom of Information Act (FOIA) requires disclosure of the record;
- 5) a Member of Congress submitting a request involving an individual to whom the record pertains, when the individual has requested the Member's assistance with respect to the subject matter of the record;
- 6) a court, magistrate, or administrative tribunal, in the course of presenting evidence, including disclosures to opposing counsel in the course of settlement negotiations;
- 7) the Administrator, General Services Administration (GSA), or their designee, during an inspection of records conducted by GSA under authority of 44 U.S.C. 2904 and 2906, in accordance with the GSA regulations and any other relevant (i.e., GSA or Commerce) directive, where such disclosure shall not be used to make determinations about individuals;
- 8) 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));
- 9) the Office of Personnel Management (OPM) for personnel research purposes; and
- 10) the Office of Management and Budget (OMB) for legislative coordination and clearance.

If you do not furnish the information requested on this form, the USPTO may not be able to process and/or examine your submission, which may result in termination of proceedings, abandonment of the application, and/or expiration of the patent.



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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
17/549,519

RECEIPT DATE / TIME
03/20/2024 07:01:38 PM Z ET

ATTORNEY DOCKET #
CHX.1002US

Title of Invention

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	4428	FILED BY	Autumn Lee
PATENT CENTER #	64771814	FILING DATE	12/13/2021
CUSTOMER #	184959	FIRST NAMED INVENTOR	Terry Treiberg
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Greg Baker

Documents

TOTAL DOCUMENTS: 3

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
373 CHX.pdf	3	Assignee showing of ownership per 37 CFR 3.73	224 KB
POA ChampionX LLC.pdf	1	Power of Attorney	152 KB
184959_17549519_12-13-2021_ADS.pdf	8	Application Data Sheet	626 KB

Warning: This is not a USPTO supplied ADS fillable form. Data in the form cannot be automatically loaded to other USPTO systems.

Digest

DOCUMENT

MESSAGE DIGEST(SHA-512)

373 CHX.pdf	2D07B47CC17E216E0BBCB09B041DF3317E85F88DC4F58A8C 400BCFDEE2C47FC75026BAEAC5DDB94EAB23BE5BED3BAA 0716DC27C6F9212FF64CA3B0B7BB17547B
POA ChampionX LLC.pdf	697F9356088C1B4B814FB1DEB6770569373CADFB673A2DEB3 E069915DAE9CBFAA8F5849FEB4E10ED3A48EC91668118A71 19105C27E1C9AA2934A6087A659D789
184959_17549519_12-13- 2021_ADS.pdf	D69C490250E5C4A60BFE969C873106D5231EF2BB32C457F69 1174D64AB7E8085C893CA28144987E0494CEE45707DB3D4F4 24BC085612AAD07F7589D8A5C46072

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 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.



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US

CONFIRMATION NO. 4428

184959
ChampionX/BKRIP
1240B E Stringham Ave #1027
SALT LAKE CITY, UT 84106

POWER OF ATTORNEY NOTICE



OC000000070327679

Date Mailed: 03/28/2024

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/20/2024.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(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.

/qnghuyen/



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US

CONFIRMATION NO. 4428

POA ACCEPTANCE LETTER



OC000000070327714

184959
ChampionX/BKRIP
1240B E Stringham Ave #1027
SALT LAKE CITY, UT 84106

Date Mailed: 03/28/2024

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/20/2024.

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.

/qnghuyen/



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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
17/549,519	12/13/2021	2863	2300	CHX.1002US	20	4

184959
ChampionX/BKRIP
1240B E Stringham Ave #1027
SALT LAKE CITY, UT 84106

CONFIRMATION NO. 4428
REPLACEMENT FILING RECEIPT



0000000070327731

Date Mailed: 03/28/2024

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)

Terry Treiberg, Bakersfield, CA;
Terry Wright, Lequire, OK;
Eric Larson, Johnstown, CO;

Applicant(s)

CHAMPIONX LLC, Sugar Land, TX;

Power of Attorney: The patent practitioners associated with Customer Number 184959

Domestic Applications for which benefit is claimed - None.

A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

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

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: 12/27/2021

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/549,519**

Projected Publication Date: 06/15/2023

Non-Publication Request: No

Early Publication Request: No

Title

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Preliminary Class

702

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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NOT GRANTED

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Notice of References Cited	Application/Control No. 17/549,519		Applicant(s)/Patent Under Reexamination Treiberg et al.	
	Examiner MICHAEL J SINGLETARY		Art Unit 2863	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Name	CPC Classification	US Classification
*	A	US-20190203579-A1	2019-07-04	Phillips; Walter	G01V3/40	1/1
*	B	US-11319794-B2	2022-05-03	Fyfe; Kelly	G01B7/16	1/1
*	C	US-9140113-B2	2015-09-22	Hurst; Gregg W.	E21B47/009	1/1
*	D	US-20080035376-A1	2008-02-14	Freyer; Carsten	E21B12/00	702/9
*	E	US-20030236627-A1	2003-12-25	Estes, Robert A.	E21B47/022	702/9
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

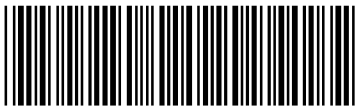
*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in YYYY-MM-DD format are publication dates. Classifications may be US or foreign.

<i>Index of Claims</i> 	Application/Control No. 17/549,519	Applicant(s)/Patent Under Reexamination Treiberg et al.
	Examiner MICHAEL J SINGLETARY	Art Unit 2863

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47										
CLAIM		DATE								
Final	Original	06/07/2024								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	✓								

<i>Search Notes</i> 	Application/Control No. 17/549,519	Applicant(s)/Patent Under Reexamination Treiberg et al.
	Examiner MICHAEL J SINGLETARY	Art Unit 2863

CPC - Searched*		
Symbol	Date	Examiner
(E21B47/009 or E21B43/127 or E21B47/092).cpc.	06/07/2024	MS

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
Inventor name search in PALM and PE2E	06/07/2024	MS
Consulted Manish Shah regarding class/class search	06/07/2024	MS
PE2E search history attached	06/07/2024	MS

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

/MICHAEL J SINGLETARY/ Examiner, Art Unit 2863	
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PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	0	"16228233".did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/06/03 03:22 PM
L2	2	"20190203579".did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/06/03 03:24 PM
L3	16	"11319794"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/06/05 04:56 PM
L4	19	"9140113"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY,	OR	ON	ON	2024/06/06 01:14 PM

			CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L5	8	("20030236627" OR "20080035376" OR "20190203579" OR "20200123892" OR "20200392834" OR "20130181844" OR "20200263531" OR "20200340309").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/06/07 03:36 PM
L6	4	("20130181844" OR "20190203579" OR "20200263531" OR "20200340309").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/06/07 03:47 PM
L7	5	("20030236627" OR "20080035376" OR "20190203579" OR "20200123892" OR "20200392834").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/06/07 03:50 PM
L8	9678	(E21B47/009 OR E21B43/127 OR E21B47/092).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/06/07 03:51 PM
L9	1	("20230184089").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/06/07 03:52 PM
L10	33	(Artificial Intelligence) More like doc: US-20230184089-A1 Text: (WO-2023113950-A1 OR US-11814948-B2 OR CA-3216041-A1 OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2024/06/07 03:52 PM

		CA-3028433-C OR US-20240026771-A1 OR CA-3028433-A1 OR US-20190203579-A1 OR US-10508522-B2 OR US-11408271-B2 OR US-11060392-B2 OR EP-3170968-A1 OR US-20170146007-A1 OR US-20200190965-A1 OR US-6529834-B1 OR US-20160177683-A1 OR US-20160076362-A1 OR US-20020116130-A1 OR GB-2370645-A OR US-20030236627-A1 OR EP-1184539-B1).did.	IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L11	2931	(downhole OR wellbore) sensor detect\$3 movement pump\$3 system axial motion rotation velocity	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2024/06/07 03:58 PM
L12	1533	(E21B47/009).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2024/06/07 03:58 PM
L13	29	L11 AND L12	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA,	AND	ON	ON	2024/06/07 03:59 PM

			EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L14	6458	rotation axial velocity sensor magnetometer gyroscope	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2024/06/07 04:02 PM
L15	10	L14 AND L12	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2024/06/07 04:02 PM
L16	13	L10 AND axial	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA,	AND	ON	ON	2024/06/07 04:02 PM

			VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
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PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

Doc code: IDS

PTO/SB/08a (02-18)

Doc description: Information Disclosure Statement (IDS) Filed

Approved for use through 11/30/2020. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		2021-12-13
	First Named Inventor	Terry Treiberg	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	CHX.1002US	

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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U.S.PATENT APPLICATION PUBLICATIONS						Remove
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20200263531	A1	2020-08-20	4iiii Innovations Inc	
	2	20130181844	A1	2013-07-18	Weatherford Technology Holdings LLC	
	3	20190203579	A1	2019-07-04	Walter Phillips	
	4	20200340309	A1	2020-10-29	Norris Rods Inc	

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FOREIGN PATENT DOCUMENTS								Remove
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²ⁱ	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T ⁵

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number		
Filing Date		2021-12-13
First Named Inventor	Terry Treiberg	
Art Unit		
Examiner Name		
Attorney Docket Number	CHX.1002US	

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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	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, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1	International Search Report and Written Opinion, mailed 15 October 2015 in corresponding International Application No. PCT/US2015/032766 with International Filing Date of 27 May 2015.	

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EXAMINER SIGNATURE

Examiner Signature	/MICHAEL J SINGLETARY/	Date Considered	06/07/2024
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number		
Filing Date		2021-12-13
First Named Inventor	Terry Treiberg	
Art Unit		
Examiner Name		
Attorney Docket Number	CHX.1002US	

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Gregory Baker/	Date (YYYY-MM-DD)	2021-12-13
Name/Print	Gregory Baker	Registration Number	61,335

This collection of information is required by 37 CFR 1.97 and 1.98. 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 1 hour 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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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 the Freedom of Information Act requires disclosure of these records.
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 inspections 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.

Bibliographic Data

Application No: 17/549,519

Foreign Priority claimed: ☐ Yes ☒ No

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

Verified and Acknowledged:

/MICHAEL J SINGLETARY/

Examiner's Signature

Initials

Title:

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE
ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH
A WELLBORE

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
12/13/2021	702	2863	CHX.1002US
RULE			

APPLICANTS

CHAMPIONX LLC, BAKERSFIELD, CA, UNITED STATES

INVENTORS

Terry Treiberg, Bakersfield, CA, UNITED STATES

Terry Wright, Lequire, OK, UNITED STATES

Eric Larson, Johnstown, CO, UNITED STATES

CONTINUING DATA

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

12/27/2021

STATE OR COUNTRY

UNITED STATES

ADDRESS

ChampionX/BKRIP

1240B E Stringham Ave #1027

SALT LAKE CITY, UT 84106

UNITED STATES

FILING FEE RECEIVED

\$1,820

Doc code: IDS

PTO/SB/08a (01-22)

Doc description: Information Disclosure Statement (IDS) Filed

Approved for use through 05/31/2024. OMB 0651-0031

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)

Application Number	17549519
Filing Date	2021-12-13
First Named Inventor	Terry Treiberg
Art Unit	
Examiner Name	
Attorney Docket Number	CHX.1002US

U.S.PATENTS

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	1	20030236627	A1	2003-12-25	Robert Estes	
	2	20080035376	A1	2008-02-14	Carsten Freyer	
	3	20190203579	A1	2019-07-04	Walter Phillips	
	4	20200123892	A1	2020-04-23	Eduardo N. Picon	
	5	20200392834	A1	2020-12-17	Mahmut Sengul	

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Filing Date	2021-12-13
First Named Inventor	Terry Treiberg
Art Unit	
Examiner Name	
Attorney Docket Number	CHX.1002US

Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1							

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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	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, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1	International Search Report and Written Opinion for PCT/US2022/049624, 16 February 2023, 10 pages	

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EXAMINER SIGNATURE

Examiner Signature	/MICHAEL J SINGLETARY/	Date Considered	06/07/2024
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

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(Not for submission under 37 CFR 1.99)

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Filing Date	2021-12-13		
First Named Inventor	Terry Treiberg		
Art Unit			
Examiner Name			
Attorney Docket Number	CHX.1002US		

CERTIFICATION STATEMENT

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/GCB/	Date (YYYY-MM-DD)	2023-02-27
Name/Print	Gregory C. Baker	Registration Number	61,335

This collection of information is required by 37 CFR 1.97 and 1.98. 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 1 hour 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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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.
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Doc Code: IDS.3P
Description: Third Party Submission Under 37 CFR 1.290

PTO/SB/429
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE



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THIRD-PARTY SUBMISSION UNDER 37 CFR 1.290

APPLICATION #
17549519

U.S. Patents

Cite #	Patent #	Kind Code ¹	Issue Date (YYYY/MM/DD)	First Named Inventor
1	9140113		2015/09/22	Gregg W. Hurst
2	11319794		2022/05/03	Kelly Fyfe
3	9903193		2018/02/27	Peter HARDING
4	11339643		2022/05/24	Clark E. ROBISON
5	3343409		1967/09/26	Gibbs
6	11542938		2023/01/03	Min ZHAO
7	10167707		2019/01/01	James S. TRAPANI
8	11572770		2023/02/07	Mahmut Sengul

U.S. patent application publications

Cite #	Publication #	Kind Code ¹	Publication Date (YYYY/MM/DD)	First Named Inventor
1	US 2022- 0236082		2022/07/28	Jose Navar
2	US 2019- 0203579		2019/07/04	Walter Phillips

Foreign patents and published foreign patent applications

Cite #	Foreign Document # ³	Country Code ²	Kind Code ¹	Publication Date (YYYY/MM/DD)	Applicant, patentee or first named inventor	T ⁵
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Non-patent publications

Cite #	Author (if any), title of the publication, page(s) being submitted, publication date, publisher (where available), place of publication (where available).	T ⁵	E ⁶
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Statements

The party making the submission is not an individual who has a duty to disclose information with respect to the above-identified application under 37 CFR 1.56.

This submission complies with the requirements of 35 U.S.C. 122(e) and 37 CFR 1.290.

Resubmission: This resubmission is being made responsive to a notification of non-compliance issued for an earlier filed third-party submission. The corrections in this resubmission are limited to addressing the non-compliance.

1. Fee previously paid: The party making this resubmission requests that the Office apply the previously-paid fee set forth in 37 CFR 1.290(f).

2. Fee exemption applies: The party making this resubmission states that no fee is required to accompany this resubmission as the undersigned is again making the fee exemption statement set forth in 37 CFR 1.290(g).

Signature**Name****Registration #**

/Walter Phillips/

walter phillips

—

Examiner Signature**Date considered**

/MICHAEL J SINGLETARY/

06/07/2024

*EXAMINER: Signature indicates all documents listed above have been considered, except for citations through which a line is drawn. Draw line through citation if not considered. Include a copy of this form with next communication to applicant. 1. If known, enter kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16. See MPEP 901.04(a). 2. Enter the country or patent office that issued the document, by two-letter code under WIPO standard ST.3. See MPEP 1851. 3. For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 4. If known, enter the kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16. See MPEP 901.04(a). 5. Check mark indicates translation attached. 6. Check mark indicates evidence of publication attached.



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US	4428
184959	7590	06/14/2024		
ChampionX/BKRIP 1240B E Stringham Ave #1027 SALT LAKE CITY, UT 84106			EXAMINER SINGLETERY, MICHAEL J	
			ART UNIT	PAPER NUMBER
			2863	
			NOTIFICATION DATE	DELIVERY MODE
			06/14/2024	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):

USPTO@dockettrak.com
gcb-team@bkrip.com
talwinder.singh@championx.com

DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

Claim Rejections - 35 USC § 102

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis (i.e., changing from AIA to pre-AIA) for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention.

Claims 1-7 and 13-15 are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Phillips (US20190203579A1, 2019-07-04).

Regarding Claim 1, Phillips teaches a sensor system for a downhole pumping system [0019], comprising: a sensor subsystem for detecting movement of at least one component of the downhole pumping system [Claim 1], the sensor subsystem comprising: an axial motion sensor subsystem comprising a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system (Claim 1; [00126]); and a rotation sensor subsystem comprising a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system [Claim 1 and 12; [00110]]; and a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem [Claim 1], the processor subsystem to: determine axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem[0021]; and determine rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system with the gyroscope [0026; 0029; 0134; 0138; Fig. 6].

Regarding Claim 2, Phillips further teaches the sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore [Claim 1 and 13].

Regarding Claim 3, Phillips further teaches the sensor system of claim 2, wherein the processor subsystem is configured to verify the axial movement of the at least one rod before determining the rotation [0027; 00134; Claim 11; Fig. 6].

Regarding Claim 4, Phillips further teaches the sensor system of claim 2, wherein the processor subsystem is configured to determine a change in direction the at least one rod [0021-0022].

Regarding Claim 5, Phillips further teaches the sensor system of claim 4, wherein the processor subsystem is configured to begin sampling the rotational velocity after determining the change in direction the at least one rod [0110].

Regarding Claim 6, Phillips further teaches the sensor system of claim 5, wherein the processor subsystem is configured to continue sampling the rotational velocity until another change in direction the at least one rod is detected [0158].

Regarding Claim 7, Phillips further teaches the sensor system of claim 5, wherein the processor subsystem is configured to continue sampling the rotational velocity along

substantially an entire stroke of the at least one rod, the sampling beginning at a first change of direction of the at least one rod, continuing through a second change of direction of the at least one rod, and ceasing at a third change of direction of the at least one rod [0029; 0110].

Regarding Claim 13, Phillips teaches a sensor system for a downhole pumping system [0019], comprising: a sensor subsystem for detecting movement of at least one component of the downhole pumping system [Claim 1], the sensor subsystem comprising: an axial motion sensor subsystem comprising an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations detected by the axial motion sensor generated by movement of the at least one component of the downhole pumping system [Col. 2, lines 33-48]; and a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system ([Claim 1 and 12; [00110]); and a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem [Claim 1], the processor subsystem to: verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and when the axial movement has been verified, determine rotational velocity of the at

least one component of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem [0021; Fig. 6; Claim 1].

Regarding Claim 14, Phillips further teaches the sensor system of claim 13, wherein the axial motion sensor subsystem comprises a magnetometer and the rotation sensor subsystem comprises a gyroscope [Claim 8; Claim 12].

Regarding Claim 15, Phillips further teaches the sensor system of claim 14, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore, and wherein the processor subsystem is configured to continue sampling the rotational velocity values of the at least one rod over a stroke of the at least one rod [0029; 0042; 00103; 00110].

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious

before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claim 10 and 11 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips (US 20190203579A1, 04-07-2019).

Regarding Claim 10, Phillips teaches the sensor system of claim 1, wherein the processor subsystem is configured to determine the rotational velocity of the at least one component of the downhole pumping system by summing both positive and negative samples of the rotational velocity values sensed by the rotation sensor subsystem [0029; 0110; 0115].

Although Phillips does not specifically disclose the summing both positive and negative samples of the rotational velocity values, acceleration is the rate of change of velocity over time, and velocity is the rate of change of position over time.

Therefore, it would have been obvious to a person of ordinary skill in the art that determining rotational velocity by summing both positive and negative samples, was previously taught by Phillips.

Regarding Claim 11, Phillips further teaches the sensor system of claim 10, wherein the processor subsystem is configured to compare the determined rotational velocity of the at least one component of the downhole pumping system with an expected amount of rotational velocity to determine a failure in the rotation of the at least one component of the downhole pumping system [Claim 1; Claim 10].

Claims 8, 9, and 16-18 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips, in view of Hurst et al. (US9140113B2, 2015-09-22), herein referred to as Hurst.

Regarding Claim 8, Phillips teaches all of the limitations of Claim 1. Phillips further teaches wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system (abstract).

Phillips fails to specifically mention a tubing rotator, he does mention tubing that surrounds the rod string (which is well known in the art as a tubular rotator (Hurst Col. 3, lines 42-49)).

However, in a related field, Hurst teaches wherein monitoring is performed by a mechanism incorporated in at least one of a load cell, a rod rotator, or a tubing rotator (Claim 2).

Therefore, it would have been obvious to a person of ordinary skill in the art prior to the effective filing date of the claimed invention to have modified Phillips to incorporate the teachings of Hurst by including: a tubing rotator in order to distribute wear.

Regarding Claim 9, the combination further teaches the sensor system of claim 8, wherein the sensor subsystem is configured to detect rotation of the tubing rotator while detecting axial movement of a polished of the downhole pumping system (Phillips: Claim 1, Fig. 6).

Regarding Claim 16, Phillips teaches a sensor system for a downhole pumping system, comprising: a sensor subsystem for detecting movement (Abstract). Phillips further teaches a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system ([Claim 1 and 12; 00110]). Additionally, Phillips discloses a processor configured to compare the determined rotational velocity of the at least one component of the downhole pumping system with an expected amount of rotational velocity to determine a failure in the rotation of the at least one component of the downhole pumping system [Claim 1; Claim 10].

Phillips fails to specifically mention a tubing rotator, he does mention tubing that surrounds the rod string (which is well known in the art as a tubular rotator (Hurst Col. 3, lines 42-49).

However, in a related field, Hurst teaches wherein monitoring is performed by a mechanism incorporated in at least one of a load cell, a rod rotator, or a tubing rotator (Claim 2).

Therefore, it would have been obvious to a person of ordinary skill in the art prior to the effective filing date of the claimed invention to have modified Phillips to incorporate the teachings of Hurst by including: a tubing rotator in order to distribute wear.

Regarding Claim 17, the combination further teaches the sensor system of claim 16, wherein the rotation sensor subsystem comprises at least one of a gyroscope or an accelerometer [Phillips: Claim 12].

Regarding Claim 18, the combination teaches all of the limitations of Claim 16. The combination further teaches wherein the rotation sensor subsystem is configured to monitor the rotation of the tubing rotator along a path that extends in a direction substantially perpendicular to a surface upon which the downhole pumping system is positioned [Hurst: Col. 13, lines 50-63].

Although Hurst doesn't specifically disclose "monitoring the rotation of the tubing rotator along a path that extends in a direction substantially perpendicular to a surface upon which the downhole pumping system is positioned," it is inherent that the path

would be substantially perpendicular being that the monitoring system is surface level and the tubing rotator is subsurface and perpendicular to the surface.

Claim 12, 19 and 20 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips, in view of Fyfe et al. (US 11319794B2, 2022-05-03) herein referred to as Fyfe.

Regarding Claim 12, Phillips teaches all of the limitations of Claim 1.

Phillips fails to teach a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system over a vibrational baseline. However, in a related field,

Fyfe discloses a dynamometer that measures vibration of the polished rod (Col. 2, lines 14-18; Fig. 4-5).

Therefore, it would have been obvious to a person of ordinary skill in the art prior to the effective filing date of the claimed invention to have modified Phillips to incorporate the teachings of Fyfe by including: a vibration sensor in order to give early warning of pump failure.

Regarding Claim 19, Phillips teaches a method of detecting motion of at least one component of a downhole pumping system, the method comprising: detecting axial movement of at least one component of the downhole pumping system based on variations detected by an axial motion sensor coupled to the at least one component of the downhole pumping system generated by translation of the at least one component

of the downhole pumping system [0077]; detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system ([Claim 1 and 12; [00110]); and verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the at least one component of the downhole pumping system with the rotational sensor [0027; 00134; Claim 11; Fig. 6].

Regarding Claim 20, The method of claim 19, further comprising comparing a rotational velocity detected with the rotational sensor with a threshold value to determine a performance characteristic of the at least one component of the downhole pumping system [0026; 0158; Claim 9].

Conclusion

The prior art made record and not relied upon is considered pertinent to applicant's disclosure.

Freyer (Apparatus And Methods For Estimating Loads And Movements Of Members Downhole, 2008-02-14) teaches This disclosure, in one aspect, provides an apparatus for use in a wellbore that includes a member having an encoded magnetic field and a sensor proximate the encoded magnetic field that measures a change in the magnetic field due to a change in the load on the member. In another aspect, a method for measuring loads on a downhole tool is provided that comprises inducing an encoded

magnetic field along a section of a member of the tool and detecting a change in the magnetic field due to a load on the member when the tool is in the wellbore;

Estes (Use Of MWD Assembly For Multiple-well Drilling, 2003-12-25) teaches a measurement-while-drilling (MWD) downhole assembly for use in drilling boreholes which utilizes gyroscopes, magnetometers and accelerometers for determining the borehole inclination and azimuth during the drilling of the borehole.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MICHAEL J SINGLETARY whose telephone number is (571)272-4593. The examiner can normally be reached Monday-Friday 8:00am-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, Manish Shah can be reached on (571) 272-2152. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Art Unit: 2863

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/MICHAEL J SINGLETARY/

Examiner, Art Unit 2863

/Manish S Shah/

Primary Examiner, Art Unit 2853



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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 17/549,519		Filing Date 12/13/2021		☐ To be Mailed	
ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO									
APPLICATION AS FILED - PART I									
		(Column 1)		(Column 2)		RATE (\$)		FEE (\$)	
FOR		NUMBER FILED		NUMBER EXTRA					
☐ 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 \$480 =			
☐ 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	09/17/2024	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	x \$100 =		0	
	Independent (37 CFR 1.16(h))	* 4	Minus	*** 4	= 0	x \$480 =		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.						SLIE			
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".						/SHEMICA K DOWNING/			
*** 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.									

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Terry Treiberg et al.

Serial No.: 17/549,519

Filed: August 12, 2022

For: DEVICES, SYSTEMS, AND
METHODS FOR DETECTING THE
ROTATION OF ONE OR MORE
COMPONENTS FOR USE WITH A
WELLBORE

Confirmation No.: 4428

Examiner: SINGLETARY, MICHAEL J

Group Art Unit: 2863

Attorney Docket No.: CHX.1002US

VIA ELECTRONIC FILING

AMENDMENT

TO THE COMMISSIONER FOR PATENTS:

In response to the Office Action mailed June 14, 2024, please amend the above-identified patent application as follows.

Amendments to the claims are reflected in the **Listing of Claims** beginning on page 2 of this paper.

Remarks follow the Amendments sections of this paper.

IN THE CLAIMS:

All of the pending claims are presented below. This listing of claims will replace all prior versions and listings of claims in the application. Please enter these claims as amended.

Listing of the Claims:

1. (Currently Amended) A sensor system for a downhole pumping system, comprising:
a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising:
an axial motion sensor subsystem comprising a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to ~~detect~~measure axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system;
a rotation sensor subsystem comprising a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system; and
a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes; and
a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:
~~determine~~measure axial movement of the at least one component of the downhole pumping system with the magnetometer of the axial motion sensor subsystem;
determine rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational velocity values

generated by the rotation of the at least one component of the downhole pumping system with only the gyroscope.

2. (Original) The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore.
3. (Original) The sensor system of claim 2, wherein the processor subsystem is configured to verify the axial movement of the at least one rod before determining the rotation.
4. (Original) The sensor system of claim 2, wherein the processor subsystem is configured to determine a change in direction the at least one rod.
5. (Original) The sensor system of claim 4, wherein the processor subsystem is configured to begin sampling the rotational velocity after determining the change in direction the at least one rod.
6. (Original) The sensor system of claim 5, wherein the processor subsystem is configured to continue sampling the rotational velocity until another change in direction the at least one rod is detected.
7. (Original) The sensor system of claim 5, wherein the processor subsystem is configured to continue sampling the rotational velocity along substantially an entire stroke of the at least one rod, the sampling beginning at a first change of direction of the at least one rod, continuing through a second change of direction of the at least one rod, and ceasing at a third change of direction of the at least one rod.

8. (Original) The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising a tubing rotator of the downhole pumping system.

9. (Original) The sensor system of claim 8, wherein the sensor subsystem is configured to detect rotation of the tubing rotator while detecting axial movement of a polished of the downhole pumping system.

10. (Original) The sensor system of claim 1, wherein the processor subsystem is configured to determine the rotational velocity of the at least one component of the downhole pumping system by summing both positive and negative samples of the rotational velocity values sensed by the rotation sensor subsystem.

11. (Original) The sensor system of claim 10, wherein the processor subsystem is configured to compare the determined rotational velocity of the at least one component of the downhole pumping system with an expected amount of rotational velocity to determine a failure in the rotation of the at least one component of the downhole pumping system.

12. (Currently Amended) The sensor system of claim 1, further comprising a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes over a vibrational baseline.

13. (Currently Amended) A sensor system for a downhole pumping system, comprising:
a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising:
an axial motion sensor subsystem comprising an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to ~~detect~~measure axial movement of the at least one component of the downhole pumping system based on variations detected by the axial motion

sensor generated by movement of the at least one component of the downhole pumping system; and

a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system; and

a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes; and

a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:

derive a vibrational baseline of the at least one component of the downhole pumping system from the vibration sensor subsystem in three axes during normal operation;

verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and

when the axial movement has been verified, determine rotational velocity of the at least one component of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

14. (Original) The sensor system of claim 13, wherein the axial motion sensor subsystem comprises a magnetometer and the rotation sensor subsystem comprises a gyroscope.

15. (Original) The sensor system of claim 14, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore, and wherein the processor subsystem is configured to continue sampling the rotational velocity values of the at least one rod over a stroke of the at least one rod.

16. (Currently Amended) A sensor system for a downhole pumping system, comprising:
an axial motion sensor subsystem comprising a magnetometer to measure axial movement of at least one component of the downhole pumping system and to determine a change in axial direction of the at least one component of the downhole pumping system;
a sensor subsystem for detecting movement of a tubing rotator of the downhole pumping system, the sensor subsystem comprising a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the tubing rotator of the downhole pumping system and to detect rotational movement of the tubing rotator of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the tubing rotator of the downhole pumping system; and
a processor subsystem to receive data from the rotation sensor subsystem, the processor subsystem to determine rotational velocity of the tubing rotator of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

17. (Original) The sensor system of claim 16, wherein the rotation sensor subsystem comprises at least one of a gyroscope or an accelerometer.

18. (Original) The sensor system of claim 16, wherein the rotation sensor subsystem is configured to monitor the rotation of the tubing rotator along a path that extends in a direction substantially perpendicular to a surface upon which the downhole pumping system is positioned.

19. (Currently Amended) A method of detecting motion of at least one component of a downhole pumping system, the method comprising:
~~detecting axial movement~~determining a change in axial direction of at least one component of the downhole pumping system based on magnetic variations detected by an axial motion sensor coupled to the at least one component of the downhole pumping system generated by translation of the at least one component of the downhole pumping system;

detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system; and

verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the at least one component of the downhole pumping system with the rotational sensor.

20. (Original) The method of claim 19, further comprising comparing a rotational velocity detected with the rotational sensor with a threshold value to determine a performance characteristic of the at least one component of the downhole pumping system.

REMARKS

Status of the Claims

This amendment is filed in response to the Office Action mailed June 14, 2024.

Claims 1-20 are pending and stand rejected.

Claims 1, 12, 13, 16, and 19 are amended.

Support for the amendments to claims 1, 12, 16, and 19 is found at least at paragraphs [0028], and [0051] of the application as filed. Support for the amendments to claim 13 is found at least at paragraphs [0027], [0039], and [0043] of the application as filed.

No new matter is added.

For at least the reasons presented below, Applicant respectfully submits that each of the pending claims is in condition for allowance.

35 U.S.C. § 102

Claims 1-7 and 13-15 are rejected under 35 U.S.C. 102(a)(1) as being anticipated by **Phillips** (US 20190203579A1) (hereinafter “Phillips”).

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Brothers v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). The identical invention must be shown in as complete detail as is contained in the claim. *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

Unless a single prior art reference describes “all of the limitations claimed” *and* “all of the limitations *arranged or combined in the same way* as recited in the claim, it cannot be said to prove prior invention of the thing claimed and, thus, cannot anticipate under 35 U.S.C. § 102.” *Net MoneyIN Inc. v. VeriSign Inc.*, 545 F.3d 1359, 1371 (Fed. Cir. 2008) (emphasis added). A single prior art reference must “clearly and unequivocally” describe the claimed invention “without *any* need for picking, choosing, and combining various disclosures not directly related to each other by the teachings of the cited reference.” *Id.* (citing *In re Arkley*, 455 F.2d 586, 587 (C.C.P.A. 1972)).

Claims 1-7

Applicant respectfully asserts that claims 1-7 are not anticipated by Phillips under 35 U.S.C. § 102(a)(1) at least because Phillips does not describe each and every element of independent claim 1, as currently amended.

For example, Phillips does not describe a “**magnetometer** to be coupled to the at least one component of the downhole pumping system and to **measure axial movement** of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer” as recited in claim 1.

Phillips describes a sensing device that includes a magnetometer and that “[t]he magnetometer is effectively a compass that identifies a **radial orientation** of the sensor relative to a fixed external location such as true north.” Phillips, ¶ [0022] (emphasis added).

Phillips does not appear to describe, however, that the magnetometer is used to “**measure axial movement** of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer” as recited in claim 1.

While Phillips appears to make some contradictory statements regarding movement of polished rod, at best, Phillips only appears to be capable of detecting whether the rod is moving or not. However, the configurations of Phillips do not appear to be capable of measuring axial movement with the magnetometer.

Further, Phillips does not disclose “determin[ing] rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem **by sampling rotational velocity values** generated by the rotation of the at least one component of the downhole pumping system **with only the gyroscope**,” as further recited in amended claim 1.

Thus, claims 1, and claims 2-7 depending therefrom, are believed to be in condition for allowance.

Claims 13-15

Applicant respectfully asserts that claims 13-15 are not anticipated by Phillips under 35 U.S.C. § 102(a)(1) at least because Phillips does not describe each and every element of independent claim 13, as currently amended.

For example, Phillips does not describe “a **vibration sensor** subsystem for monitoring vibration of the at least one component of the downhole pumping system **in three axes**,” or deriving “a **vibrational baseline** of the at least one component of the downhole pumping system from the vibration sensor subsystem **in three axes** during normal operation” as recited in claim 13.

As recognized in the Office Action, Phillips fails to teach a vibration sensor subsystem. *Office Action*, page 11.

Thus, claims 13, and claims 14 and 15 depending therefrom, are believed to be in condition for allowance.

35 U.S.C. § 103

Claims 10 and 11 are rejected under 35 U.S.C. 103 as being unpatentable over **Phillips**.

To establish a *prima facie* case of obviousness, the prior art reference itself (or references when combined) or “the inferences and creative steps that a person of ordinary skill in the art would [have] employ[ed]” at the time of the invention must teach or suggest all of the claim elements. *K.S.R. Intern. Co. v. Teleflex Inc.*, 550 U.S. 398, 418, 82 U.S.P.Q.2d 1385 (2007); *see also* M.P.E.P. § 2143.03. Additionally, the Examiner must determine whether there is “an apparent reason to combine the known elements in the fashion claimed by the patent at issue.” *Id.* “[A] patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.” *Id.* Further, rejections on obviousness grounds “cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *Id.* (quoting *In re Kahn*, 441, F.3d 977, 988 (Fed. Cir. 2006)). Finally, to establish a *prima facie* case of obviousness there must be a reasonable expectation of success. *In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986). Furthermore, the reason that would have prompted the combination and the reasonable expectation of success must be found in the

prior art, common knowledge, or the nature of the problem itself, and not based on the Applicant's disclosure. *DyStar Textilfarben GmbH & Co. Deutschland KG v. C. H. Patrick Co.*, 464 F.3d 1356, 1367 (Fed. Cir. 2006); MPEP § 2144. Underlying the obvious determination is the fact that hindsight cannot be used. *KSR*, 550 U.S. at 421; *DyStar*, 464 F.3d at 1367.

Applicant respectfully asserts that claims 10 and 11 could not have been obvious to a person of ordinary skill in the art at the time the invention was made considering Phillips at least because Phillips does not teach or suggest each and every element as recited in independent claim 1, as currently amended.

For example, Phillips does not teach or suggest a “**magnetometer** to be coupled to the at least one component of the downhole pumping system and to **measure axial movement** of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer” as recited in claim 1.

Phillips teaches a sensing device that includes a magnetometer and that “[t]he magnetometer is effectively a compass that identifies a **radial orientation** of the sensor relative to a fixed external location such as true north.” *Phillips*, ¶ [0022] (emphasis added). Phillips does not appear to teach or suggest, however, that the magnetometer is used to “**measure axial movement** of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer” as recited in claim 1.

Thus, claim 1, and claims 10 and 11 depending therefrom, are believed to be in condition for allowance.

Claims 8, 9, and 16-18 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips in view of **Hurst** et al. (US9140113B2) (hereinafter “Hurst”).

Applicant respectfully asserts that claims 8, 9, and 16-18 could not have been obvious to a person of ordinary skill in the art at the time the invention was made considering Phillips in view of Hurst at least because Phillips and Hurst, alone or in combination, do not teach or suggest each and every element as recited in independent claims 1 or 16, as currently amended.

For example, Phillips and Hurst, alone or in combination, do not teach or suggest “**magnetometer** to be coupled to the at least one component of the downhole pumping system and to **measure axial movement** of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer” as recited in claim 1, or “an axial motion sensor subsystem comprising a **magnetometer to measure axial movement** of at least one component of the downhole pumping system and to **determine a change in axial direction** of the at least one component of the downhole pumping system,” as recited in claim 16.

Phillips teaches a sensing device that includes a magnetometer and that “[t]he magnetometer is effectively a compass that identifies a **radial orientation** of the sensor relative to a fixed external location such as true north.” Phillips, ¶ [0022] (emphasis added). Phillips does not appear to teach or suggest, however, that the magnetometer is used to “**measure axial movement**” as recited in claims 1 and 16, or to “**determine a change in axial direction**” as recited in claim 16.

Hurst appears to be relied upon for teachings with regard to a tubing rotator. *Office Action*, page 8. Hurst, however, does not appear to teach or suggest a magnetometer is used to “**measure axial movement**” as recited in claims 1 and 16, or to “**determine a change in axial direction**” as recited in claim 16.

Thus, claims 1 and 16, and claims 8, 9, 17, and 18 depending therefrom, are believed to be in condition for allowance.

Claims 12, 19, and 20 are rejected under 35 U.S.C. 103 as being unpatentable over **Phillips** in view of **Fyfe** et al. (US 11319794B2) (hereinafter “Fyfe”).

Claim 12

Applicant respectfully asserts that claim 12 is allowable at least because Fyfe does not cure the deficiencies of Phillips with regard to claim 2, from which claim 12 depends.

Additionally, claim 12 could not have been obvious to a person of ordinary skill in the art at the time the invention was made considering Phillips in view of Fyfe at least because Phillips and Fyfe, alone or in combination, do not teach or suggest each and every element as recited in claim 12, as currently amended.

For example, Phillips and Fyfe, alone or in combination, do not teach or suggest “a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system **in three axes** over a vibrational baseline,” as recited in claim 12.

As recognized in the Office Action, Phillips fails to teach a vibration sensor subsystem. *Office Action*, page 11.

Fyfe teaches “a polished-rod dynamometer has at least one accelerometer adapted to measure acceleration and vibration of the polished rod.” Fyfe, col. 2, ll. 13-15. Fyfe does not appear to teach or suggest, however, “a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system **in three axes** over a vibrational baseline,” as recited in claim 12.

Thus, claim 12 is believed to be in condition for allowance.

Claims 19 and 20

Applicant respectfully asserts that claims 19 and 20 could not have been obvious to a person of ordinary skill in the art at the time the invention was made considering Phillips in view of Fyfe at least because Phillips and Fyfe, alone or in combination, do not teach or suggest each and every element as recited in independent claim 19, as currently amended.

For example, Phillips and Fyfe, alone or in combination, do not teach or suggest “**determining a change in axial direction** of at least one component of the downhole pumping system **based on magnetic variations**” as recited in claim 19.

Phillips teaches a sensing device that includes a magnetometer and that “[t]he magnetometer is effectively a compass that identifies a **radial orientation** of the sensor relative to a fixed external location such as true north.” *Phillips*, ¶ [0022] (emphasis added). Phillips does

not appear to teach or suggest, however, “**determining a change in axial direction** of at least one component of the downhole pumping system **based on magnetic variations**” as recited in claim 19.

Fyfe teaches “a polished-rod dynamometer has at least one accelerometer adapted to measure acceleration and vibration of the polished rod.” Fyfe, col. 2, ll. 13-15. Fyfe does not appear to teach or suggest, however, “**determining a change in axial direction** of at least one component of the downhole pumping system **based on magnetic variations**” as recited in claim 19.

Thus, claim 19, and claim 20 depending therefrom, are believed to be in condition for allowance.

Conclusion

In view of the foregoing, Applicant believes all claims now pending in this application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please contact the undersigned at (801) 870-4092.

Respectfully submitted,

/Terry S. Jones/

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Date: September 17, 2024



UNITED STATES
PATENT AND TRADEMARK OFFICE

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #
17/549,519

RECEIPT DATE / TIME
09/17/2024 07:12:48 PM Z ET

ATTORNEY DOCKET #
CHX.1002US

Title of Invention

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	4428	FILED BY	Greg Baker
PATENT CENTER #	67213653	AUTHORIZED BY	-
CUSTOMER #	184959	FILING DATE	12/13/2021
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Terry Treiberg

Payment Information

PAYMENT METHOD CARD / 1001	PAYMENT TRANSACTION ID E20249GJ16116802	PAYMENT AUTHORIZED BY Greg Baker
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FEE CODE	DESCRIPTION	ITEM PRICE(\$)	QUANTITY	ITEM TOTAL(\$)
1251	EXTENSION FOR RESPONSE WITHIN FIRST MONTH	220.00	1	220.00
			TOTAL AMOUNT:	\$220.00

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for 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. EX-1002, p. 242 of 378

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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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)		Docket Number (Optional) CHX.1002US																														
Application Number 17/549,519	Filed August 12, 2022																															
For DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE																																
Art Unit 2863	Examiner SINGLETARY, MICHAEL J																															
This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application. The requested extension and fee are as follows (check time period desired and enter the appropriate fee below): <table style="width: 100%; border-collapse: collapse;"><thead><tr><th></th><th style="text-align: center;"><u>Fee</u></th><th style="text-align: center;"><u>Small Entity Fee</u></th><th style="text-align: center;"><u>Micro Entity Fee</u></th><th></th></tr></thead><tbody><tr><td>☒ One month (37 CFR 1.17(a)(1))</td><td style="text-align: right;">\$220</td><td style="text-align: right;">\$88</td><td style="text-align: right;">\$44</td><td style="text-align: right;">\$ <u>220</u></td></tr><tr><td>☐ Two months (37 CFR 1.17(a)(2))</td><td style="text-align: right;">\$640</td><td style="text-align: right;">\$256</td><td style="text-align: right;">\$128</td><td style="text-align: right;">\$ _____</td></tr><tr><td>☐ Three months (37 CFR 1.17(a)(3))</td><td style="text-align: right;">\$1,480</td><td style="text-align: right;">\$592</td><td style="text-align: right;">\$296</td><td style="text-align: right;">\$ _____</td></tr><tr><td>☐ Four months (37 CFR 1.17(a)(4))</td><td style="text-align: right;">\$2,320</td><td style="text-align: right;">\$928</td><td style="text-align: right;">\$464</td><td style="text-align: right;">\$ _____</td></tr><tr><td>☐ Five months (37 CFR 1.17(a)(5))</td><td style="text-align: right;">\$3,160</td><td style="text-align: right;">\$1,264</td><td style="text-align: right;">\$632</td><td style="text-align: right;">\$ _____</td></tr></tbody></table> ☐ Applicant asserts small entity status. See 37 CFR 1.27. ☐ Applicant certifies micro entity status. See 37 CFR 1.29. Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously. ☐ A check in the amount of the fee is enclosed. ☐ Payment by credit card. Form PTO-2038 is attached. ☐ The Director has already been authorized to charge fees in this application to a Deposit Account. ☐ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number _____. ☒ Payment made via EFS-Web.				<u>Fee</u>	<u>Small Entity Fee</u>	<u>Micro Entity Fee</u>		☒ One month (37 CFR 1.17(a)(1))	\$220	\$88	\$44	\$ <u>220</u>	☐ Two months (37 CFR 1.17(a)(2))	\$640	\$256	\$128	\$ _____	☐ Three months (37 CFR 1.17(a)(3))	\$1,480	\$592	\$296	\$ _____	☐ Four months (37 CFR 1.17(a)(4))	\$2,320	\$928	\$464	\$ _____	☐ Five months (37 CFR 1.17(a)(5))	\$3,160	\$1,264	\$632	\$ _____
	<u>Fee</u>	<u>Small Entity Fee</u>	<u>Micro Entity Fee</u>																													
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WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038. I am the ☐ applicant/inventor. ☐ assignee of record of the entire interest. See 37 CFR 3.71. 37 CFR 3.73(b) statement is enclosed (Form PTO/SB/96). ☒ attorney or agent of record. Registration number <u>61335</u>. ☐ attorney or agent acting under 37 CFR 1.34. Registration number _____. <table style="width: 100%; border-collapse: collapse;"><tr><td style="width: 50%; vertical-align: bottom;"><u>/GCB/</u> _____ Signature</td><td style="width: 50%; vertical-align: bottom;"><u>9/17/2024</u> _____ Date</td></tr><tr><td style="vertical-align: bottom;"><u>Gregory Baker</u> _____ Typed or printed name</td><td style="vertical-align: bottom;"><u>801-554-8311</u> _____ Telephone Number</td></tr></table>			<u>/GCB/</u> _____ Signature	<u>9/17/2024</u> _____ Date	<u>Gregory Baker</u> _____ Typed or printed name	<u>801-554-8311</u> _____ Telephone Number																										
<u>/GCB/</u> _____ Signature	<u>9/17/2024</u> _____ Date																															
<u>Gregory Baker</u> _____ Typed or printed name	<u>801-554-8311</u> _____ Telephone Number																															
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APPLICATION #
17/549,519

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ATTORNEY DOCKET #
CHX.1002US

Title of Invention

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	4428	FILED BY	Greg Baker
PATENT CENTER #	67213653	FILING DATE	12/13/2021
CUSTOMER #	184959	FIRST NAMED INVENTOR	Terry Treiberg
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	-

Documents

TOTAL DOCUMENTS: 3

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
2024-09-17_NFOA_Amend-APP.TEXT.docx	15	Application body structured text document	65 KB
Warning: The automatic document description has been replaced. Track changes containing insertions/deletions have been detected. These changes will be displayed in the document as underlines/strikethroughs. Dynamic dates have been converted to static dates. Bookmarks were found and have been removed. Dynamic dates have been converted to static dates. Bookmarks were found and have been removed. Track changes containing insertions/deletions have been detected. These changes will be displayed in the document as underlines/strikethroughs.			
2024-09-17_EXT.pdf	2	Extension of Time	346 KB
2024-09-17_NFOA_Amend.pdf	15	Auxiliary PDF of Application	265 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
2024-09-17_NFOA_Amend-APP.TEXT.docx	C68978E1091E61136D7362199D2662BFD1C2013606C26374F16E17FC0C26B290E1E647F1DA14745035DD3DF212695C281EB43EFF0617B463B714ED3CEB7573AB
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2024-09-17_NFOA_Amend.pdf	3DF44A047314B08C05790C14A0B35700FB66DBEC38C9B59BB2A2D56B73AFF525AD8BF620DF329C297AAA050F65620DE5429B8786E7D41D49E2205A244B526473

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New Applications Under 35 U.S.C. 111

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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

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.

Serial No.: 17/549,519

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Terry Treiberg et al.

Serial No.: 17/549,519

Filed: August 12, 2022

For: DEVICES, SYSTEMS, AND
METHODS FOR DETECTING THE
ROTATION OF ONE OR MORE
COMPONENTS FOR USE WITH A
WELLBORE

Confirmation No.: 4428

Examiner: SINGLETARY, MICHAEL J

Group Art Unit: 2863

Attorney Docket No.: CHX.1002US

VIA ELECTRONIC FILING

AMENDMENT

TO THE COMMISSIONER FOR PATENTS:

In response to the Office Action mailed June 14, 2024, please amend the above-identified patent application as follows.

Amendments to the claims are reflected in the **Listing of Claims** beginning on page 2 of this paper.

Remarks follow the Amendments sections of this paper.

IN THE CLAIMS:

All of the pending claims are presented below. This listing of claims will replace all prior versions and listings of claims in the application. Please enter these claims as amended.

Listing of the Claims:

1. (Currently Amended) A sensor system for a downhole pumping system, comprising:
a sensor subsystem for detecting movement of the at least one component of the downhole pumping system, the sensor subsystem comprising:
an axial motion sensor subsystem comprising a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to ~~detect~~measure axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system;
a rotation sensor subsystem comprising a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system; and
a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes; and
a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:
~~determine~~measure axial movement of the at least one component of the downhole pumping system with the magnetometer of the axial motion sensor subsystem;
determine rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational velocity values

generated by the rotation of the at least one component of the downhole pumping system with only the gyroscope.

2. (Original) The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore.

3. (Original) The sensor system of claim 2, wherein the processor subsystem is configured to verify the axial movement of the at least one rod before determining the rotation.

4. (Original) The sensor system of claim 2, wherein the processor subsystem is configured to determine a change in direction the at least one rod.

5. (Original) The sensor system of claim 4, wherein the processor subsystem is configured to begin sampling the rotational velocity after determining the change in direction the at least one rod.

6. (Original) The sensor system of claim 5, wherein the processor subsystem is configured to continue sampling the rotational velocity until another change in direction the at least one rod is detected.

7. (Original) The sensor system of claim 5, wherein the processor subsystem is configured to continue sampling the rotational velocity along substantially an entire stroke of the at least one rod, the sampling beginning at a first change of direction of the at least one rod, continuing through a second change of direction of the at least one rod, and ceasing at a third change of direction of the at least one rod.

8. (Original) The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising a tubing rotator of the downhole pumping system.

9. (Original) The sensor system of claim 8, wherein the sensor subsystem is configured to detect rotation of the tubing rotator while detecting axial movement of a polished of the downhole pumping system.

10. (Original) The sensor system of claim 1, wherein the processor subsystem is configured to determine the rotational velocity of the at least one component of the downhole pumping system by summing both positive and negative samples of the rotational velocity values sensed by the rotation sensor subsystem.

11. (Original) The sensor system of claim 10, wherein the processor subsystem is configured to compare the determined rotational velocity of the at least one component of the downhole pumping system with an expected amount of rotational velocity to determine a failure in the rotation of the at least one component of the downhole pumping system.

12. (Currently Amended) The sensor system of claim 1, further comprising a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes over a vibrational baseline.

13. (Currently Amended) A sensor system for a downhole pumping system, comprising:
a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising:
an axial motion sensor subsystem comprising an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to ~~detect~~measure axial movement of the at least one component of the downhole pumping system based on variations detected by the axial motion

sensor generated by movement of the at least one component of the downhole pumping system; and

a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system; and

a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes; and

a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:

derive a vibrational baseline of the at least one component of the downhole pumping system from the vibration sensor subsystem in three axes during normal operation;

verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and

when the axial movement has been verified, determine rotational velocity of the at least one component of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

14. (Original) The sensor system of claim 13, wherein the axial motion sensor subsystem comprises a magnetometer and the rotation sensor subsystem comprises a gyroscope.

15. (Original) The sensor system of claim 14, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore, and wherein the processor subsystem is configured to continue sampling the rotational velocity values of the at least one rod over a stroke of the at least one rod.

16. (Currently Amended) A sensor system for a downhole pumping system, comprising:
an axial motion sensor subsystem comprising a magnetometer to measure axial movement of at least one component of the downhole pumping system and to determine a change in axial direction of the at least one component of the downhole pumping system;
a sensor subsystem for detecting movement of a tubing rotator of the downhole pumping system, the sensor subsystem comprising a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the tubing rotator of the downhole pumping system and to detect rotational movement of the tubing rotator of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the tubing rotator of the downhole pumping system; and
a processor subsystem to receive data from the rotation sensor subsystem, the processor subsystem to determine rotational velocity of the tubing rotator of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

17. (Original) The sensor system of claim 16, wherein the rotation sensor subsystem comprises at least one of a gyroscope or an accelerometer.

18. (Original) The sensor system of claim 16, wherein the rotation sensor subsystem is configured to monitor the rotation of the tubing rotator along a path that extends in a direction substantially perpendicular to a surface upon which the downhole pumping system is positioned.

19. (Currently Amended) A method of detecting motion of at least one component of a downhole pumping system, the method comprising:
~~detecting axial movement~~determining a change in axial direction of at least one component of the downhole pumping system based on magnetic variations detected by an axial motion sensor coupled to the at least one component of the downhole pumping system generated by translation of the at least one component of the downhole pumping system;

detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system; and

verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the at least one component of the downhole pumping system with the rotational sensor.

20. (Original) The method of claim 19, further comprising comparing a rotational velocity detected with the rotational sensor with a threshold value to determine a performance characteristic of the at least one component of the downhole pumping system.

REMARKS

Status of the Claims

This amendment is filed in response to the Office Action mailed June 14, 2024.

Claims 1-20 are pending and stand rejected.

Claims 1, 12, 13, 16, and 19 are amended.

Support for the amendments to claims 1, 12, 16, and 19 is found at least at paragraphs [0028], and [0051] of the application as filed. Support for the amendments to claim 13 is found at least at paragraphs [0027], [0039], and [0043] of the application as filed.

No new matter is added.

For at least the reasons presented below, Applicant respectfully submits that each of the pending claims is in condition for allowance.

35 U.S.C. § 102

Claims 1-7 and 13-15 are rejected under 35 U.S.C. 102(a)(1) as being anticipated by **Phillips** (US 20190203579A1) (hereinafter “Phillips”).

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Brothers v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). The identical invention must be shown in as complete detail as is contained in the claim. *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

Unless a single prior art reference describes “all of the limitations claimed” *and* “all of the limitations *arranged or combined in the same way* as recited in the claim, it cannot be said to prove prior invention of the thing claimed and, thus, cannot anticipate under 35 U.S.C. § 102.” *Net MoneyIN Inc. v. VeriSign Inc.*, 545 F.3d 1359, 1371 (Fed. Cir. 2008) (emphasis added). A single prior art reference must “clearly and unequivocally” describe the claimed invention “without *any* need for picking, choosing, and combining various disclosures not directly related to each other by the teachings of the cited reference.” *Id.* (citing *In re Arkley*, 455 F.2d 586, 587 (C.C.P.A. 1972)).

Claims 1-7

Applicant respectfully asserts that claims 1-7 are not anticipated by Phillips under 35 U.S.C. § 102(a)(1) at least because Phillips does not describe each and every element of independent claim 1, as currently amended.

For example, Phillips does not describe a “*magnetometer* to be coupled to the at least one component of the downhole pumping system and to *measure axial movement* of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer” as recited in claim 1.

Phillips describes a sensing device that includes a magnetometer and that “[t]he magnetometer is effectively a compass that identifies a *radial orientation* of the sensor relative to a fixed external location such as true north.” *Phillips*, ¶ [0022] (emphasis added).

Phillips does not appear to describe, however, that the magnetometer is used to “*measure axial movement* of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer” as recited in claim 1.

While Phillips appears to make some contradictory statements regarding movement of polished rod, at best, Phillips only appears to be capable of detecting whether the rod is moving or not. However, the configurations of Phillips do not appear to be capable of measuring axial movement with the magnetometer.

Further, Phillips does not disclose “determin[ing] rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem *by sampling rotational velocity values* generated by the rotation of the at least one component of the downhole pumping system *with only the gyroscope*,” as further recited in amended claim 1.

Thus, claims 1, and claims 2-7 depending therefrom, are believed to be in condition for allowance.

Claims 13-15

Applicant respectfully asserts that claims 13-15 are not anticipated by Phillips under 35 U.S.C. § 102(a)(1) at least because Phillips does not describe each and every element of independent claim 13, as currently amended.

For example, Phillips does not describe “a ***vibration sensor*** subsystem for monitoring vibration of the at least one component of the downhole pumping system ***in three axes***,” or deriving “a ***vibrational baseline*** of the at least one component of the downhole pumping system from the vibration sensor subsystem ***in three axes*** during normal operation” as recited in claim 13.

As recognized in the Office Action, Phillips fails to teach a vibration sensor subsystem. *Office Action*, page 11.

Thus, claims 13, and claims 14 and 15 depending therefrom, are believed to be in condition for allowance.

35 U.S.C. § 103

Claims 10 and 11 are rejected under 35 U.S.C. 103 as being unpatentable over **Phillips**.

To establish a *prima facie* case of obviousness, the prior art reference itself (or references when combined) or “the inferences and creative steps that a person of ordinary skill in the art would [have] employ[ed]” at the time of the invention must teach or suggest all of the claim elements. *K.S.R. Intern. Co. v. Teleflex Inc.*, 550 U.S. 398, 418, 82 U.S.P.Q.2d 1385 (2007); *see also* M.P.E.P. § 2143.03. Additionally, the Examiner must determine whether there is “an apparent reason to combine the known elements in the fashion claimed by the patent at issue.” *Id.* “[A] patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.” *Id.* Further, rejections on obviousness grounds “cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *Id.* (quoting *In re Kahn*, 441, F.3d 977, 988 (Fed. Cir. 2006)). Finally, to establish a *prima facie* case of obviousness there must be a reasonable expectation of success. *In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986). Furthermore, the reason that would have prompted the combination and the reasonable expectation of success must be found in the

prior art, common knowledge, or the nature of the problem itself, and not based on the Applicant's disclosure. *DyStar Textilfarben GmbH & Co. Deutschland KG v. C. H. Patrick Co.*, 464 F.3d 1356, 1367 (Fed. Cir. 2006); MPEP § 2144. Underlying the obvious determination is the fact that hindsight cannot be used. *KSR*, 550 U.S. at 421; *DyStar*, 464 F.3d at 1367.

Applicant respectfully asserts that claims 10 and 11 could not have been obvious to a person of ordinary skill in the art at the time the invention was made considering Phillips at least because Phillips does not teach or suggest each and every element as recited in independent claim 1, as currently amended.

For example, Phillips does not teach or suggest a “*magnetometer* to be coupled to the at least one component of the downhole pumping system and to *measure axial movement* of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer” as recited in claim 1.

Phillips teaches a sensing device that includes a magnetometer and that “[t]he magnetometer is effectively a compass that identifies a *radial orientation* of the sensor relative to a fixed external location such as true north.” *Phillips*, ¶ [0022] (emphasis added). Phillips does not appear to teach or suggest, however, that the magnetometer is used to “*measure axial movement* of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer” as recited in claim 1.

Thus, claim 1, and claims 10 and 11 depending therefrom, are believed to be in condition for allowance.

Claims 8, 9, and 16-18 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips in view of **Hurst** et al. (US9140113B2) (hereinafter “Hurst”).

Applicant respectfully asserts that claims 8, 9, and 16-18 could not have been obvious to a person of ordinary skill in the art at the time the invention was made considering Phillips in view of Hurst at least because Phillips and Hurst, alone or in combination, do not teach or suggest each and every element as recited in independent claims 1 or 16, as currently amended.

For example, Phillips and Hurst, alone or in combination, do not teach or suggest “**magnetometer** to be coupled to the at least one component of the downhole pumping system and to **measure axial movement** of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer” as recited in claim 1, or “an axial motion sensor subsystem comprising a **magnetometer to measure axial movement** of at least one component of the downhole pumping system and to **determine a change in axial direction** of the at least one component of the downhole pumping system,” as recited in claim 16.

Phillips teaches a sensing device that includes a magnetometer and that “[t]he magnetometer is effectively a compass that identifies a **radial orientation** of the sensor relative to a fixed external location such as true north.” Phillips, ¶ [0022] (emphasis added). Phillips does not appear to teach or suggest, however, that the magnetometer is used to “**measure axial movement**” as recited in claims 1 and 16, or to “**determine a change in axial direction**” as recited in claim 16.

Hurst appears to be relied upon for teachings with regard to a tubing rotator. *Office Action*, page 8. Hurst, however, does not appear to teach or suggest a magnetometer is used to “**measure axial movement**” as recited in claims 1 and 16, or to “**determine a change in axial direction**” as recited in claim 16.

Thus, claims 1 and 16, and claims 8, 9, 17, and 18 depending therefrom, are believed to be in condition for allowance.

Claims 12, 19, and 20 are rejected under 35 U.S.C. 103 as being unpatentable over **Phillips** in view of **Fyfe et al.** (US 11319794B2) (hereinafter “Fyfe”).

Claim 12

Applicant respectfully asserts that claim 12 is allowable at least because Fyfe does not cure the deficiencies of Phillips with regard to claim 2, from which claim 12 depends.

Additionally, claim 12 could not have been obvious to a person of ordinary skill in the art at the time the invention was made considering Phillips in view of Fyfe at least because Phillips and Fyfe, alone or in combination, do not teach or suggest each and every element as recited in claim 12, as currently amended.

For example, Phillips and Fyfe, alone or in combination, do not teach or suggest “a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system *in three axes* over a vibrational baseline,” as recited in claim 12.

As recognized in the Office Action, Phillips fails to teach a vibration sensor subsystem. *Office Action*, page 11.

Fyfe teaches “a polished-rod dynamometer has at least one accelerometer adapted to measure acceleration and vibration of the polished rod.” Fyfe, col. 2, ll. 13-15. Fyfe does not appear to teach or suggest, however, “a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system *in three axes* over a vibrational baseline,” as recited in claim 12.

Thus, claim 12 is believed to be in condition for allowance.

Claims 19 and 20

Applicant respectfully asserts that claims 19 and 20 could not have been obvious to a person of ordinary skill in the art at the time the invention was made considering Phillips in view of Fyfe at least because Phillips and Fyfe, alone or in combination, do not teach or suggest each and every element as recited in independent claim 19, as currently amended.

For example, Phillips and Fyfe, alone or in combination, do not teach or suggest “*determining a change in axial direction* of at least one component of the downhole pumping system *based on magnetic variations*” as recited in claim 19.

Phillips teaches a sensing device that includes a magnetometer and that “[t]he magnetometer is effectively a compass that identifies a *radial orientation* of the sensor relative to a fixed external location such as true north.” *Phillips*, ¶ [0022] (emphasis added). Phillips does

not appear to teach or suggest, however, “*determining a change in axial direction* of at least one component of the downhole pumping system *based on magnetic variations*” as recited in claim 19.

Fyfe teaches “a polished-rod dynamometer has at least one accelerometer adapted to measure acceleration and vibration of the polished rod.” Fyfe, col. 2, ll. 13-15. Fyfe does not appear to teach or suggest, however, “*determining a change in axial direction* of at least one component of the downhole pumping system *based on magnetic variations*” as recited in claim 19.

Thus, claim 19, and claim 20 depending therefrom, are believed to be in condition for allowance.

Conclusion

In view of the foregoing, Applicant believes all claims now pending in this application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please contact the undersigned at (801) 870-4092.

Respectfully submitted,

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Date: September 17, 2024

Notice of References Cited	Application/Control No. 17/549,519		Applicant(s)/Patent Under Reexamination Treiberg et al.	
	Examiner MICHAEL J SINGLETARY		Art Unit 2863	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Name	CPC Classification	US Classification
*	A	US-20200362686-A1	2020-11-19	Puwanto; Arifin	E21B21/10	1/1
	B					
	C					
	D					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in YYYY-MM-DD format are publication dates. Classifications may be US or foreign.

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
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L7	5	("20030236627" OR "20080035376" OR "20190203579" OR "20200123892" OR "20200392834").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/06/07 03:50 PM
L8	9678	(E21B47/009 OR E21B43/127 OR E21B47/092).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/06/07 03:51 PM
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			EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L14	6458	rotation axial velocity sensor magnetometer gyroscope	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2024/06/07 04:02 PM
L15	10	L14 AND L12	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2024/06/07 04:02 PM
L16	13	L10 AND axial	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA,	AND	ON	ON	2024/06/07 04:02 PM

			VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L17	19	vibration sensor wellbore ((three ADJ dimensional) OR 3D)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	WITH	ON	ON	2025/01/03 09:33 AM
L18	2	"20040206170".did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/01/03 09:37 AM
L19	40	(Artificial Intelligence) More like doc: CN-103410500-A Text: (GB-9120854-D0 OR CN-2791245-Y OR CN- 201486545-U OR CN- 201507303-U OR CN- 201851102-U OR CN- 102562035-B OR CN- 202926322-U OR CN- 103410500-A OR US- 9328602-B2 OR CA- 2769227-A1 OR US- 20240191612-A1 OR CN-102200009-B OR US-9109397-B2 OR GB-2616788-A OR US- 20120138367-A1 OR WO-2024123912-A1 OR US-20150184503-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	WITH	ON	ON	2025/01/03 10:44 AM

		A1 OR CA-2769227-C OR NO-20201306-A1 OR OA-20232-A).did.					
L20	0	vibration sensor wellbore ((three ADJ dimensional) OR 3D) (alarm OR alert)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	WITH	ON	ON	2025/01/03 11:19 AM
L21	19	vibration sensor wellbore ((three ADJ dimensional) OR 3D) (alarm OR alert)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	SAME	ON	ON	2025/01/03 11:19 AM
L22	0	vibration sensor wellbore ((three ADJ dimensional) OR 3D) (alarm OR alert)	(US-PGPUB; USPAT)	SAME	ON	ON	2025/01/03 11:19 AM
L23	1065	vibration sensor wellbore ((three ADJ dimensional) OR 3D) (alarm OR alert)	(US-PGPUB; USPAT)	AND	ON	ON	2025/01/03 11:19 AM
L24	3	L12 AND L23	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA,	OR	ON	ON	2025/01/03 11:19 AM

			VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
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PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US	4428
184959	7590	02/04/2025		
ChampionX/BKRIP			EXAMINER	
1240B E Stringham Ave #1027			SINGLETON, MICHAEL J	
SALT LAKE CITY, UT 84106				
			ART UNIT	PAPER NUMBER
			2863	
			NOTIFICATION DATE	DELIVERY MODE
			02/04/2025	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):

USPTO@dockettrak.com
gcb-team@bkrip.com
talwinder.singh@championx.com

DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

Response to Arguments

Applicant's arguments filed 09/17/2024 have been fully considered but they are not persuasive. Applicant discloses that Phillips does not describe a “**magnetometer** to be coupled to the at least one component of the downhole pumping system and to **measure axial movement** of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer” as recited in claim 1. The examiner respectfully disagrees. Paragraph [0094] discloses “FIG. 3 illustrates a generic multi-axis sensing device 301. In one aspect, the device 301 is a magnetometer and the field 302 is the earth's magnetic field.” It is further disclosed in detail in paragraphs [0094-0099, 0122-0123].

Further, Applicant discloses that Phillips does not disclose “determining rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem **by sampling rotational velocity values** generated by the rotation of the at least one component of the downhole pumping system **with only the gyroscope**,” as further recited in amended claim 1. Examiner respectfully disagrees.

The reference clearly states that “the sensing components may comprise a magnetometer, accelerometer **and/or a gyroscope [0043]**. In this instance, the accelerometer and gyroscope are configured to determine immediate rotational deflection of the bridle assembly during the course of a single stroke by way of an inertial reference. A 3-axis gyroscope is similar to a 3-axis accelerometer, except the frame of reference is a static inertial frame. As a result, the indicated field lines 302 would not necessarily have a meaning at rest in the context of a gyroscope as the magnitude and direction of the gyroscope reading measures the change in inertia of the sensor [0096].” Lastly, applicant discloses that Phillips does not describe “a **vibration sensor** subsystem for monitoring vibration of the at least one component of the downhole pumping system **in three axes**,” or deriving “a **vibrational baseline** of the at least one component of the downhole pumping system from the vibration sensor subsystem **in three axes** during normal operation.” This argument is moot because claims have been amended. Examiner has therefore, added an additional reference that teaches to this limitation. It is for these reasons, the examiner maintains the rejections.

Claim Rejections - 35 USC § 102

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis (i.e., changing from AIA to pre-AIA) for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention.

Claims 1-7 and 13-15 are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Phillips (US20190203579A1, 2019-07-04).

Regarding Claim 1, Phillips teaches a sensor system for a downhole pumping system [0019], comprising: a sensor subsystem for detecting movement of at least one component of the downhole pumping system [Claim 1], the sensor subsystem comprising:

an axial motion sensor subsystem comprising a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to measure axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system (Claim 1; [00126]); and

a rotation sensor subsystem comprising a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system [Claim 1 and 12; [00110]]; and

a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem [Claim 1], the processor subsystem to: measure axial movement of the at least one component of the downhole pumping system with the magnetometer of the axial motion sensor subsystem [0021]; and

determine rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system with only the gyroscope [0026; 0029; 0043; 0096; 0134; 0138; Fig. 6].

Regarding Claim 2, Phillips further teaches the sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore [Claim 1 and 13].

Regarding Claim 3, Phillips further teaches the sensor system of claim 2, wherein the processor subsystem is configured to verify the axial movement of the at least one rod before determining the rotation [0027; 00134; Claim 11; Fig. 6].

Regarding Claim 4, Phillips further teaches the sensor system of claim 2, wherein the processor subsystem is configured to determine a change in direction the at least one rod [0021-0022].

Regarding Claim 5, Phillips further teaches the sensor system of claim 4, wherein the processor subsystem is configured to begin sampling the rotational velocity after determining the change in direction the at least one rod [0110].

Regarding Claim 6, Phillips further teaches the sensor system of claim 5, wherein the processor subsystem is configured to continue sampling the rotational velocity until another change in direction the at least one rod is detected [0158].

Regarding Claim 7, Phillips further teaches the sensor system of claim 5, wherein the processor subsystem is configured to continue sampling the rotational velocity along substantially an entire stroke of the at least one rod, the sampling beginning at a first change of direction of the at least one rod, continuing through a second change of direction of the at least one rod, and ceasing at a third change of direction of the at least one rod [0029; 0110].

Regarding Claim 19, Phillips teaches a method of detecting motion of at least one component of a downhole pumping system, the method comprising: detecting axial movement of at least one component of the downhole pumping system based on variations detected by an axial motion sensor coupled to the at least one component of the downhole pumping system generated by translation of the at least one component of the downhole pumping system [0077]; detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system ([Claim 1 and

12; [00110]); and verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the at least one component of the downhole pumping system with the rotational sensor [0027; 00134; Claim 11; Fig. 6].

Regarding Claim 20, The method of claim 19, further comprising comparing a rotational velocity detected with the rotational sensor with a threshold value to determine a performance characteristic of the at least one component of the downhole pumping system [0026; 0158; Claim 9].

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claim 10 and 11 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips (US 20190203579A1, 04-07-2019).

Regarding Claim 10, Phillips teaches the sensor system of claim 1, wherein the processor subsystem is configured to determine the rotational velocity of the at least one component of the downhole pumping system by summing both positive and negative samples of the rotational velocity values sensed by the rotation sensor subsystem [0029; 0110; 0115].

Although Phillips does not specifically disclose the summing both positive and negative samples of the rotational velocity values, acceleration is the rate of change of velocity over time, and velocity is the rate of change of position over time.

Therefore, it would have been obvious to a person of ordinary skill in the art that determining rotational velocity by summing both positive and negative samples, was previously taught by Phillips.

Regarding Claim 11, Phillips further teaches the sensor system of claim 10, wherein the processor subsystem is configured to compare the determined rotational velocity of the at least one component of the downhole pumping system with an

expected amount of rotational velocity to determine a failure in the rotation of the at least one component of the downhole pumping system [Claim 1; Claim 10].

Claims 8, 9, and 16-18 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips, in view of Hurst et al. (US9140113B2, 2015-09-22), herein referred to as Hurst.

Regarding Claim 8, Phillips teaches all of the limitations of Claim 1. Phillips further teaches wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system (abstract).

Phillips fails to specifically mention a tubing rotator, he does mention tubing that surrounds the rod string (which is well known in the art as a tubular rotator (Hurst Col. 3, lines 42-49)).

However, in a related field, Hurst teaches wherein monitoring is performed by a mechanism incorporated in at least one of a load cell, a rod rotator, or a tubing rotator (Claim 2).

Therefore, it would have been obvious to a person of ordinary skill in the art prior to the effective filing date of the claimed invention to have modified Phillips to incorporate the teachings of Hurst by including: a tubing rotator in order to distribute wear.

Regarding Claim 9, the combination further teaches the sensor system of claim 8, wherein the sensor subsystem is configured to detect rotation of the tubing rotator

while detecting axial movement of a polished of the downhole pumping system (Phillips: Claim 1, Fig. 6).

Regarding Claim 16, Phillips teaches a sensor system for a downhole pumping system, comprising:

an axial motion sensor subsystem comprising a magnetometer to measure axial movement of at least one component of the downhole pumping system and to determine a change in axial direction of the at least one component of the downhole pumping system [0095-0099; 0081].

a sensor subsystem for detecting movement (Abstract). Phillips further teaches a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system ([Claim 1 and 12; [00110]).

Additionally, Phillips discloses a processor configured to compare the determined rotational velocity of the at least one component of the downhole pumping system with an expected amount of rotational velocity to determine a failure in the rotation of the at least one component of the downhole pumping system [Claim 1; Claim 10].

Phillips fails to specifically mention a tubing rotator, he does mention tubing that surrounds the rod string (which is well known in the art as a tubular rotator (Hurst Col. 3, lines 42-49).

However, in a related field, Hurst teaches wherein monitoring is performed by a mechanism incorporated in at least one of a load cell, a rod rotator, or a tubing rotator (Claim 2).

Therefore, it would have been obvious to a person of ordinary skill in the art prior to the effective filing date of the claimed invention to have modified Phillips to incorporate the teachings of Hurst by including: a tubing rotator in order to distribute wear.

Regarding Claim 17, the combination further teaches the sensor system of claim 16, wherein the rotation sensor subsystem comprises at least one of a gyroscope or an accelerometer [Phillips: Claim 12].

Regarding Claim 18, the combination teaches all of the limitations of Claim 16. The combination further teaches wherein the rotation sensor subsystem is configured to monitor the rotation of the tubing rotator along a path that extends in a direction substantially perpendicular to a surface upon which the downhole pumping system is positioned [Hurst: Col. 13, lines 50-63].

Although Hurst doesn't specifically disclose "monitoring the rotation of the tubing rotator along a path that extends in a direction substantially perpendicular to a surface upon which the downhole pumping system is positioned," it is inherent that the path would be substantially perpendicular being that the monitoring system is surface level and the tubing rotator is subsurface and perpendicular to the surface.

Claim 12-15 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips, in view of Puwanto et al. (US 20200362686A1) herein referred to as Puwanto.

Regarding Claim 12, Phillips teaches all of the limitations of Claim 1.

Phillips fails to teach a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes over a vibrational baseline. However, in a related field,

Puwanto discloses a vibration measuring device included in the MWD tool that measures vibration detecting real time drilling parameters and can be used as a trigger (in an alarm system) for a system to hold on drilling parameter recommendation change [0032; 0129; 0149; 0161].

Therefore, it would have been obvious to a person of ordinary skill in the art prior to the effective filing date of the claimed invention to have modified Phillips to incorporate the teachings of Puwanto by including: a vibration measuring device in order to give early warning of component failure.

Regarding Claim 13, Phillips teaches a sensor system for a downhole pumping system [0019], comprising: a sensor subsystem for detecting movement of at least one component of the downhole pumping system [Claim 1], the sensor subsystem comprising:

an axial motion sensor subsystem comprising an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to measure axial movement of the at least one component of the downhole

pumping system based on variations detected by the axial motion sensor generated by movement of the at least one component of the downhole pumping system [Col. 2, lines 33-48]; and

a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system ([Claim 1 and 12; [00110]); and

a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem [Claim 1], the processor subsystem to:

verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and when the axial movement has been verified, determine rotational velocity of the at least one component of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem [0021; Fig. 6; Claim 1].

Philips fails to teach a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes; derive a vibrational baseline of the at least one component of the downhole pumping system from the vibration sensor subsystem in three axes during normal operation.

However, in a related field, Puwanto discloses a vibration measuring device included in the MWD tool that measures vibration detecting real time drilling parameters and can be used as a trigger (in an alarm system) for a system to hold on drilling

parameter recommendation change [0032; 0129; 0149; 0161]. Although Puwanto doesn't specifically disclose vibrational baseline, one of ordinary skill in the art would determine that in order for a parameter to be used as a trigger, a baseline/threshold would have to be set.

Therefore, it would have been obvious to a person of ordinary skill in the art prior to the effective filing date of the claimed invention to have modified Phillips to incorporate the teachings of Puwanto by including: a vibration measuring device in order to give early warning of component failure.

Regarding Claim 14, Phillips further teaches the sensor system of claim 13, wherein the axial motion sensor subsystem comprises a magnetometer and the rotation sensor subsystem comprises a gyroscope [Claim 8; Claim 12].

Regarding Claim 15, Phillips further teaches the sensor system of claim 14, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore, and wherein the processor subsystem is configured to continue sampling the rotational velocity values of the at least one rod over a stroke of the at least one rod [0029; 0042; 00103; 00110].

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MICHAEL J SINGLETARY whose telephone number is (571)272-4593. The examiner can normally be reached Monday-Friday 8:00am-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, Lisa Caputo can be reached on (571) 272-2388. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: <https://patentcenter.uspto.gov>. Visit <https://www.uspto.gov/patents/apply/patent-center> for more information about Patent Center and <https://www.uspto.gov/patents/docx> for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MICHAEL J SINGLETARY/
Examiner, Art Unit 2863

/NATALIE HULS/
Primary Examiner, Art Unit 2863

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 17/549,519		Filing Date 12/13/2021		☐ To be Mailed			
ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO											
APPLICATION AS FILED - PART I											
		(Column 1)		(Column 2)							
FOR		NUMBER FILED		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 \$480 =					
☐ 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	05/05/2025	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	x \$200 =		0			
	Independent (37 CFR 1.16(h))	* 4	Minus	*** 4	= 0	x \$600 =		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".								/RENEE D HAWKINS/			
*** 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.											

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Terry Treiberg et al.

Serial No.: 17/549,519

Filed: December 13, 2021

For: DEVICES, SYSTEMS, AND
METHODS FOR DETECTING THE
ROTATION OF ONE OR MORE
COMPONENTS FOR USE WITH A
WELLBORE

Confirmation No.: 4428

Examiner: SINGLETARY, MICHAEL J

Group Art Unit: 2863

Attorney Docket No.: CHX.1002US

VIA ELECTRONIC FILING

RCE AMENDMENT

TO THE COMMISSIONER FOR PATENTS:

In response to the Final Office Action mailed February 4, 2025, please amend the above-identified patent application as follows.

Amendments to the claims are reflected in the **Listing of Claims** beginning on page 2 of this paper.

Remarks follow the Amendments sections of this paper.

IN THE CLAIMS:

All of the pending claims are presented below. This listing of claims will replace all prior versions and listings of claims in the application. Please enter these claims as amended.

Listing of the Claims:

1. (Currently Amended) A sensor system for a downhole pumping system, comprising:
a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising:
an axial motion sensor subsystem comprising a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to measure axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system;
a rotation sensor subsystem comprising a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system; and
a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes; and
a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:
~~measure~~detect axial movement of the at least one component of the downhole pumping system with the magnetometer of the axial motion sensor subsystem, the detecting axial movement comprising:
sensing a direction change in the at least one component of the downhole pumping system to determine when a stroke of the at least one component

of the downhole pumping system has been completed and to determine that a new stroke is beginning; and
after the direction change in the at least one component of the downhole pumping system has been detected, begin to determine rotation ~~determine rotational velocity~~ of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system, without the gyroscope the determining the rotational values of the at least one component of the downhole pumping system comprising:
continuing sampling the rotational values through a second direction change of the at least one component of the downhole pumping system; and
ceasing sampling the rotational values at a third direction change of the at least one component of the downhole pumping system.

2. (Original) The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore.

3. (Currently Amended) The sensor system of claim 2, wherein the processor subsystem is configured to verify the axial movement and the direction change of the at least one rod before determining the rotation.

4. (Currently Amended) The sensor system of claim 2, wherein the processor subsystem is configured to determine ~~a change in direction~~ the direction change of the at least one rod to indicate that a previous stroke has been completed and that a new stroke is beginning.

5. (Currently Amended) The sensor system of claim 4, wherein the processor subsystem is configured to begin sampling the rotational values comprising rotational velocity after determining the direction change of ~~the change in direction~~ the at least one rod.

6. (Currently Amended) The sensor system of ~~claim 5~~claim 1, wherein the processor subsystem is configured receive the rotational values from only a gyroscope~~to continue sampling the rotational velocity until another change in direction the at least one rod is detected.~~

7. (Currently Amended) The sensor system of ~~claim 5~~claim 1, wherein the processor subsystem is configured to compare the sampled rotational values with previously sampled rotational values detected by the rotation sensor subsystem during a previous stroke of the downhole pumping system to determine if rotation of the at least one component of the downhole pumping system has occurred~~continue sampling the rotational velocity along substantially an entire stroke of the at least one rod, the sampling beginning at a first change of direction of the at least one rod, continuing through a second change of direction of the at least one rod, and ceasing at a third change of direction of the at least one rod.~~

8. (Original) The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising a tubing rotator of the downhole pumping system.

9. (Original) The sensor system of claim 8, wherein the sensor subsystem is configured to detect rotation of the tubing rotator while detecting axial movement of a polished of the downhole pumping system.

10. (Currently Amended) The sensor system of claim 1, wherein the processor subsystem is configured to determine the ~~rotational velocity~~rotational values of the at least one component of the downhole pumping system by summing both positive and negative samples of the rotational ~~velocity~~ values sensed by the rotation sensor subsystem.

11. (Currently Amended) The sensor system of claim 10, wherein the processor subsystem is configured to compare the determined ~~rotational velocity~~rotational values of the at least one component of the downhole pumping system with an expected amount of ~~rotational~~

~~velocity~~rotational values to determine a failure in the rotation of the at least one component of the downhole pumping system.

12. (Previously Presented) The sensor system of claim 1, further comprising a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes over a vibrational baseline.

13. (Currently Amended) A sensor system for a downhole pumping system, comprising:
a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising:
an axial motion sensor subsystem comprising an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to measure axial movement of the at least one component of the downhole pumping system based on variations detected by the axial motion sensor generated by movement of the at least one component of the downhole pumping system; and
a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational ~~velocity~~ values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system; and
~~a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes; and~~
a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:
~~derive a vibrational baseline of the at least one component of the downhole pumping system from the vibration sensor subsystem in three axes during normal operation;~~

verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; ~~[[and]]~~
when the axial movement has been verified, ~~determine rotational velocity of the at least one component of the downhole pumping system with~~ detecting the rotational velocity values detected by with the rotation sensor subsystem during a current stroke of the downhole pumping system; and
comparing the rotational values with previously sensed rotational values detected by the rotation sensor subsystem during a previous stroke of the downhole pumping system to determine if rotation of the at least one component of the downhole pumping system has occurred.

14. (Original) The sensor system of claim 13, wherein the axial motion sensor subsystem comprises a magnetometer and the rotation sensor subsystem comprises a gyroscope.

15. (Currently Amended) The sensor system of claim 14, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore, and wherein the processor subsystem is configured to continue sampling the rotational ~~velocity~~ values of the at least one rod over a stroke of the at least one rod.

16. (Currently Amended) A sensor system for a downhole pumping system, comprising:
an axial motion sensor subsystem comprising a magnetometer to measure axial movement of at least one component of the downhole pumping system and to determine a change in axial direction of the at least one component of the downhole pumping system;
a sensor subsystem for detecting movement of a tubing rotator of the downhole pumping system, the sensor subsystem comprising a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the tubing rotator of the downhole pumping system and to detect rotational movement of the tubing rotator of the downhole pumping

system by sampling rotational ~~velocity~~ values with the rotational sensor generated by rotation of the tubing rotator of the downhole pumping system; and
a processor subsystem to receive data from the rotation sensor subsystem, the processor subsystem to determine ~~rotational velocity~~ rotation of the tubing rotator of the downhole pumping system with the rotational ~~velocity~~ values detected by the rotation sensor subsystem, the processor subsystem configured to:
detect the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem;
when the axial movement of the at least one component is detected, begin detecting the rotational movement of the tubing rotator of the downhole pumping system with the rotational sensor;
continue detecting the rotational movement of the tubing rotator of the downhole pumping system through a second direction change of the at least one component of the downhole pumping system; and
cease detecting the rotational movement of the tubing rotator of the downhole pumping system after a third direction change of the at least one component of the downhole pumping system.

17. (Original) The sensor system of claim 16, wherein the rotation sensor subsystem comprises at least one of a gyroscope or an accelerometer.

18. (Original) The sensor system of claim 16, wherein the rotation sensor subsystem is configured to monitor the rotation of the tubing rotator along a path that extends in a direction substantially perpendicular to a surface upon which the downhole pumping system is positioned.

19. (Currently Amended) A method of detecting motion of at least one component of a downhole pumping system, the method comprising:
determining a first change in axial direction of at least one component of the downhole pumping system based on magnetic variations detected by an axial motion sensor coupled to the at

least one component of the downhole pumping system generated by translation of the at least one component of the downhole pumping system;

when detecting no change in the axial direction, ceasing any sensing of rotation movement;

when verifying the first change in the axial direction:

begin detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system;

continuing detecting the rotational movement of the at least one component of the downhole pumping system through a second direction change of the at least one component of the downhole pumping system; and

ceasing detecting the rotational movement of the at least one component of the downhole pumping system after a third direction change of the at least one component of the downhole pumping systemand

~~verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the at least one component of the downhole pumping system with the rotational sensor.~~

20. (Original) The method of claim 19, further comprising comparing a rotational velocity detected with the rotational sensor with a threshold value to determine a performance characteristic of the at least one component of the downhole pumping system.

REMARKS

Status of the Claims

This amendment is filed in response to the Final Office Action mailed February 4, 2025.

Claims 1 through 20 are pending and stand rejected.

Claims 1, 3 through 7, 10, 11, 13, 15, 16, and 19 are amended.

Support for the amendments in the claims as-filed and paragraphs [0043], [0044], [0052] of the application as filed.

No new matter is added.

For at least the reasons presented below, Applicant respectfully submits that each of the pending claims is in condition for allowance.

35 U.S.C. § 102

Claims 1 through 7, 19, and 20 are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Phillips (US 20190203579A1) (hereinafter “Phillips”).

Claims 1 through 7

Applicant respectfully asserts that claims 1 through 7 are not anticipated by Phillips under 35 U.S.C. § 102(a)(1) at least because Phillips does not describe each and every element of independent claim 1, as currently amended.

In particular, Phillips does not describe the sensor system of amended claim 13 including a processor subsystem to:

detect axial movement of the at least one component of the downhole pumping system with the magnetometer of the axial motion sensor subsystem, the detecting axial movement comprising:
sensing a direction change in the at least one component of the downhole pumping system ***to determine when a stroke of the at least one component of the downhole pumping system has been completed and to determine that a new stroke is beginning***; and
after the direction change in the at least one component of the downhole pumping system has been detected, begin to determine rotation of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational values generated by the rotation of the at least one component of the downhole pumping system, the determining the rotational

values of the at least one component of the downhole pumping system comprising:
continuing sampling the rotational values through a second direction change of the at least one component of the downhole pumping system; and
ceasing sampling the rotational values at a third direction change of the at least one component of the downhole pumping system.

The Final Office Action points to various generic statements in Phillips references strokes and potential differences in sensing rotation and/or axial movement.

However, there is no disclosure in Phillips of the particular chain of sensing events, including explicitly reciting the conditions for the starting and stopping events of the rotational sensing, as detailed in amended claim 1.

First, there is no disclosure in Phillips that rotation sensing only occurs once a direction change is sensed, indicating that a new stroke is beginning.

Second, there is no disclosure in Phillips that the sensing then continues during a second change in direction.

Finally, there is no disclosure in Phillips of then ceasing the sensing once a third change in direction is detected.

There appears to be no particulars in Phillips relating to other actions taking during only single stroke besides looking to the data from a single stroke.

Thus, claims 1, and claims 2 through 7 depending therefrom, are believed to be in condition for allowance.

Claims 19 and 20

Applicant respectfully asserts that claims 19 and 20 are not anticipated by Phillips under 35 U.S.C. § 102(a)(1) at least because Phillips does not describe each and every element of independent claim 19, as currently amended.

In particular, Phillips does not describe the method of amended claim 19 including:
when detecting no change in the axial direction, ceasing any sensing of rotation movement;
when verifying the first change in the axial direction:

begin detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system;
continuing detecting the rotational movement of the at least one component of the downhole pumping system ***through a second direction change*** of the at least one component of the downhole pumping system; and
ceasing detecting the rotational movement of the at least one component of the downhole pumping system ***after a third direction change*** of the at least one component of the downhole pumping system.

As above, there is no disclosure in Phillips of the particular chain of sensing events, including explicitly reciting the conditions for the starting and stopping events of the rotational sensing, as detailed in amended claim 19.

Thus, claim 19, and claim 20 depending therefrom, are believed to be in condition for allowance.

35 U.S.C. § 103

Claims 10 and 11 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips.

Claims 10 and 11 depend from claim 1 and are allowable for at least some of the reasons discussed above.

Claims 8, 9, and 16 through 18 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips in view of Hurst et al. (US9140113B2) (hereinafter “Hurst”).

Claims 8 and 9

Claims 8 and 9 depend from claim 1 and are allowable for at least some of the reasons discussed above. Hurst does not remedy the deficiencies of Phillips noted above.

Claims 16 through 18

Applicant respectfully asserts that claims 16 through 18 would not have been obvious in view of Phillips and Hurst at least because Phillips and Hurst do not teach or suggest describe each and every element of independent claim 18, as currently amended.

In particular, Phillips and Hurst do not disclose the sensor system of amended claim 16 including a processor subsystem to:

detect the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem;
when the axial movement of the at least one component is detected, begin detecting the rotational movement of the tubing rotator of the downhole pumping system with the rotational sensor;
continue detecting the rotational movement of the tubing rotator of the downhole pumping system through a second direction change of the at least one component of the downhole pumping system; and
cease detecting the rotational movement of the tubing rotator of the downhole pumping system after a third direction change of the at least one component of the downhole pumping system.

As above, there is no disclosure in Phillips of the particular chain of sensing events, including explicitly reciting the conditions for the starting event of the rotational sensing, as detailed in amended claim 16.

Hurst does not remedy the deficiencies of Phillips noted above.

Thus, claim 16, and claims 17 and 18 depending therefrom, are believed to be in condition for allowance.

Claims 12 through 15 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips in view of Puwanto (US 20200362686A1) (hereinafter “Puwanto”).

Claim 12

Claim 12 depends from claim 1 and is allowable for at least some of the reasons discussed above. Puwanto does not remedy the deficiencies of Phillips noted above.

Claims 13 through 15

Applicant respectfully asserts that claims 13 through 15 would not have been obvious in view of Phillips and Puwanto at least because Phillips and Puwanto do not teach or suggest describe each and every element of independent claim 13, as currently amended.

In particular, Phillips and Puwanto do not disclose the sensor system of amended claim 13 including a processor subsystem to:

verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem;
when the axial movement has been verified, detecting the rotational values with the rotation sensor subsystem during a current stroke of the downhole pumping system; and
comparing the rotational values with previously sensed rotational values detected by the rotation sensor subsystem ***during a previous stroke*** of the downhole pumping system ***to determine if rotation of the at least one component of the downhole pumping system has occurred.***

As above, there is no disclosure in Phillips of the particular chain of sensing events, including explicitly reciting the conditions for the starting event of the rotational sensing, as detailed in amended claim 13.

Further, while Phillips discussed some comparison of values, Phillips does not disclose using the value detected during a previous stroke ***to determine if rotation of the at least one component of the downhole pumping system has occurred.***

Puwanto is cited for a vibration sensor and does not remedy the deficiencies of Phillips noted above.

Thus, claim 13, and claims 14 and 15 depending therefrom, are believed to be in condition for allowance.

Conclusion

In view of the foregoing, Applicant believes all claims now pending in this application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please contact the undersigned at (801) 554-8311.

Respectfully submitted,

/Gregory C. Baker/

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Date: May 5, 2025

Serial No.: 17/549,519

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Terry Treiberg et al.

Serial No.: 17/549,519

Filed: December 13, 2021

For: DEVICES, SYSTEMS, AND
METHODS FOR DETECTING THE
ROTATION OF ONE OR MORE
COMPONENTS FOR USE WITH A
WELLBORE

Confirmation No.: 4428

Examiner: SINGLETARY, MICHAEL J

Group Art Unit: 2863

Attorney Docket No.: CHX.1002US

VIA ELECTRONIC FILING

RCE AMENDMENT

TO THE COMMISSIONER FOR PATENTS:

In response to the Final Office Action mailed February 4, 2025, please amend the above-identified patent application as follows.

Amendments to the claims are reflected in the **Listing of Claims** beginning on page 2 of this paper.

Remarks follow the Amendments sections of this paper.

IN THE CLAIMS:

All of the pending claims are presented below. This listing of claims will replace all prior versions and listings of claims in the application. Please enter these claims as amended.

Listing of the Claims:

1. (Currently Amended) A sensor system for a downhole pumping system, comprising:
a sensor subsystem for detecting movement of the at least one component of the downhole pumping system, the sensor subsystem comprising:
an axial motion sensor subsystem comprising a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to measure axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system;
a rotation sensor subsystem comprising a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system; and
a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes; and
a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:
~~measure~~detect axial movement of the at least one component of the downhole pumping system with the magnetometer of the axial motion sensor subsystem, the detecting axial movement comprising:
sensing a direction change in the at least one component of the downhole pumping system to determine when a stroke of the at least one component

of the downhole pumping system has been completed and to determine that a new stroke is beginning; and
after the direction change in the at least one component of the downhole pumping system has been detected, begin to determine rotation ~~determine rotational velocity~~ of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system, without the gyroscope the determining the rotational values of the at least one component of the downhole pumping system comprising:
continuing sampling the rotational values through a second direction change of the at least one component of the downhole pumping system; and
ceasing sampling the rotational values at a third direction change of the at least one component of the downhole pumping system.

2. (Original) The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore.

3. (Currently Amended) The sensor system of claim 2, wherein the processor subsystem is configured to verify the axial movement and the direction change of the at least one rod before determining the rotation.

4. (Currently Amended) The sensor system of claim 2, wherein the processor subsystem is configured to determine ~~a change in direction~~ the direction change of the at least one rod to indicate that a previous stroke has been completed and that a new stroke is beginning.

5. (Currently Amended) The sensor system of claim 4, wherein the processor subsystem is configured to begin sampling the rotational values comprising rotational velocity after determining the direction change of ~~the change in direction~~ the at least one rod.

6. (Currently Amended) The sensor system of ~~claim 5~~claim 1, wherein the processor subsystem is configured receive the rotational values from only a gyroscope~~to continue sampling the rotational velocity until another change in direction the at least one rod is detected.~~

7. (Currently Amended) The sensor system of ~~claim 5~~claim 1, wherein the processor subsystem is configured to compare the sampled rotational values with previously sampled rotational values detected by the rotation sensor subsystem during a previous stroke of the downhole pumping system to determine if rotation of the at least one component of the downhole pumping system has occurred~~continue sampling the rotational velocity along substantially an entire stroke of the at least one rod, the sampling beginning at a first change of direction of the at least one rod, continuing through a second change of direction of the at least one rod, and ceasing at a third change of direction of the at least one rod.~~

8. (Original) The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising a tubing rotator of the downhole pumping system.

9. (Original) The sensor system of claim 8, wherein the sensor subsystem is configured to detect rotation of the tubing rotator while detecting axial movement of a polished of the downhole pumping system.

10. (Currently Amended) The sensor system of claim 1, wherein the processor subsystem is configured to determine the ~~rotational velocity~~rotational values of the at least one component of the downhole pumping system by summing both positive and negative samples of the rotational ~~velocity~~ values sensed by the rotation sensor subsystem.

11. (Currently Amended) The sensor system of claim 10, wherein the processor subsystem is configured to compare the determined ~~rotational velocity~~rotational values of the at least one component of the downhole pumping system with an expected amount of ~~rotational~~

~~velocity~~rotational values to determine a failure in the rotation of the at least one component of the downhole pumping system.

12. (Previously Presented) The sensor system of claim 1, further comprising a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes over a vibrational baseline.

13. (Currently Amended) A sensor system for a downhole pumping system, comprising:

a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising:

an axial motion sensor subsystem comprising an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to measure axial movement of the at least one component of the downhole pumping system based on variations detected by the axial motion sensor generated by movement of the at least one component of the downhole pumping system; and

a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational ~~velocity~~ values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system; and

~~a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes; and~~

a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:

~~derive a vibrational baseline of the at least one component of the downhole pumping system from the vibration sensor subsystem in three axes during normal operation;~~

verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; ~~[[and]]~~

when the axial movement has been verified, ~~determine rotational velocity of the at least one component of the downhole pumping system with~~ detecting the rotational velocity values detected by with the rotation sensor subsystem during a current stroke of the downhole pumping system; and

comparing the rotational values with previously sensed rotational values detected by the rotation sensor subsystem during a previous stroke of the downhole pumping system to determine if rotation of the at least one component of the downhole pumping system has occurred.

14. (Original) The sensor system of claim 13, wherein the axial motion sensor subsystem comprises a magnetometer and the rotation sensor subsystem comprises a gyroscope.

15. (Currently Amended) The sensor system of claim 14, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore, and wherein the processor subsystem is configured to continue sampling the rotational ~~velocity~~ values of the at least one rod over a stroke of the at least one rod.

16. (Currently Amended) A sensor system for a downhole pumping system, comprising:
an axial motion sensor subsystem comprising a magnetometer to measure axial movement of at least one component of the downhole pumping system and to determine a change in axial direction of the at least one component of the downhole pumping system;
a sensor subsystem for detecting movement of a tubing rotator of the downhole pumping system, the sensor subsystem comprising a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the tubing rotator of the downhole pumping system and to detect rotational movement of the tubing rotator of the downhole pumping

system by sampling rotational ~~velocity~~ values with the rotational sensor generated by rotation of the tubing rotator of the downhole pumping system; and
a processor subsystem to receive data from the rotation sensor subsystem, the processor subsystem to determine ~~rotational velocity~~ rotation of the tubing rotator of the downhole pumping system with the rotational ~~velocity~~ values detected by the rotation sensor subsystem, the processor subsystem configured to:
detect the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem;
when the axial movement of the at least one component is detected, begin detecting the rotational movement of the tubing rotator of the downhole pumping system with the rotational sensor;
continue detecting the rotational movement of the tubing rotator of the downhole pumping system through a second direction change of the at least one component of the downhole pumping system; and
cease detecting the rotational movement of the tubing rotator of the downhole pumping system after a third direction change of the at least one component of the downhole pumping system.

17. (Original) The sensor system of claim 16, wherein the rotation sensor subsystem comprises at least one of a gyroscope or an accelerometer.

18. (Original) The sensor system of claim 16, wherein the rotation sensor subsystem is configured to monitor the rotation of the tubing rotator along a path that extends in a direction substantially perpendicular to a surface upon which the downhole pumping system is positioned.

19. (Currently Amended) A method of detecting motion of at least one component of a downhole pumping system, the method comprising:
determining a first change in axial direction of at least one component of the downhole pumping system based on magnetic variations detected by an axial motion sensor coupled to the at

least one component of the downhole pumping system generated by translation of the at

least one component of the downhole pumping system;

when detecting no change in the axial direction, ceasing any sensing of rotation movement;

when verifying the first change in the axial direction;

begin detecting rotational movement of the at least one component of the downhole

pumping system with a rotational sensor generated by rotation of the at least one

component of the downhole pumping system;

continuing detecting the rotational movement of the at least one component of the

downhole pumping system through a second direction change of the at least one

component of the downhole pumping system; and

ceasing detecting the rotational movement of the at least one component of the downhole

pumping system after a third direction change of the at least one component of the

downhole pumping systemand

~~verifying axial movement of the at least one component of the downhole pumping system with~~

~~the axial motion sensor before the detecting of the rotational movement of the at least one~~

~~component of the downhole pumping system with the rotational sensor.~~

20. (Original) The method of claim 19, further comprising comparing a rotational velocity detected with the rotational sensor with a threshold value to determine a performance characteristic of the at least one component of the downhole pumping system.

REMARKS

Status of the Claims

This amendment is filed in response to the Final Office Action mailed February 4, 2025.

Claims 1 through 20 are pending and stand rejected.

Claims 1, 3 through 7, 10, 11, 13, 15, 16, and 19 are amended.

Support for the amendments in the claims as-filed and paragraphs [0043], [0044], [0052] of the application as filed.

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35 U.S.C. § 102

Claims 1 through 7, 19, and 20 are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Phillips (US 20190203579A1) (hereinafter “Phillips”).

Claims 1 through 7

Applicant respectfully asserts that claims 1 through 7 are not anticipated by Phillips under 35 U.S.C. § 102(a)(1) at least because Phillips does not describe each and every element of independent claim 1, as currently amended.

In particular, Phillips does not describe the sensor system of amended claim 13 including a processor subsystem to:

detect axial movement of the at least one component of the downhole pumping system with the magnetometer of the axial motion sensor subsystem, the detecting axial movement comprising:
sensing a direction change in the at least one component of the downhole pumping system ***to determine when a stroke of the at least one component of the downhole pumping system has been completed and to determine that a new stroke is beginning***; and
after the direction change in the at least one component of the downhole pumping system has been detected, begin to determine rotation of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational values generated by the rotation of the at least one component of the downhole pumping system, the determining the rotational

values of the at least one component of the downhole pumping system comprising:
continuing sampling the rotational values through a second direction change of the at least one component of the downhole pumping system; and
ceasing sampling the rotational values at a third direction change of the at least one component of the downhole pumping system.

The Final Office Action points to various generic statements in Phillips references strokes and potential differences in sensing rotation and/or axial movement.

However, there is no disclosure in Phillips of the particular chain of sensing events, including explicitly reciting the conditions for the starting and stopping events of the rotational sensing, as detailed in amended claim 1.

First, there is no disclosure in Phillips that rotation sensing only occurs once a direction change is sensed, indicating that a new stroke is beginning.

Second, there is no disclosure in Phillips that the sensing then continues during a second change in direction.

Finally, there is no disclosure in Phillips of then ceasing the sensing once a third change in direction is detected.

There appears to be no particulars in Phillips relating to other actions taking during only single stroke besides looking to the data from a single stroke.

Thus, claims 1, and claims 2 through 7 depending therefrom, are believed to be in condition for allowance.

Claims 19 and 20

Applicant respectfully asserts that claims 19 and 20 are not anticipated by Phillips under 35 U.S.C. § 102(a)(1) at least because Phillips does not describe each and every element of independent claim 19, as currently amended.

In particular, Phillips does not describe the method of amended claim 19 including:
when detecting no change in the axial direction, ceasing any sensing of rotation movement;
when verifying the first change in the axial direction:

begin detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system;
continuing detecting the rotational movement of the at least one component of the downhole pumping system ***through a second direction change*** of the at least one component of the downhole pumping system; and
ceasing detecting the rotational movement of the at least one component of the downhole pumping system ***after a third direction change*** of the at least one component of the downhole pumping system.

As above, there is no disclosure in Phillips of the particular chain of sensing events, including explicitly reciting the conditions for the starting and stopping events of the rotational sensing, as detailed in amended claim 19.

Thus, claim 19, and claim 20 depending therefrom, are believed to be in condition for allowance.

35 U.S.C. § 103

Claims 10 and 11 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips.

Claims 10 and 11 depend from claim 1 and are allowable for at least some of the reasons discussed above.

Claims 8, 9, and 16 through 18 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips in view of Hurst et al. (US9140113B2) (hereinafter “Hurst”).

Claims 8 and 9

Claims 8 and 9 depend from claim 1 and are allowable for at least some of the reasons discussed above. Hurst does not remedy the deficiencies of Phillips noted above.

Claims 16 through 18

Applicant respectfully asserts that claims 16 through 18 would not have been obvious in view of Phillips and Hurst at least because Phillips and Hurst do not teach or suggest describe each and every element of independent claim 18, as currently amended.

In particular, Phillips and Hurst do not disclose the sensor system of amended claim 16 including a processor subsystem to:

detect the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem;
when the axial movement of the at least one component is detected, begin detecting the rotational movement of the tubing rotator of the downhole pumping system with the rotational sensor;
continue detecting the rotational movement of the tubing rotator of the downhole pumping system through a second direction change of the at least one component of the downhole pumping system; and
cease detecting the rotational movement of the tubing rotator of the downhole pumping system after a third direction change of the at least one component of the downhole pumping system.

As above, there is no disclosure in Phillips of the particular chain of sensing events, including explicitly reciting the conditions for the starting event of the rotational sensing, as detailed in amended claim 16.

Hurst does not remedy the deficiencies of Phillips noted above.

Thus, claim 16, and claims 17 and 18 depending therefrom, are believed to be in condition for allowance.

Claims 12 through 15 are rejected under 35 U.S.C. 103 as being unpatentable over Phillips in view of Puwanto (US 20200362686A1) (hereinafter “Puwanto”).

Claim 12

Claim 12 depends from claim 1 and is allowable for at least some of the reasons discussed above. Puwanto does not remedy the deficiencies of Phillips noted above.

Claims 13 through 15

Applicant respectfully asserts that claims 13 through 15 would not have been obvious in view of Phillips and Puwanto at least because Phillips and Puwanto do not teach or suggest describe each and every element of independent claim 13, as currently amended.

In particular, Phillips and Puwanto do not disclose the sensor system of amended claim 13 including a processor subsystem to:

verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem;
when the axial movement has been verified, detecting the rotational values with the rotation sensor subsystem during a current stroke of the downhole pumping system; and
comparing the rotational values with previously sensed rotational values detected by the rotation sensor subsystem during a previous stroke of the downhole pumping system to determine if rotation of the at least one component of the downhole pumping system has occurred.

As above, there is no disclosure in Phillips of the particular chain of sensing events, including explicitly reciting the conditions for the starting event of the rotational sensing, as detailed in amended claim 13.

Further, while Phillips discussed some comparison of values, Phillips does not disclose using the value detected during a previous stroke ***to determine if rotation of the at least one component of the downhole pumping system has occurred.***

Puwanto is cited for a vibration sensor and does not remedy the deficiencies of Phillips noted above.

Thus, claim 13, and claims 14 and 15 depending therefrom, are believed to be in condition for allowance.

Conclusion

In view of the foregoing, Applicant believes all claims now pending in this application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please contact the undersigned at (801) 554-8311.

Serial No.: 17/549,519

Respectfully submitted,

/Gregory C. Baker/

Gregory C. Baker
Registration No. 61,335
Attorney for Applicant
BKRIP LLC
1240B E Stringham Ave #1027
Salt Lake City, Utah 84106
Telephone: 801-554-8311

Date: May 5, 2025

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL (Submitted Only via EFS-Web)

Application Number	17/549,519	Filing Date	2021-12-13	Docket Number (if applicable)	CHX.1002US	Art Unit	2863
First Named Inventor	Terry Treiberg			Examiner Name	SINGLETARY, MICHAEL J		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.

Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

☐ Other _____

☒ Enclosed

☒ Amendment/Reply

☐ Information Disclosure Statement (IDS)

☐ Affidavit(s)/ Declaration(s)

☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

☐ The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No _____

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

☐ Applicant Signature

Signature of Registered U.S. Patent Practitioner			
Signature	/Gregory C Baker/	Date (YYYY-MM-DD)	2025-05-05
Name	Gregory C Baker	Registration Number	61335

This collection of information is required by 37 CFR 1.114. 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.

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

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 the Freedom of Information Act requires disclosure of these records.
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 inspections 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.



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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
17/549,519

RECEIPT DATE / TIME
05/05/2025 05:01:19 PM Z ET

ATTORNEY DOCKET #
CHX.1002US

Title of Invention

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	4428	FILED BY	Greg Baker
PATENT CENTER #	70295739	FILING DATE	12/13/2021
CUSTOMER #	184959	FIRST NAMED INVENTOR	Terry Treiberg
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	-

Documents

TOTAL DOCUMENTS: 3

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
2025-05-05_RCEAmend-APP.TEXT.docx	14	Application body structured text document	63 KB
Warning: Track changes containing insertions/deletions have been detected. These changes will be displayed in the document as underlines/strikethroughs. Dynamic dates have been converted to static dates. Bookmarks were found and have been removed.			
2025-05-05_RCE.pdf	3	Request for Continued Examination (RCE)	681 KB
2025-05-05_RCEAmend.pdf	14	Auxiliary PDF of Application	252 KB

Digest

DOCUMENT**MESSAGE DIGEST(SHA-512)**

2025-05-05_RCEAmend-
APP.TEXT.docx

FB623882BE663C7DE9BAF36B226F1FB532C8B47921B8CAE63
2850FF9C350612B6C975DB3C79468A8DFC375C4936177BC6A
51E78BF083CD48E0E2E974CCE7DF10

2025-05-05_RCE.pdf

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F5C3005E3E301AF0A4B76D23BAA2756

2025-05-05_RCEAmend.pdf

395F02A183790D2D61EBE4BF3747A424A7E26CEEE86605DA9
335369D68479C92906659721A920D0B229265BF83A6E15368B
685E58EE3D512E121EC4637D3470D

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 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.



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ELECTRONIC PAYMENT RECEIPT

APPLICATION #
17/549,519

RECEIPT DATE / TIME
05/05/2025 05:01:19 PM Z ET

ATTORNEY DOCKET #
CHX.1002US

Title of Invention

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	4428	FILED BY	Greg Baker
PATENT CENTER #	70295739	AUTHORIZED BY	-
CUSTOMER #	184959	FILING DATE	12/13/2021
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Terry Treiberg

Payment Information

PAYMENT METHOD CARD / 1001	PAYMENT TRANSACTION ID E202555H02575814	PAYMENT AUTHORIZED BY Greg Baker
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FEE CODE	DESCRIPTION	ITEM PRICE(\$)	QUANTITY	ITEM TOTAL(\$)
1801	REQUEST FOR CONTINUED EXAMINATION (RCE) - 1ST REQUEST (SEE 37 CFR 1.114)	1500.00	1	1500.00
TOTAL AMOUNT:				\$1,500.00

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

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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.



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NOTICE OF ALLOWANCE AND FEE(S) DUE

184959 7590 07/11/2025
ChampionX/BKRIP
1240B E Stringham Ave #1027
SALT LAKE CITY, UT 84106

EXAMINER

SINGLETARY, MICHAEL J

ART UNIT

PAPER NUMBER

2863

DATE MAILED: 07/11/2025

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US	4428

TITLE OF INVENTION: DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1290	\$0.00	\$0.00	\$1290	10/14/2025

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 40% the amount of undiscounted fees, and micro entity fees are 20% the amount of undiscounted 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. 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 the USPTO patent electronic filing system.

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 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. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

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

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.

184959 7590 07/11/2025
ChampionX/BKRIP
1240B E Stringham Ave #1027
SALT LAKE CITY, UT 84106

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 the USPTO patent electronic filing system 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.
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US	4428

TITLE OF INVENTION: DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1290	\$0.00	\$0.00	\$1290	10/14/2025

EXAMINER	ART UNIT	CLASS-SUBCLASS
SINGLETARY, MICHAEL J	2863	702-006000

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/AIA/122 or PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 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,

1 _____

(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.

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)

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

☐ Electronic Payment via the USPTO patent electronic filing system ☐ 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. _____



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US	4428
184959	7590	07/11/2025	EXAMINER	
ChampionX/BKRIP			SINGLETARY, MICHAEL J	
1240B E Stringham Ave #1027			ART UNIT	
SALT LAKE CITY, UT 84106			PAPER NUMBER	
			2863	
DATE MAILED: 07/11/2025				

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.

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. The United States Patent and Trademark Office (USPTO) collects the information in this record under authority of 35 U.S.C. 2. The USPTO's system of records is used to manage all applicant and owner information including name, citizenship, residence, post office address, and other information with respect to inventors and their legal representatives pertaining to the applicant's/owner's activities in connection with the invention for which a patent is sought or has been granted. The applicable Privacy Act System of Records Notice for the information collected in this form is COMMERCE/PAT-TM-7 Patent Application Files, available in the Federal Register at 78 FR 19243 (March 29, 2013).

<https://www.govinfo.gov/content/pkg/FR-2013-03-29/pdf/2013-07341.pdf>

Routine uses of the information in this record may include disclosure to:

- 1) law enforcement, in the event that the system of records indicates a violation or potential violation of law;
- 2) a federal, state, local, or international agency, in response to its request;
- 3) a contractor of the USPTO having need for the information in order to perform a contract;
- 4) the Department of Justice for determination of whether the Freedom of Information Act (FOIA) requires disclosure of the record;
- 5) a Member of Congress submitting a request involving an individual to whom the record pertains, when the individual has requested the Member's assistance with respect to the subject matter of the record;
- 6) a court, magistrate, or administrative tribunal, in the course of presenting evidence, including disclosures to opposing counsel in the course of settlement negotiations;
- 7) the Administrator, General Services Administration (GSA), or their designee, during an inspection of records conducted by GSA under authority of 44 U.S.C. 2904 and 2906, in accordance with the GSA regulations and any other relevant (i.e., GSA or Commerce) directive, where such disclosure shall not be used to make determinations about individuals;
- 8) 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));
- 9) the Office of Personnel Management (OPM) for personnel research purposes; and
- 10) the Office of Management and Budget (OMB) for legislative coordination and clearance.

If you do not furnish the information requested on this form, the USPTO may not be able to process and/or examine your submission, which may result in termination of proceedings, abandonment of the application, and/or expiration of the patent.

Notice of Allowability	Application No. 17/549,519	Applicant(s) Treiberg et al.	
	Examiner MICHAEL J SINGLETARY	Art Unit 2863	AIA (First Inventor to File) 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 05/05/2025.
☐ 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 1-20. 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 _____.
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/MICHAEL J SINGLETARY/ Examiner, Art Unit 2863	/LISA M CAPUTO/ Supervisory Patent Examiner, Art Unit 2863
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DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 05/05/2025 has been entered.

Response to Arguments

Applicant's arguments, see pages 2 through 5, filed 05/05/2025, with respect to claims 1 through 20 have been fully considered and are persuasive.

Allowable Subject Matter

Claims 1 through 20 are allowed.

The following is an examiner's statement of reasons for allowance:

Regarding Claim 1, Phillips teaches a sensor system for a downhole pumping system [0019], comprising: a sensor subsystem for detecting movement of at least one component of the downhole pumping system [Claim 1], the sensor subsystem comprising:

an axial motion sensor subsystem comprising a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to measure axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system (Claim 1; [00126]); and

a rotation sensor subsystem comprising a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system [Claim 1 and 12; [00110]]; and

a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem [Claim 1], the processor subsystem to: measure

axial movement of the at least one component of the downhole pumping system with the magnetometer of the axial motion sensor subsystem [0021]; and

determine rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system with only the gyroscope [0026; 0029; 0043; 0096; 0134; 0138; Fig. 6].

Further, Philips teaches a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem [0021], the processor subsystem to:

detect axial movement of the at least one component of the downhole pumping system with the magnetometer of the axial motion sensor subsystem [0021-0023], the detecting axial movement comprising:

sensing a direction change in the at least one component of the downhole pumping system to determine when a stroke of the at least one component of the downhole pumping system has been completed and to determine that a new stroke is beginning [0081]; and

after the direction change in the at least one component of the downhole pumping system has been detected, begin to determine rotation of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational values generated by the rotation of the at least one component of the downhole pumping system, the determining the rotational values of the at least one component of the downhole pumping system comprising [0087].

Philips fails to teach a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes;

continuing sampling the rotational values through a second direction change of the at least one component of the downhole pumping system: and

ceasing sampling the rotational values at a third direction change of the at least one component of the downhole pumping system.

However, in a related field, Puwanto discloses a vibration measuring device included in the MWD tool that measures vibration detecting real time drilling parameters and can be used as a trigger (in an alarm system) for a system to hold on drilling parameter recommendation change [0032; 0129; 0149; 0161].

Puwanto, along with all other references, fail to teach continuing sampling the rotational values through a second direction change of the at least one component of the downhole pumping system: and

ceasing sampling the rotational values at a third direction change of the at least one component of the downhole pumping system.

It is for this reason, Claim 1 and all of its dependencies are allowed.

Claim 13, 16 and 19 include analogous, though not necessarily coextensive, features in conjunction with Claim 1, and is, therefore, along with its dependencies, for similar rationale as disclosed above, allowed.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably

accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MICHAEL J SINGLETARY whose telephone number is (571)272-4593. The examiner can normally be reached Monday-Friday 8:00am-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, Lisa Caputo can be reached at (571) 272-2388. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: <https://patentcenter.uspto.gov>. Visit <https://www.uspto.gov/patents/apply/patent-center> for more information about Patent Center and <https://www.uspto.gov/patents/docx> for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197

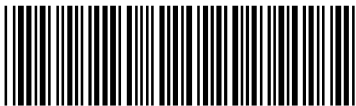
Art Unit: 2863

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Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MICHAEL J SINGLETARY/
Examiner, Art Unit 2863

/LISA M CAPUTO/
Supervisory Patent Examiner, Art Unit 2863

Search Notes 	Application/Control No. 17/549,519	Applicant(s)/Patent Under Reexamination Treiberg et al.
	Examiner MICHAEL J SINGLETARY	Art Unit 2863

CPC - Searched*		
Symbol	Date	Examiner
(E21B47/009 or E21B43/127 or E21B47/092).cpc.	06/07/2024	MS

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
Inventor name search in PALM and PE2E	06/07/2024	MS
Consulted Manish Shah regarding class/class search	06/07/2024	MS
PE2E search history attached	06/07/2024	MS

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	Text search claim/claim language in PGPub/Patent database	06/26/2025	MS

/MICHAEL J SINGLETARY/ Examiner, Art Unit 2863	
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<i>Issue Classification</i> 	Application/Control No. 17/549,519	Applicant(s)/Patent Under Reexamination Treiberg et al.
	Examiner MICHAEL J SINGLETARY	Art Unit 2863

CPC						
Symbol					Type	Version
E21B	/	47	/	009	F	2020-05-01
E21B	/	47	/	092	I	2020-05-01
E21B	/	43	/	127	I	2013-01-01

CPC Combination Sets				
Symbol		Type	Set	Ranking
	/		/	

/MICHAEL J SINGLETARY/ Examiner, Art Unit 2863 (Assistant Examiner)	26 June 2025 (Date)	Total Claims Allowed: 20	
/LISA M CAPUTO/ Supervisory Patent Examiner, Art Unit 2863 (Primary Examiner)	27 June 2025 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

<i>Issue Classification</i> 	Application/Control No. 17/549,519	Applicant(s)/Patent Under Reexamination Treiberg et al.	
	Examiner MICHAEL J SINGLETARY	Art Unit 2863	

INTERNATIONAL CLASSIFICATION			
CLAIMED			
E21B47/009	/	47	/ 009
E21B47/092	/	47	/ 092
E21B43/12	/	43	/ 12
NON-CLAIMED			
	/		/

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

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

/MICHAEL J SINGLETARY/ Examiner, Art Unit 2863 (Assistant Examiner)	26 June 2025 (Date)	Total Claims Allowed: 20	
/LISA M CAPUTO/ Supervisory Patent Examiner, Art Unit 2863 (Primary Examiner)	27 June 2025 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

Issue Classification 	Application/Control No. 17/549,519	Applicant(s)/Patent Under Reexamination Treiberg et al.
	Examiner MICHAEL J SINGLETARY	Art Unit 2863

☒ 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		10		19										
	2		11		20										
	3		12												
	4		13												
	5		14												
	6		15												
	7		16												
	8		17												
	9		18												

/MICHAEL J SINGLETARY/ Examiner, Art Unit 2863 (Assistant Examiner)	26 June 2025 (Date)	Total Claims Allowed: 20	
/LISA M CAPUTO/ Supervisory Patent Examiner, Art Unit 2863 (Primary Examiner)	27 June 2025 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	0	"16228233".did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/06/03 03:22 PM
L2	2	"20190203579".did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/06/03 03:24 PM
L3	16	"11319794"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/06/05 04:56 PM
L4	19	"9140113"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY,	OR	ON	ON	2024/06/06 01:14 PM

			CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L5	8	("20030236627" OR "20080035376" OR "20190203579" OR "20200123892" OR "20200392834" OR "20130181844" OR "20200263531" OR "20200340309").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/06/07 03:36 PM
L6	4	("20130181844" OR "20190203579" OR "20200263531" OR "20200340309").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/06/07 03:47 PM
L7	5	("20030236627" OR "20080035376" OR "20190203579" OR "20200123892" OR "20200392834").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/06/07 03:50 PM
L8	9678	(E21B47/009 OR E21B43/127 OR E21B47/092).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/06/07 03:51 PM
L9	1	("20230184089").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/06/07 03:52 PM
L10	33	(Artificial Intelligence) More like doc: US-20230184089-A1 Text: (WO-2023113950-A1 OR US-11814948-B2 OR CA-3216041-A1 OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2024/06/07 03:52 PM

		CA-3028433-C OR US-20240026771-A1 OR CA-3028433-A1 OR US-20190203579-A1 OR US-10508522-B2 OR US-11408271-B2 OR US-11060392-B2 OR EP-3170968-A1 OR US-20170146007-A1 OR US-20200190965-A1 OR US-6529834-B1 OR US-20160177683-A1 OR US-20160076362-A1 OR US-20020116130-A1 OR GB-2370645-A OR US-20030236627-A1 OR EP-1184539-B1).did.	IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L11	2931	(downhole OR wellbore) sensor detect\$3 movement pump\$3 system axial motion rotation velocity	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2024/06/07 03:58 PM
L12	1533	(E21B47/009).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2024/06/07 03:58 PM
L13	29	L11 AND L12	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA,	AND	ON	ON	2024/06/07 03:59 PM

			EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L14	6458	rotation axial velocity sensor magnetometer gyroscope	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2024/06/07 04:02 PM
L15	10	L14 AND L12	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2024/06/07 04:02 PM
L16	13	L10 AND axial	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA,	AND	ON	ON	2024/06/07 04:02 PM

			VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L17	19	vibration sensor wellbore ((three ADJ dimensional) OR 3D)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	WITH	ON	ON	2025/01/03 09:33 AM
L18	2	"20040206170".did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/01/03 09:37 AM
L19	40	(Artificial Intelligence) More like doc: CN-103410500-A Text: (GB-9120854-D0 OR CN-2791245-Y OR CN- 201486545-U OR CN- 201507303-U OR CN- 201851102-U OR CN- 102562035-B OR CN- 202926322-U OR CN- 103410500-A OR US- 9328602-B2 OR CA- 2769227-A1 OR US- 20240191612-A1 OR CN-102200009-B OR US-9109397-B2 OR GB-2616788-A OR US- 20120138367-A1 OR WO-2024123912-A1 OR US-20150184503-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	WITH	ON	ON	2025/01/03 10:44 AM

		A1 OR CA-2769227-C OR NO-20201306-A1 OR OA-20232-A).did.					
L20	0	vibration sensor wellbore ((three ADJ dimensional) OR 3D) (alarm OR alert)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	WITH	ON	ON	2025/01/03 11:19 AM
L21	19	vibration sensor wellbore ((three ADJ dimensional) OR 3D) (alarm OR alert)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	SAME	ON	ON	2025/01/03 11:19 AM
L22	0	vibration sensor wellbore ((three ADJ dimensional) OR 3D) (alarm OR alert)	(US-PGPUB; USPAT)	SAME	ON	ON	2025/01/03 11:19 AM
L23	1065	vibration sensor wellbore ((three ADJ dimensional) OR 3D) (alarm OR alert)	(US-PGPUB; USPAT)	AND	ON	ON	2025/01/03 11:19 AM
L24	3	L12 AND L23	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA,	OR	ON	ON	2025/01/03 11:19 AM

			VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L25	50	(Artificial Intelligence) Similar to: 17/549,519 with 0 CPC Selections and 0 Text Selections Text: (WO-2023113950-A1 OR US-20220213886- A1 OR US- 20170268328-A1 OR US-10240452-B2 OR US-20140234122-A1 OR US-20170145811- A1 OR US-10605051- B2 OR US-10113380- B2 OR WO- 2019152915-A3 OR WO-9302289-A1 OR US-20170241222-A1 OR AU-2010249996-B2 OR EP-2432966-B1 OR AU-2010249996-A1 OR US-20100288493-A1 OR US-20210301815- A1 OR CA-2760423-A1 OR US-20110300008- A1 OR US-8534366-B2 OR CA-2760423-C OR CA-2799958-C OR WO-2010135049-A1 OR US-8833441-B2 OR US-20170146006-A1 OR US-8443900-B2 OR CA-2799958-A1 OR US-10344573-B2 OR DK-2576973-T3 OR US-20160356109-A1 OR WO-9735094-A1 OR RU-2801378-C1 OR US-10208551-B2 OR US-5699858-A OR EP-0899421-A2 OR RU-2666931-C2 OR US-8505627-B2 OR US-20050155759-A1 OR US-10428628-B2 OR RU-2013103776-A OR CA-2727616-A1 OR CA-2727616-C OR US- 20090301782-A1 OR GB-2464263-A OR US- 20090090511-A1 OR WO-2015123318-A1 OR US-20100084192-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2025/06/26 12:01 PM

		A1 OR US-7954252-B2 OR US-20150233182- A1 OR US- 20190309621-A1 OR US-20200095861- A1).did.					
L26	1013	vibration sensor wellbore ((three ADJ dimensional) OR 3D) (alarm OR alert) direction change	(US-PGPUB; USPAT)	AND	ON	ON	2025/06/26 12:04 PM
L27	4852	wellbore rotational velocity direction change	(US-PGPUB; USPAT)	AND	ON	ON	2025/06/26 12:06 PM
L28	0	wellbore rotational velocity direction change	(US-PGPUB; USPAT)	WITH	ON	ON	2025/06/26 12:06 PM
L29	6	wellbore rotational velocity direction change	(US-PGPUB; USPAT)	SAME	ON	ON	2025/06/26 12:06 PM
L30	4852	wellbore rotational velocity direction change	(US-PGPUB; USPAT)	AND	ON	ON	2025/06/26 12:24 PM
L31	23	wellbore rotational velocity direction change AND L12	(US-PGPUB; USPAT)	AND	ON	ON	2025/06/26 12:24 PM
L32	16	wellbore rotational velocity direction NEAR change AND L12	(US-PGPUB; USPAT)	AND	ON	ON	2025/06/26 12:25 PM
L33	839	wellbore sensor rotational velocity direction NEAR change	(US-PGPUB; USPAT)	AND	ON	ON	2025/06/26 12:26 PM
L34	361	wellbore downhole pumping sensor rotational velocity direction NEAR change	(US-PGPUB; USPAT)	AND	ON	ON	2025/06/26 12:26 PM
L35	310	wellbore downhole pumping sensor detect\$3 rotational velocity direction NEAR change	(US-PGPUB; USPAT)	AND	ON	ON	2025/06/26 12:29 PM
L36	441	wellbore downhole pumping sensor detect\$3 rotational direction NEAR change	(US-PGPUB; USPAT)	AND	ON	ON	2025/06/26 01:03 PM
L37	0	wellbore downhole pumping sensor detect\$3 rotational direction NEAR change	(US-PGPUB; USPAT)	WITH	ON	ON	2025/06/26 01:03 PM
L38	0	wellbore downhole pumping sensor detect\$3 rotational	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY,	WITH	ON	ON	2025/06/26 01:03 PM

		direction NEAR change	CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L39	10	wellbore downhole pumping sensor detect\$3 rotational direction NEAR change	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	SAME	ON	ON	2025/06/26 01:03 PM
L40	808	wellbore downhole pumping sensor detect\$3 rotational direction NEAR change	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2025/06/26 01:10 PM
L41	2369	wellbore sensor detect\$3 rotational direction NEAR change	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO,	AND	ON	ON	2025/06/26 01:13 PM

			RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L42	36	wellbore motion sensor detect\$3 direction NEAR change polish rod	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2025/06/26 01:14 PM
L43	5	wellbore motion sensor detect\$3 direction NEAR change polish rod	(US-PGPUB; USPAT)	AND	ON	ON	2025/06/26 01:15 PM

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	1	sensor system (downhole NEAR pump\$3 NEAR system) sensor subsystem detect\$3 movement axial motion magnetometer gyroscope	(US-PGPUB; USPAT)	AND	ON	ON	2025/06/26 03:28 PM



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Alexandria, VA 22313 - 1450
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
17/549,519

RECEIPT DATE / TIME
10/10/2025 03:52:08 PM Z ET

ATTORNEY DOCKET #
CHX.1002US

Title of Invention

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
 under 35 USC 111(a)

PATENT # -

CONFIRMATION # 4428

FILED BY Greg Baker

PATENT CENTER # 72666822

FILING DATE 12/13/2021

CUSTOMER # 184959

FIRST NAMED
INVENTOR Terry Treiberg

CORRESPONDENCE
ADDRESS -

AUTHORIZED BY -

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
web85b.pdf	3	Issue Fee Payment (PTO-85B)	58 KB
2025-07-11_Comments.pdf	2	Amendment after Notice of Allowance (Rule 312)	154 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
web85b.pdf	B29ABD7997C3328634DCFC5E462D7090475C89D0FCC66E0E DB027F97BDEAD109177D2C37199DD51806B541BD6771369C CB67092A2113A41D4B6AA3727A7D089E
2025-07-11_Comments.pdf	DAD964EFC7D1BA05985F91A448C5B90EAE89C6D32DCA8D4

5C76ABC951053248CB576E530EC92D7FA69EB9F117807823A
EB2C60270EDC9D566717CFCA44F8A9C2

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 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.



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ELECTRONIC PAYMENT RECEIPT

APPLICATION #
17/549,519

RECEIPT DATE / TIME
10/10/2025 03:52:08 PM Z ET

ATTORNEY DOCKET #
CHX.1002US

Title of Invention

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
under 35 USC 111(a)

PATENT # -

CONFIRMATION # 4428

FILED BY Greg Baker

PATENT CENTER # 72666822

AUTHORIZED BY -

CUSTOMER # 184959

FILING DATE 12/13/2021

CORRESPONDENCE ADDRESS -

FIRST NAMED INVENTOR Terry Treiberg

Payment Information

PAYMENT METHOD
CARD / 1008

PAYMENT TRANSACTION ID
E202500F52209461

PAYMENT AUTHORIZED BY
Greg Baker

FEE CODE	DESCRIPTION	ITEM PRICE(\$)	QUANTITY	ITEM TOTAL(\$)
1501	UTILITY ISSUE FEE	1290.00	1	1290.00
TOTAL AMOUNT:				\$1,290.00

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for 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
EX-1002, p. 352 of 378

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.



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ISSUE FEE TRANSMITTAL FORM

APPLICATION #	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET #
17549519	12/13/2021	Terry Treiberg	CHX.1002US

Title of Invention

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

Application Information

APPLICATION TYPE	Nonprovisional Application under 35 USC 111(a)	DATE DUE	10/14/2025
CONFIRMATION #	4428	ISSUE FEE DUE	\$ 1290
EXAMINER	MICHAEL SINGLETARY	PUBLICATION DUE	\$ 0
GROUP ART UNIT	2863	TOTAL FEES DUE	\$1290
CLASS - SUBCLASS	702/006000	PREV. PAID FEE	\$ 0
ENTITY STATUS	Regular Undiscounted		

1. CHANGE OF CORRESPONDENCE ADDRESS AND/OR INDICATION OF FEE ADDRESS (37 CFR 1.33 & 1.363)

Correspondence Address

Maintenance Fee Address

CURRENT ADDRESS

CURRENT ADDRESS

☐

Change of correspondence address requested, system generated AIA/122-PC form attached

☐

Fee address indication requested, system generated SB/47-PC form attached

2. ENTITY STATUS

Change in Entity Status

NEW STATUS

3. THE FOLLOWING FEES ARE SUBMITTED

☒

Issue Fee

☒

Publication Fee

4. FEE AUTHORIZATION

☐

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

☐

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:

☐

If in 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:

5. 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

BKRIP LLC

6. ASSIGNEE NAME(S) AND RESIDENCE DATA TO BE PRINTED

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

CHAMPIONX LLC

SUGAR LAND, TX UNITED STATES Corporation

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 Patent Center on the date indicated below.

Signature	Name	Registration #	Date
/GCB/	Greg Baker	61335	10/10/2025

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Terry Treiberg et al.

Serial No.: 17/549,519

Filed: December 13, 2021

For: DEVICES, SYSTEMS, AND METHODS
FOR DETECTING THE ROTATION OF ONE
OR MORE COMPONENTS FOR USE WITH
A WELLBORE

Confirmation No.: 4428

Examiner: SINGLETARY, MICHAEL J

Group Art Unit: 2863

Attorney Docket No.: CHX.1002US

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE

Mail Stop Issue Fee
Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Examiner:

This communication is filed in response to the Statement of Reasons for Allowance, and sets forth Applicant's comments, pursuant to 37 C.F.R. § 1.104(e), on the Examiner's Statement of Reasons for Allowance.

Applicant concurs with the reasons as stated by the Examiner insofar as they comprise a summary, which is exemplary and not limiting. However, the scope of the claims is based on the actual language of the claims and equivalents thereof, and not on a paraphrase or summary of the claim language.

The independent claims as allowed recite features and methodology in addition to, and in different language than, those described in the Statement of Reasons for Allowance.

Furthermore, the dependent claims recite elements in addition to those of the independent claims, which are also not reflected in the Statement of Reasons for Allowance. Such additional elements, in combination with those of the independent claims from which each claim depends, provide additional reasons for patentability. Accordingly, the scope of the claims must be determined from the literal language of each as a whole, as well as all equivalents thereof.

Therefore, to the extent that the Examiner's reasons for allowance as stated are not relevant to, or wholly encompassing of, a particular claim, independent or dependent, Applicant assumes that (pursuant to 37 C.F.R. § 1.104(e)) the Examiner has determined that the record of the prosecution as a whole of the application makes clear the reasons for allowing those claims. Further, it appears, pursuant to M.P.E.P. § 1302.14, that the Examiner's Statement of Reasons for Allowance is not intended to encompass all of the reasons for allowance.

Respectfully submitted,

/Gregory C. Baker/

Gregory C. Baker
Registration No. 61,335
Attorney for Applicant
BKRIP LLC
1240B E Stringham Ave #1027
Salt Lake City, Utah 84106
Telephone: 801-554-8311

Date: July 11, 2025

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)

Approved for use through 11/30/2020. 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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)

Application Number

Filing Date

First Named Inventor

Art Unit

Examiner Name

Attorney Docket Number

2021-12-13

Terry Treiberg

CHX.1002US

U.S.PATENTS

Remove

Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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U.S.PATENT APPLICATION PUBLICATIONS

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Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
Change(s) applied to document, /C.L./ 7/15/2025	1	20200263531	A1	2020-08-20	Fyfe et al. 4mm Innovations Inc	
	2	20130181844	A1	2013-07-18	Weatherford Technology Holdings LLC Hurst et al.	
	3	20190203579	A1	2019-07-04	Walter Phillips	
	4	20200340309	A1	2020-10-29	Cortes et al. Norris-Ross Inc	

If you wish to add additional U.S. Published Application citation information please click the Add button.

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/549,519	11/04/2025	12460537	CHX.1002US	4428

184959 7590 10/22/2025
ChampionX/BKRIP
1240B E Stringham Ave #1027
SALT LAKE CITY, UT 84106

ISSUE NOTIFICATION

The projected patent number and issue date are specified above. The patent will issue electronically. The electronically issued patent is the official patent grant pursuant to 35 U.S.C. § 153. The patent may be accessed on or after the issue date through Patent Center at <https://patentcenter.uspto.gov/>. The patent will be available in both the public and the private sides of Patent Center. Further assistance in electronically accessing the patent, or about Patent Center, is available by calling the Patent Electronic Business Center at 1-888-217-9197.

The USPTO is implementing electronic patent issuance with a transition period, during which period the USPTO will mail a ceremonial paper copy of the electronic patent grant to the correspondence address of record. Additional copies of the patent (i.e., certified and presentation copies) may be ordered for a fee from the USPTO's Certified Copy Center at <https://certifiedcopycenter.uspto.gov/index.html>. The Certified Copy Center may be reached at (800)972-6382.

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 744 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 Center (<https://patentcenter.uspto.gov>).

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of Science and Useful Arts

The Director

*of the United States Patent and Trademark Office has received
an application for a patent for a new and useful invention. The title
and description of the invention are enclosed. The requirements
of law have been complied with, and it has been determined that
a patent on the invention shall be granted under the law.*

Therefore, this United States

Patent

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John A. Guarnieri

DIRECTOR OF THE UNITED STATES PATENT AND TRADEMARK OFFICE

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If the application for this patent was filed on or after December 12, 1980, maintenance fees are due three years and six months, seven years and six months, and eleven years and six months after the date of this grant, or within a grace period of six months thereafter upon payment of a surcharge as provided by law. The amount, number and timing of the maintenance fees required may be changed by law or regulation. Unless payment of the applicable maintenance fee is received in the United States Patent and Trademark Office on or before the date the fee is due or within a grace period of six months thereafter, the patent will expire as of the end of such grace period.

Patent Term Notice

If the application for this patent was filed on or after June 8, 1995, the term of this patent begins on the date on which this patent issues and ends twenty years from the filing date of the application or, if the application contains a specific reference to an earlier filed application or applications under 35 U.S.C. 120, 121, 365(c), or 386(c), twenty years from the filing date of the earliest such application (“the twenty-year term”), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b), and any extension as provided by 35 U.S.C. 154(b) or 156 or any disclaimer under 35 U.S.C. 253.

If this application was filed prior to June 8, 1995, the term of this patent begins on the date on which this patent issues and ends on the later of seventeen years from the date of the grant of this patent or the twenty-year term set forth above for patents resulting from applications filed on or after June 8, 1995, subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b) and any extension as provided by 35 U.S.C. 156 or any disclaimer under 35 U.S.C. 253.



US012460537B2

(12) **United States Patent**
Treiberg et al.

(10) **Patent No.:** **US 12,460,537 B2**
(45) **Date of Patent:** **Nov. 4, 2025**

(54) **DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 744 days.

(21) Appl. No.: **17/549,519**

(22) Filed: **Dec. 13, 2021**

(65) **Prior Publication Data**
US 2023/0184089 A1 Jun. 15, 2023

(51) **Int. Cl.**
E21B 47/009 (2012.01)
E21B 43/12 (2006.01)
E21B 47/092 (2012.01)

(52) **U.S. Cl.**
CPC **E21B 47/009** (2020.05); **E21B 43/127** (2013.01); **E21B 47/092** (2020.05)

(58) **Field of Classification Search**
CPC E21B 47/009; E21B 43/127; E21B 47/092
See application file for complete search history.

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Primary Examiner — Lisa M Caputo

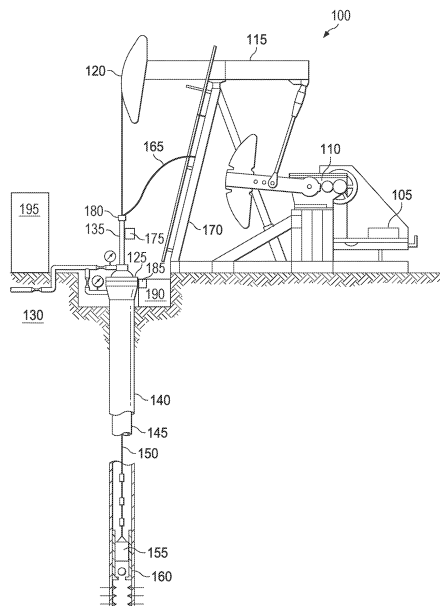
Assistant Examiner — Michael J Singletary

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(57) **ABSTRACT**

Sensor systems and methods for downhole pumping systems include a sensor subsystem for detecting movement of at least one component of the downhole pumping system. The sensor subsystem includes an axial motion sensor to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system and a rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system.

20 Claims, 3 Drawing Sheets



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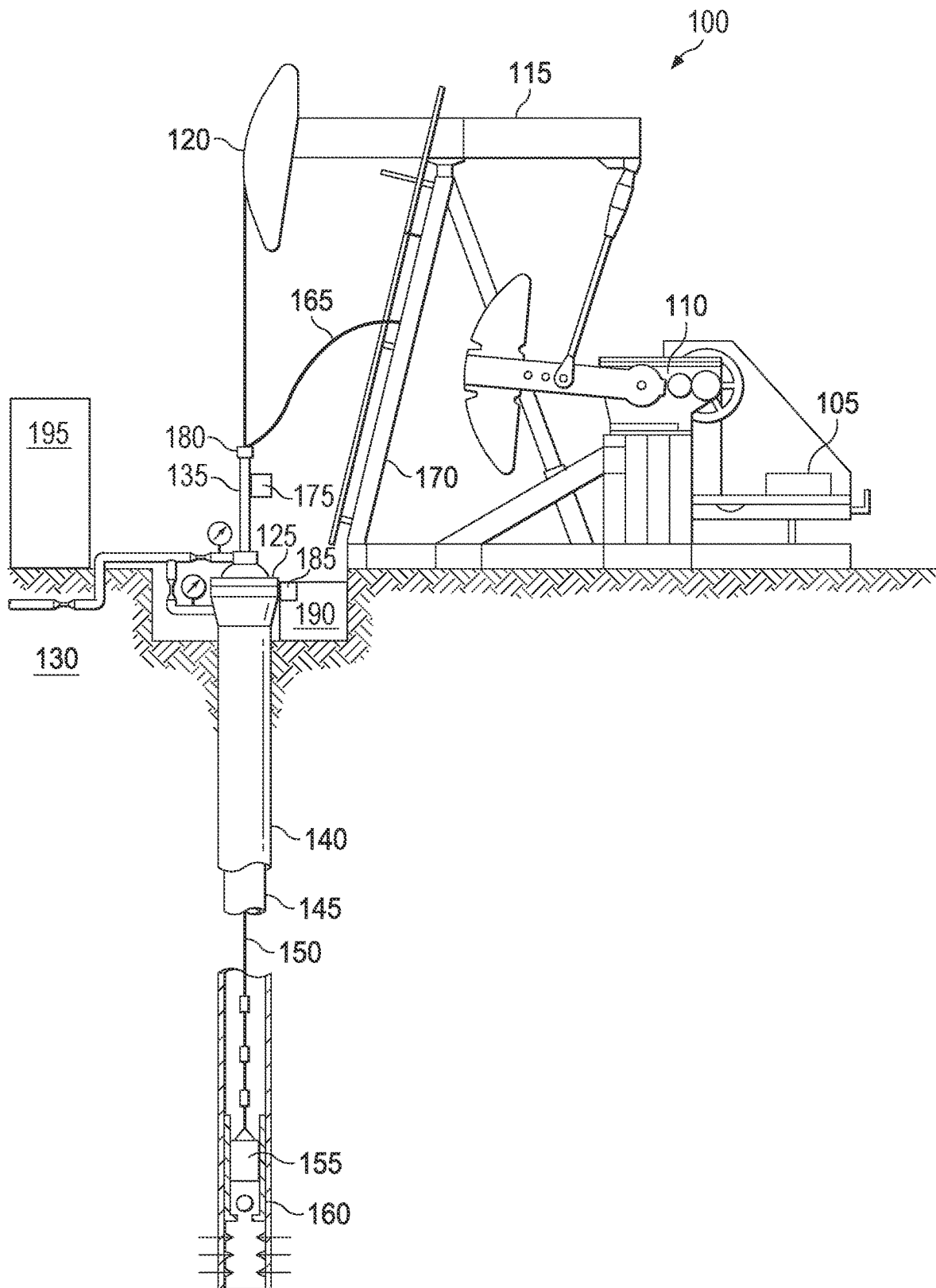


FIG. 1

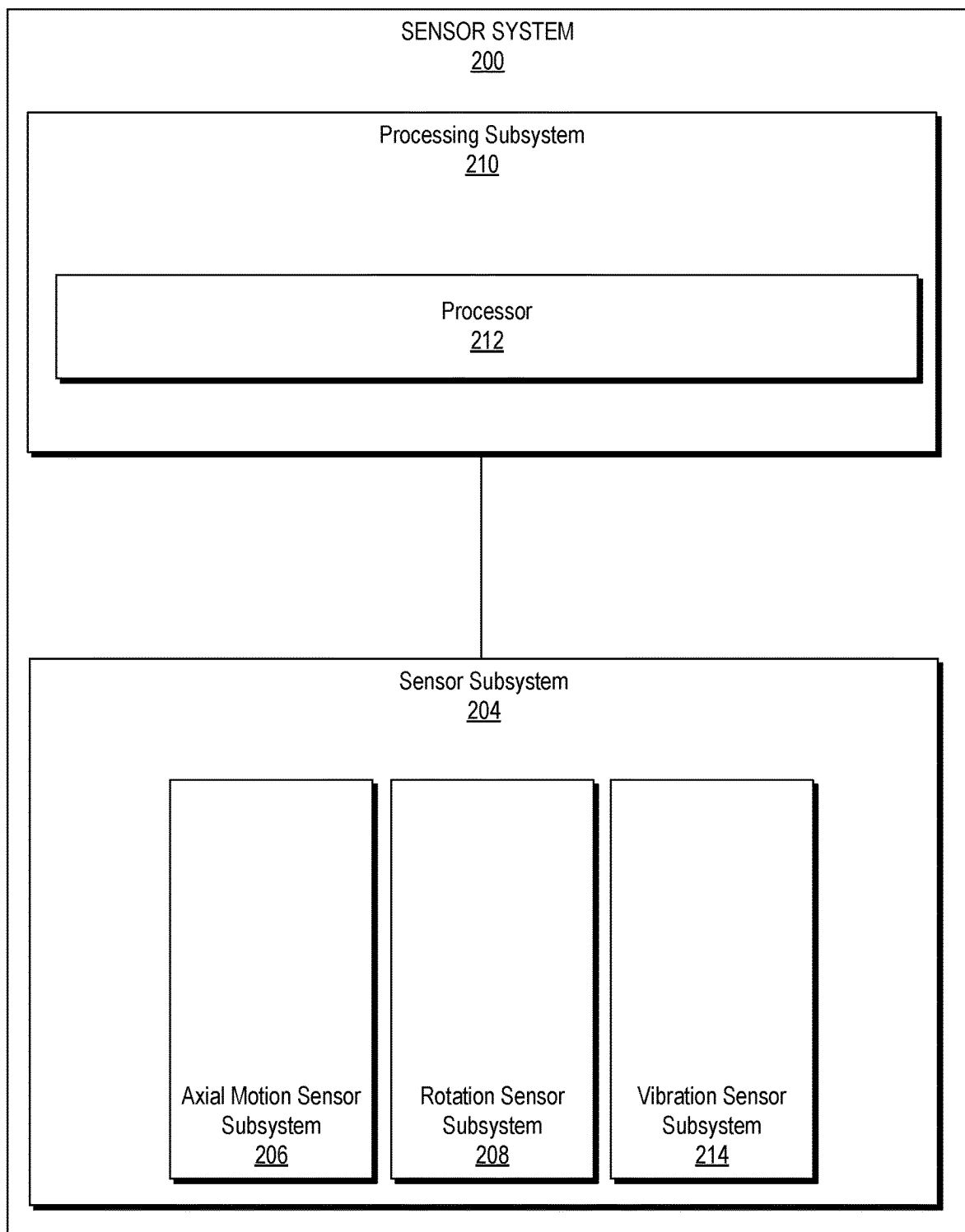


FIG. 2

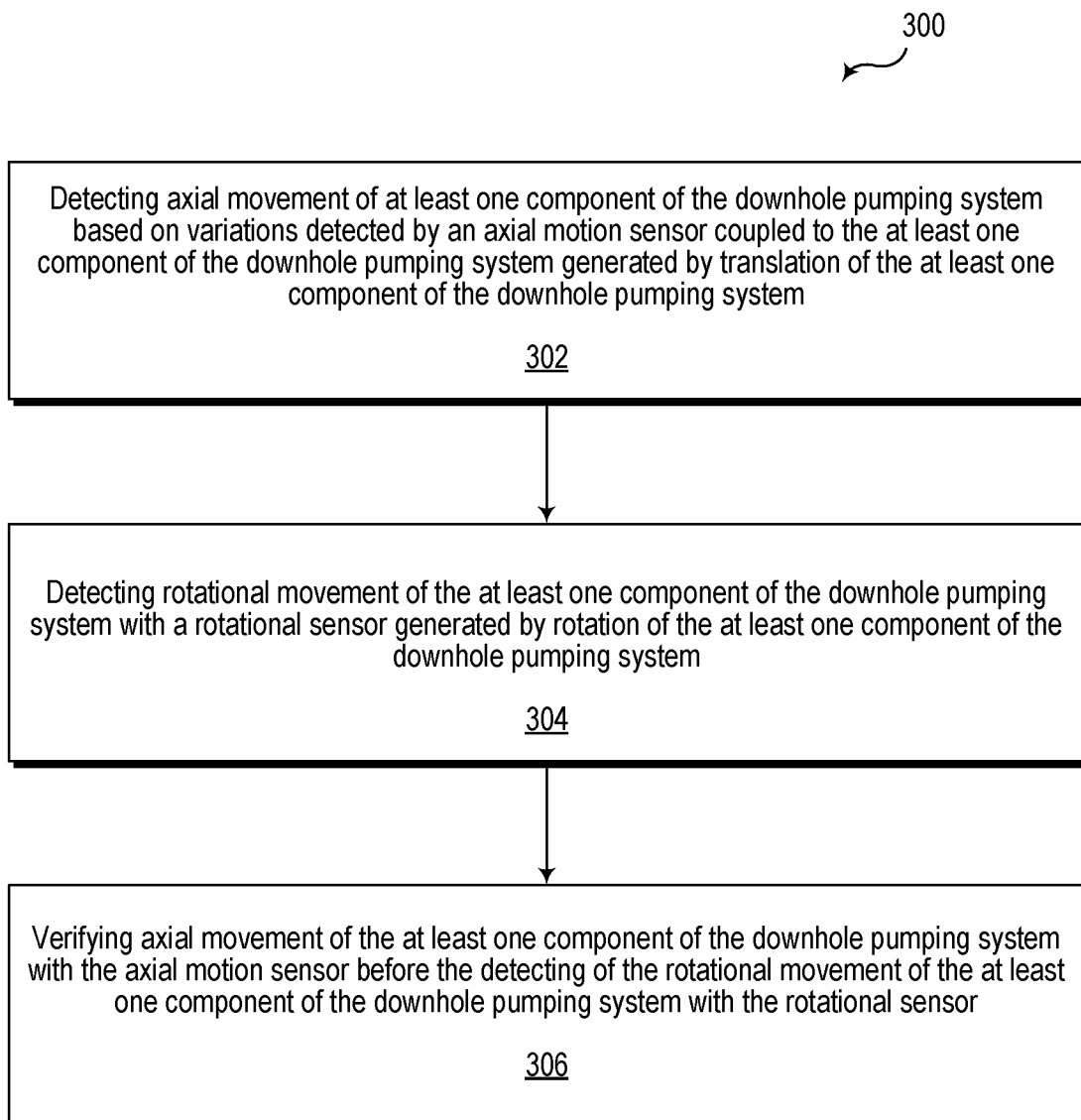


FIG. 3

1

DEVICES, SYSTEMS, AND METHODS FOR DETECTING THE ROTATION OF ONE OR MORE COMPONENTS FOR USE WITH A WELLBORE

TECHNICAL FIELD

The present disclosure relates to the detection of rotation of one or more components used in the production of fluid from a wellbore. More specifically, the present disclosure relates to the production of fluids from a wellbore using artificial lift and detecting the mechanical rotation of components during operation of a surface pumping unit and related assemblies, apparatuses, systems, and methods.

BACKGROUND

In a wellbore for the production of hydrocarbon fluids, a string of production tubing is run into the casing. The production tubing serves as a conduit for carrying production fluids to the surface. A packer is optionally set at a lower end of the production tubing to seal an annular area formed between the tubing and the surrounding strings of casing. In order to carry the hydrocarbon fluids to the surface, a pump may be placed at a lower end of the production tubing in order to produce the fluids through artificial lift. In some cases, oil wells undergoing artificial lift use a reciprocating plunger-type of pump. The pump has one or more valves that capture fluid on a downstroke, and then lift the fluid up on the upstroke through positive displacement.

Mechanically actuated downhole pumps generally build pressure to lift fluid to the surface. Reciprocal movement of the pump is induced by cycling a rod-string hung within the production tubing. The rod-string comprises a series of long, thin joints of steel bar that are threadedly connected through couplings. The rod-string is pivotally attached to a pumping unit at the surface. In response to movement of the pumping unit, the rod-string moves up and down within the production tubing to incrementally lift production fluids from a subsurface formation up to the surface.

The production of hydrocarbon fluids using a sucker rod pump creates friction and wear as the rods reciprocate up and down within the production tubing. Wellbore deviations and other factors may impart a side-load on the rod-string, resulting in friction and wear at deviation points. To mitigate this wear, it is desirable to rotate the rods during pumping to more evenly distribute wear along the circumference of the rods. This is accomplished by using a slow-moving gear, actuated through a ratchet mechanism by the stroking motion of the pumping unit.

Because the rotation is relatively very slow, it is difficult for the operator to visually observe rotation at the wellhead. For this reason, a failed rotation mechanism can go undetected for an extended period of time, sometimes weeks. A failed or otherwise ineffective rod rotator can result in premature failure due to uneven downhole rod or tubing wear. Further, adverse downhole conditions can prevent the rotational motion of the rotator from transferring torque to the rod string. Examples of such conditions include the presence of heavy crude, paraffin, or down-hole friction which may impede the fall of the rod string. This condition is known as rod float and can cause the polished rod clamp to briefly lift off the rod rotator table, losing the frictional contact and associated torque imparted on the rods. Additionally, dynamic conditions such as pump impact or fluid pound can cause the rotator and polished rod to briefly

2

separate and lose the imparted torque. These conditions are virtually impossible to identify from a brief, onsite observation as they are transient.

SUMMARY

Embodiments of the instant disclosure may be directed to a sensor system for a downhole pumping system. The sensor system including a sensor subsystem for detecting movement of at least one component of the downhole pumping system. The sensor subsystem including: an axial motion sensor subsystem including a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system; and a rotation sensor subsystem including a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system. The sensor system further including a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to: determine axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and determine rotational velocity of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational velocity values generated by the rotation of the at least one component of the downhole pumping system with the gyroscope.

In some aspects, embodiments described herein relate to a sensor system for a downhole pumping system. The sensor system including: a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem including: an axial motion sensor subsystem including an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to detect axial movement of the at least one component of the downhole pumping system based on variations detected by the axial motion sensor generated by movement of the at least one component of the downhole pumping system; and a rotation sensor subsystem including a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system. The sensor system further including a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to: verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem; and when the axial movement has been verified, determine rotational velocity of the at least one component of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

In some aspects, embodiments described herein relate to a sensor system for a downhole pumping system, The sensor system including: a sensor subsystem for detecting movement of a tubing rotator of the downhole pumping system,

3

the sensor subsystem including a rotation sensor subsystem including a rotational sensor, the rotational sensor to be coupled to the tubing rotator of the downhole pumping system and to detect rotational movement of the tubing rotator of the downhole pumping system by sampling rotational velocity values with the rotational sensor generated by rotation of the tubing rotator of the downhole pumping system. The sensor system further including a processor subsystem to receive data from the rotation sensor subsystem, the processor subsystem to determine rotational velocity of the tubing rotator of the downhole pumping system with the rotational velocity values detected by the rotation sensor subsystem.

In some aspects, embodiments described herein relate to a method of detecting motion of at least one component of a downhole pumping system. The method including: detecting axial movement of at least one component of the downhole pumping system based on variations detected by an axial motion sensor coupled to the at least one component of the downhole pumping system generated by translation of the at least one component of the downhole pumping system; detecting rotational movement of the at least one component of the downhole pumping system with a rotational sensor generated by rotation of the at least one component of the downhole pumping system; and verifying axial movement of the at least one component of the downhole pumping system with the axial motion sensor before the detecting of the rotational movement of the at least one component of the downhole pumping system with the rotational sensor.

Features from any of the above-mentioned embodiments may be used in combination with one another in accordance with the general principles described herein. These and other embodiments, features, and advantages will be more fully understood upon reading the following detailed description in conjunction with the accompanying drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate a number of exemplary embodiments and are a part of the specification. Together with the following description, these drawings demonstrate and explain various principles of the instant disclosure.

FIG. 1 is an elevational view of a pumping system according to embodiments of the disclosure.

FIG. 2 illustrates a simplified representation of a sensor system for use in a pumping system to perform a plurality of functions in accordance with embodiments of the present disclosure.

FIG. 3 illustrates a flow chart of a method of detecting motion of at least one component of the downhole pumping system in accordance with embodiments of the present disclosure.

DETAILED DESCRIPTION

In the following detailed description, reference is made to the accompanying drawings, which form a part hereof, and in which are shown, by way of illustration, specific example embodiments in which the present disclosure may be practiced. These embodiments are described in sufficient detail to enable a person of ordinary skill in the art to practice the present disclosure. However, other embodiments may be utilized, and structural, material, and process changes may be made without departing from the scope of the disclosure. The illustrations presented herein are not meant to be actual

4

views of any particular method, system, device, or structure, but are merely idealized representations that are employed to describe the embodiments of the present disclosure. The drawings presented herein are not necessarily drawn to scale. Similar structures or components in the various drawings may retain the same or similar numbering for the convenience of the reader; however, the similarity in numbering does not mean that the structures or components are necessarily identical in size, composition, configuration, or any other property.

It will be readily understood that the components of the embodiments as generally described herein and illustrated in the drawings could be arranged and designed in a wide variety of different configurations. Thus, the following description of various embodiments is not intended to limit the scope of the present disclosure, but is merely representative of various embodiments. While the various aspects of the embodiments may be presented in drawings, the drawings are not necessarily drawn to scale unless specifically indicated.

Furthermore, specific implementations shown and described are only examples and should not be construed as the only way to implement the present disclosure unless specified otherwise herein. Elements, circuits, and functions may be shown in block diagram form in order not to obscure the present disclosure in unnecessary detail. Conversely, specific implementations shown and described are exemplary only and should not be construed as the only way to implement the present disclosure unless specified otherwise herein. Additionally, block definitions and partitioning of logic between various blocks is exemplary of a specific implementation. It will be readily apparent to one of ordinary skill in the art that the present disclosure may be practiced by numerous other partitioning solutions. For the most part, details concerning timing considerations and the like have been omitted where such details are not necessary to obtain a complete understanding of the present disclosure and are within the abilities of persons of ordinary skill in the relevant art.

Those of ordinary skill in the art would understand that information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, sensors, and chips that may be referenced throughout this description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof. Some drawings may illustrate signals as a single signal for clarity of presentation and description. It will be understood by a person of ordinary skill in the art that the signal may represent a bus of signals, wherein the bus may have a variety of bit widths and the present disclosure may be implemented on any number of data signals including a single data signal.

The various illustrative logical blocks, modules, and circuits described in connection with the embodiments disclosed herein may be implemented or performed with a general purpose processor, a special purpose processor, a Digital Signal Processor (DSP), an Application Specific Integrated Circuit (ASIC), a Field Programmable Gate Array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a com-

5

combination of computing devices, such as a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. A general-purpose computer including a processor is considered a special-purpose computer while the general-purpose computer is configured to execute computing instructions (e.g., software code) related to embodiments of the present disclosure.

Also, it is noted that the embodiments may be described in terms of a process that is depicted as a flowchart, a flow diagram, a structure diagram, or a block diagram. Although a flowchart may describe operational acts as a sequential process, many of these acts can be performed in another sequence, in parallel, or substantially concurrently. In addition, the order of the acts may be rearranged. A process may correspond to a method, a thread, a function, a procedure, a subroutine, a subprogram, etc. Furthermore, the methods disclosed herein may be implemented in hardware, software, or both. If implemented in software, the functions may be stored or transmitted as one or more instructions or code on computer-readable media. Computer-readable media includes both computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another.

Several aspects of the embodiments disclosed herein may be implemented as software modules or components. As used herein, a software module or component may include any type of computer instruction or computer-executable code located within a memory device that is operable in conjunction with appropriate hardware to implement the programmed instructions. A software module or component may, for instance, comprise one or more physical or logical blocks of computer instructions, which may be organized as a routine, program, object, component, data structure, etc., that performs one or more tasks or implements particular abstract data types.

In certain embodiments, a particular software module or component may comprise disparate instructions stored in different locations of a memory device, which together implement the described functionality of the module. Indeed, a module or component may comprise a single instruction or many instructions, and may be distributed over several different code segments, among different programs, and across several memory devices. Some embodiments may be practiced in a distributed computing environment where tasks are performed by a remote processing device linked through a communications network. In a distributed computing environment, software modules or components may be located in local and/or remote memory storage devices. In addition, data being tied or rendered together in a database record may be resident in the same memory device, or across several memory devices, and may be linked together in fields of a record in a database across a network.

Embodiments may be provided as a computer program product including a non-transitory machine-readable medium having stored thereon instructions that may be used to program a computer or other electronic device to perform processes described herein. The non-transitory machine-readable medium may include, but is not limited to, hard drives, floppy diskettes, optical disks, CD-ROMs, DVD-ROMs, ROMs, RAMs, EPROMs, EEPROMs, magnetic or optical cards, solid-state memory devices, or other types of media/machine-readable media suitable for storing electronic instructions.

As used herein, relational terms, such as "first," "second," "top," "bottom," etc., are generally used for clarity and

6

convenience in understanding the disclosure and accompanying drawings and do not connote or depend on any specific preference, orientation, or order, except where the context clearly indicates otherwise.

As used herein, the term "and/or" means and includes any and all combinations of one or more of the associated listed items.

As used herein, the terms "vertical," "lateral," and "radial" refer to the orientations as depicted in the figures.

Embodiments of the disclosure may include systems including one or more remote wireless sensors (e.g., an array of sensors) that are implemented near a wellhead involved in the production of fluid (e.g., hydrocarbon) from a wellbore. Such sensors may provide enhancements in detecting and preventing failures during the production of the fluid. For example, a rod rotator sensor may be used to detect when the rod rotator is not functioning properly. Rod rotators that fail to operate lead to premature failures of rods and tubing. A wireless sensor may be installed on the rod string above the rod clamp and/or below a carrier bar. The sensor may include a rotational sensor (e.g., a gyroscope) to measure rotational velocity and a magnetometer to measure axial movement in order to provide detection of proper rotation of the rods. This detected data may be reported back through the point of connection at the wellhead and displayed in associated local or remote software for use and reference for an operator.

In some embodiments, the sensors may be used to detect rod string vibration. Such vibration detection may be used to detect fluid pound/tagging, high friction, and/or other rod motion anomalies. By tracking accurate rod position, along with the addition of a force sensor, such as a load cell, may provide a full load/position sensor. During operation, the rods generally exhibit vibrational motion as the rods slide up and down within the tubing. This vibration is amplified by excessive friction, obstruction, plunger hitting fluid on the downstroke, and/or other potential failures in the pumping system. By establishing a vibrational baseline during the stroke of a unit under normal circumstances, deviation from this baseline may be monitored and reported to prompt investigation into the cause of this deviation from baseline. The vibrational baseline may be derived from the sensor (e.g., an accelerometer) in three axes during the stroke of the pumping unit. A configurable limit may be established to alert the operator when the current vibrations exceed this limit.

In some embodiments, sensors (e.g., accelerometer and/or vibration sensor) may be used with other components of the pumping unit system to facilitate early detection of equipment failure, such as, for example, beams, gearboxes, and/or other components.

For example, the sensors may be implemented with a tubing rotator, which serves to reduce wear in the tubing, similar to how a rod rotator reduces wear in the rods. Tubing rotators are mechanical devices that are prone to failure where a sensor may report back the proper functioning of the rotator. In some embodiments, the tubing rotator sensor may use similar or the same components as the rod rotator sensor. However, as the orientation of the rotating shaft is horizontal (e.g., substantially parallel to the surface of the Earth on which the pumping system is positioned), the gyro axis may be aligned to a different plane. In some embodiments, the tubing rotator sensor may use an accelerometer to measure the tilt of the sensor as it rotates about the horizontal axis.

The present disclosure relates, in some embodiments, to gear rod systems used in a reciprocating sucker rod pumping systems (e.g., pumping system 100) that transport oil from

oil wells. Such sucker rod pumping systems **100** may function on the positive displacement principle used by cylinder and piston pumps. FIG. **1** illustrates the basic components of a sucker rod pumping system **100**. As shown in FIG. **1**, the basic sucker rod pumping system **100** components include a motor base **105**, a gearbox **110**, a walking beam **115**, a horsehead **120**, a wellhead **125**, a flowline **130**, a polished rod **135**, a casing **140**, a tubing **145**, a rod string **150**, a plunger **155**, cable **165**, Samson beam **170**, and a barrel **160**.

The motor base **105** provides the driving power to the system **100** and can be an electric motor or a gas engine. The gearbox **110** reduces the high rotational speed of the motor base **105** into the reciprocating motion required to operate the downhole pump. The main element of the gearbox **110**, the walking beam **115**, functions as a mechanical lever that adjusts the position of the horsehead **120** that is connected to the polished rod **135**. The Samson beam **170** serves as a vertical stabilizing leg to hold up the horsehead **120** and the walking beam **115**. The Samson beam **170** can be connected through a cable **165** to the polished rod. The horsehead **120** translates the rotational motion from the motor base **105** into the reciprocating motion of the polished rod **135**, which reciprocates through the wellhead **125** and into the oil well. At the end of the polished rod **135** or a string of sucker rods is the plunger **155** that is the main mechanical driver of fluid out of the oil well. Around the polished rod **135** and within the oil well is a casing **140** that surrounds tubing **145**. Together, the casing **140** and tubing **145** form a casing-tubing annulus that surrounds the sub-surface pump system components. Sucker rod string **150**, composed of sucker rods, runs inside the tubing string of the well and provides the mechanical link between the surface drive and the subsurface pump. The pump barrel **160** or working barrel is the stationary part of the subsurface pump that serves as a stopping point for the plunger **155**. The barrel **160** generally contains a standing valve that acts together with the plunger **155** as a suction valve through which well fluids enter the pump barrel during an upstroke.

As discussed above, as the sucker rod string **150** reciprocates (e.g., translates) within the well, the sucker rod string **150** may asymmetrically wear through rod-on-tubing friction. This friction may increase in cases with crooked wells, cases with fluid or gas over-pressurization, and situations where there is tubing or rod buckling. To help minimize this uneven wear, the gradual rotation of the polished rod and/or the tubing in which the rod is translated is used to balance the wear may be implemented to substantially increase their operating life.

In order to monitor the rotation of one or more components of the pumping system **100** (e.g., the polished rod **135** and/or the tubing **145**), a sensor system may be used. For example, a rod sensor **175** may be secured to a movable portion of the pumping system **100** (e.g., the polished rod **135**). The rod sensor **175** may monitor the rotation of the polished rod **135** about an axis along which the polished rod **135** extends into the wellbore (e.g., about the longitudinal axis of the polished rod **135**) as a rod rotator **180** gradually rotates the polished rod **135** during strokes of the sucker rod string **150**. In some embodiments, the rod rotator **180** may be similar to those disclosed in U.S. Patent Application Publication No. US 2020/0340309 A1, the disclosure of which is incorporated herein, in its entirety, by this reference.

In additional embodiments, a tubing sensor **185** may be coupled to a portion of a tubing rotator **190**. As discussed above, the tubing rotator **190** may rotate the tubing **145** in

order to spread wear caused by the translation of the polished rod **135** and the sucker rod string **150** over the inner surface of the tubing **145**. In some embodiments, the tubing rotator **190** may include a worm drive the interaction with a worm wheel coupled to the tubing **145**. The tubing sensor **185** may be coupled to a portion of the worm drive of the tubing rotator **190** in order to monitor the rotation of the tubing rotator **190** directly. The tubing sensor **185** may monitor the rotation of the tubing rotator **190** (e.g., the worm drive) about an axis that extends along a surface of the Earth on which the pumping system **100** is positioned. For example, the rotational path of the tubing sensor **185** may extend in a direction (e.g., lie in a plane) that is substantially perpendicular to a surface upon which the downhole pumping system **100** is positioned.

In additional embodiments, the tubing sensor **185** may be coupled to a portion of the tubing **145** in order to directly monitor the rotation of the tubing **145**.

The sensor system may include a base unit **195** (e.g., a stationary point of connection) that communicates (e.g., wirelessly communicates via radio waves without the use of an electrical conductor between two or more components) with one or more of the sensors (e.g., the rod sensor **175** and/or tubing sensor **185**) of the sensor system coupled to movable components of the pumping system **100**. The base unit **195** may be in communication with additional systems, such as, operational systems of the overall pumping system **100**. For example, an operator of the pumping system **100** may receive data from the wireless the rod sensor **175** and/or tubing sensor **185** via the base unit **195** as the movable wireless sensors **175**, **185** provide data relating to the operation of the components on which the wireless sensors **175**, **185** are mounted.

FIG. **2** illustrates a simplified representation of a sensor system **200** for use in a pumping system (e.g., the pumping system **100** shown in FIG. **1**). As shown in FIGS. **1** and **2**, the sensor system **200** may include a sensor subsystem **204** for detecting movement of at least one component of the downhole pumping system **100**. In some embodiments, the rod sensor **175** and/or tubing sensor **185** may each include such a sensor subsystem **204**. The sensor subsystem **204** may include sensors for sensing various types of motion of the components of the downhole pumping system **100** as discussed below. In some embodiments, the sensor subsystem **204** may include sensors that are self-calibrating, wireless, and/or independently powered (e.g., battery-powered). In some embodiments, these sensors or others sensors may measure conductivity, temperature, humidity, acoustics, load, etc.

The sensor subsystem **204** may include an axial motion sensor subsystem **206** including one or more sensors for detecting linear movement (e.g., a magnetometer, a capacitive sensor, a Hall effect sensor, an optical sensor, etc.). For example, the axial motion sensor subsystem **206**, which may be contained in the sensors **175**, **185** may be coupled to one or more components (e.g., the polished rod **135**) of the downhole pumping system **100** to detect axial movement of the polished rod **135** of the downhole pumping system **100**. In embodiments where the axial motion sensor subsystem **206** includes a magnetometer, the axial motion of the polished rod **135** may be monitored based on variations in a magnetic field detected by the magnetometer generated by movement of the polished rod **135** of the downhole pumping system **100**. For example, the magnetic field surrounding the polished rod **135** and the nearby metallic structures (e.g., the wellhead **125**) may provide a sinusoidal-type waveform in the magnetometer that can be monitored to determine when

the polished rod **135** changes axial (e.g., vertical) direction (e.g., during an up and down stroke of the polished rod **135**).

The sensor subsystem **204** may include a rotation sensor subsystem **208** including a sensor for determining rotational motion or a component thereof (e.g., a gyroscope, an accelerometer, etc.). The rotation sensor subsystem **208** may be coupled to one or more components (e.g., the polished rod **135** and/or the tubing rotator **190**) of the downhole pumping system **100** to detect rotational movement of the polished rod **135** and/or the tubing rotator **190** of the downhole pumping system **100**. For example, the rotation sensor subsystem **208** may be used to determine rotational velocity (e.g., by the sampling of rotational velocity values) generated by rotation of the polished rod **135** and/or the tubing rotator **190** of the downhole pumping system **100**. In some embodiments, the rotation sensor subsystem **208** may comprise a gyroscope that monitors movement of the components of the downhole pumping system **100** in multiple degrees of freedom (e.g., nine degrees of freedom).

The sensor system **200** may include a processor subsystem **210** to receive data from the sensor subsystem **204** (e.g., the axial motion sensor subsystem **206** and/or the rotation sensor subsystem **208**). The processor subsystem **210** may include one or more processors **212** for processing the data. In some embodiments, the processor subsystem **210** may be part of (e.g., physically located with) the movable sensors **175**, **185**, may be part of (e.g., physically located with) the base unit **195**, or may be part of both the movable sensors **175**, **185** and the base unit **195**.

The processor subsystem **210** may determine axial movement of the polished rod **135** and/or the tubing rotator **190** of the downhole pumping system **100** with data from the axial motion sensor subsystem **204**. The processor subsystem **210** may determine rotational velocity of the polished rod **135** and/or the tubing rotator **190** of the downhole pumping system **100** with data from the rotation sensor subsystem **208**.

In some embodiments, data from the axial motion sensor subsystem **206** and the rotation sensor subsystem **208** may be used together (e.g., interrelated) to determine a condition of the downhole pumping system **100**. For example, the processor subsystem **210** may use data from the axial motion sensor subsystem **206** to determine a direction change in the polished rod **135** (e.g., to determine when one part of a stroke of the polished rod **135** has been completed and/or to determine that a new stroke is beginning). Once the change in direction is noted, the angular velocity data detected the rotation sensor subsystem **208** may be sampled at relatively high frequency (e.g., 10 to 10,000 samples per second) to measure rotational velocity of the polished rod **135**. When a second direction change of the polished rod **135** is determined, the sampling is continued. When the third direction change is noted (e.g., noting the completion of a complete up and down stroke), the sampling may be ceased.

In some embodiments, the sensor system **200** may only selectively detect the motion of the downhole pumping system **100** (e.g., in order to conserve battery life of the sensor system **200**). The sensor system **200** may generally reside in a standby or sleep mode while only waking occasionally to detect movement of the downhole pumping system **100**. For example, the sensor system **200** may selectively (e.g., periodically, based on an event, etc.) wake to detect the motion of the polished rod **135** during an entire stroke. Once the stroke is completed, the sensor system **200** may return to a sleep or standby mode.

The processor subsystem **210** may sum both positive and negative angular velocity measurements during the com-

pleted stroke to determine (e.g., to approximate) the overall net rotation of the polished rod **135** during the completed stroke. In some embodiments, the processor subsystem **210** may convert the overall net rotation to degrees of rotation per minute of the polished rod **135**. If the angular velocity calculation yields a value above a preselected limit (e.g., a minimum amount of expected rotation), then confirmation of rotation may be indicted by the processor subsystem **210**. Otherwise, rotation a failure in rotation may be noted. As noted above, similar monitoring and calculation may be utilized when monitoring rotation of the tubing rotator **190** and/or tubing **145** itself.

In such embodiments, verifying that the polished rod **135** is being moved (e.g., translated) by the downhole pumping system **100** may be useful to determine that the rod rotator **180** has actually failed to operate. For example, the sensor system **200** may continue to sample angular velocity only if it is determined that axial motion exists (e.g., with the axial motion sensor subsystem **206**). Otherwise, the sensor system **200** may recognize no angular velocity or angular velocity under a certain threshold and incorrectly report that rod rotation has ceased when the polished rod **135** is not actually moving in the axial direction. The magnetic change near the axial motion sensor subsystem **206** will be substantially zero when there is no vertical motion of the polished rod **135**. If little to no changes are noted in magnetic fields with the axial motion sensor subsystem **206**, the sampling of the angular velocity may be aborted or discontinued when no vertical motion is reported.

In some embodiments, through the monitoring and reporting of the angular velocity, the number of rotations of the polished rod **135** during a selected period of time may be determined and used to evaluate the operation of the rod rotator **180**. Components of the rod rotator **180** may degrade in performance over time, which often manifests in reduced velocity and reduced rotation over time. A reduced velocity of the rod rotator **180** may indicate an improper installation of the rod rotator **180**, where a full stroke of the rotation mechanism of the rod rotator **180** may not be adequately occurring because of the installation orientation.

As noted above, velocity data the from rotation sensor subsystem **208** may be used to determine that the rod rotator **180** or other component is not properly rotating and/or may also be used to monitor for changes in the velocity data from a baseline or threshold amount and/or changes over time. For example, a detected decrease in velocity and/or one or more detected velocities that are below a selected threshold may be detected by the sensor system **200**. Such data may be used to determine a performance characteristic of the downhole pumping system **100**, such as, for example, if the rod rotator **180** is underperforming and/or showing signs of impending failure.

In some embodiments, the data from the axial motion sensor subsystem **206** may be used to determine the stroke period of the polished rod **135**. Such a determination may be used to detect a condition of the well, for example, to detect a pumped-off condition.

In some embodiments, data from the rotation sensor subsystem **208** may be used to detect bridle oscillations caused by a fluid pound condition. The determination of the fluid pound condition may then be used to estimate the amount of pump fillage in the pumping operation.

In some embodiments, the sensor system **200** may include a vibration sensor subsystem **214** (e.g., load sensors, strain gauges, magnet sensors, accelerometers, gyroscopes, etc.) used to detect rod string vibration or vibration in other components of the downhole pumping system **100**. As noted

11

above, such vibration may be used to detect fluid pound/tagging, high friction, and/or other rod motion anomalies. The processor subsystem **210** may be used to establish a vibrational baseline during the stroke of the polished rod **135** under normal operational conditions. Detected deviation from this baseline may be monitored and reported to an operator of the downhole pumping system **100**. In some embodiments, the vibrational baseline may be derived from the vibration sensor subsystem **214** in more than one axis (e.g., three axes) during the stroke of the downhole pumping system **100**. A configurable limit may be established to alert the operator when the current vibrations exceed such a limit.

FIG. 3 illustrates a flow chart of a method **300** of detecting motion of one or more components of the downhole pumping system (e.g., the polished rod **135** and/or the tubing **145** of the downhole pumping system **100** of FIG. 1). As shown in FIG. 3, and with further reference to FIG. 1, at act **302**, axial motion of the component (e.g., the polished rod **135**) may be detected based on variations detected by an axial motion sensor (e.g., rod sensor **175**) coupled to the polished rod **135** of the downhole pumping system **100** generated by translation of the polished rod **135**. At act **304**, rotational movement of the (e.g., the polished rod **135** and/or the tubing **145**) may be detected with a rotational sensor (e.g., the rod sensor **175** and/or tubing sensor **185**) generated by rotation of the polished rod **135** and/or the tubing **145**. At act **306**, axial movement of the polished rod **135** may be verified with the rod sensor **175** before detecting (e.g., beginning to detect and/or continuing to detect) the rotational movement of the polished rod **135** and/or the tubing **145** with the rod sensor **175** and/or tubing sensor **185**.

Terms of degree (e.g., “about,” “substantially,” “generally,” etc.) indicate structurally or functionally insignificant variations, such as within acceptable manufacturing tolerances. In an example, when the term of degree is included with a term indicating quantity, the term of degree is interpreted to mean $\pm 10\%$, $\pm 5\%$, or $\pm 2\%$ of the term indicating quantity. In an example, when the term of degree is used to modify a shape, the term of degree indicates that the shape being modified by the term of degree has the appearance of the disclosed shape. For instance, the term of degree may be used to indicate that the shape may have rounded corners instead of sharp corners, curved edges instead of straight edges, one or more protrusions extending therefrom, is oblong, is the same as the disclosed shape, et cetera.

While the present disclosure has been described herein with respect to certain illustrated embodiments, those of ordinary skill in the art will recognize and appreciate that it is not so limited. Rather, many additions, deletions, and modifications to the illustrated embodiments may be made without departing from the scope of the disclosure as hereinafter claimed, including legal equivalents thereof. Further, the words “including,” “having,” and variants thereof (e.g., “includes” and “has”) as used herein, including the claims, shall be open-ended and have the same meaning as the word “comprising” and variants thereof (e.g., “comprise” and “comprises”). In addition, features from one embodiment may be combined with features of another embodiment while still being encompassed within the scope of the disclosure as contemplated by the inventors.

What is claimed is:

1. A sensor system for a downhole pumping system, comprising:

a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising:

12

an axial motion sensor subsystem comprising a magnetometer, the magnetometer to be coupled to the at least one component of the downhole pumping system and to measure axial movement of the at least one component of the downhole pumping system based on variations in a magnet field detected by the magnetometer generated by movement of the at least one component of the downhole pumping system;

a rotation sensor subsystem comprising a gyroscope, the gyroscope to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by detecting rotational velocity values with the gyroscope generated by rotation of the at least one component of the downhole pumping system; and

a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes; and

a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:

detect axial movement of the at least one component of the downhole pumping system with the magnetometer of the axial motion sensor subsystem, the detecting axial movement comprising:

sensing a direction change in the at least one component of the downhole pumping system to determine when a stroke of the at least one component of the downhole pumping system has been completed and to determine that a new stroke is beginning; and

after the direction change in the at least one component of the downhole pumping system has been detected, begin to determine rotation of the at least one component of the downhole pumping system with the rotation sensor subsystem by sampling rotational values generated by the rotation of the at least one component of the downhole pumping system, the determining the rotational values of the at least one component of the downhole pumping system comprising:

continuing sampling the rotational values through a second direction change of the at least one component of the downhole pumping system; and
ceasing sampling the rotational values at a third direction change of the at least one component of the downhole pumping system.

2. The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore.

3. The sensor system of claim 2, wherein the processor subsystem is configured to verify the axial movement and the direction change of the at least one rod before determining the rotation.

4. The sensor system of claim 2, wherein the processor subsystem is configured to determine the direction change of the at least one rod to indicate that a previous stroke has been completed and that a new stroke is beginning.

5. The sensor system of claim 4, wherein the processor subsystem is configured to begin sampling the rotational values comprising rotational velocity after determining the direction change of the at least one rod.

13

6. The sensor system of claim 1, wherein the processor subsystem is configured receive the rotational values from only a gyroscope.

7. The sensor system of claim 1, wherein the processor subsystem is configured to compare the sampled rotational values with previously sampled rotational values detected by the rotation sensor subsystem during a previous stroke of the downhole pumping system to determine if rotation of the at least one component of the downhole pumping system has occurred.

8. The sensor system of claim 1, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising a tubing rotator of the downhole pumping system.

9. The sensor system of claim 8, wherein the sensor subsystem is configured to detect rotation of the tubing rotator while detecting axial movement of a polished of the downhole pumping system.

10. The sensor system of claim 1, wherein the processor subsystem is configured to determine the rotational values of the at least one component of the downhole pumping system by summing both positive and negative samples of the rotational values sensed by the rotation sensor subsystem.

11. The sensor system of claim 10, wherein the processor subsystem is configured to compare the determined rotational values of the at least one component of the downhole pumping system with an expected amount of rotational values to determine a failure in the rotation of the at least one component of the downhole pumping system.

12. The sensor system of claim 1, further comprising a vibration sensor subsystem for monitoring vibration of the at least one component of the downhole pumping system in three axes over a vibrational baseline.

13. A sensor system for a downhole pumping system, comprising:

a sensor subsystem for detecting movement of at least one component of the downhole pumping system, the sensor subsystem comprising:

an axial motion sensor subsystem comprising an axial motion sensor, the axial motion sensor to be coupled to the at least one component of the downhole pumping system and to measure axial movement of the at least one component of the downhole pumping system based on variations detected by the axial motion sensor generated by movement of the at least one component of the downhole pumping system; and

a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the at least one component of the downhole pumping system and to detect rotational movement of the at least one component of the downhole pumping system by sampling rotational values with the rotational sensor generated by rotation of the at least one component of the downhole pumping system; and

a processor subsystem to receive data from the axial motion sensor subsystem and the rotation sensor subsystem, the processor subsystem to:

verify the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem;

when the axial movement has been verified, detecting the rotational values with the rotation sensor subsystem during a current stroke of the downhole pumping system; and

comparing the rotational values with previously sensed rotational values detected by the rotation sensor

14

subsystem during a previous stroke of the downhole pumping system to determine if rotation of the at least one component of the downhole pumping system has occurred.

14. The sensor system of claim 13, wherein the axial motion sensor subsystem comprises a magnetometer and the rotation sensor subsystem comprises a gyroscope.

15. The sensor system of claim 14, wherein the sensor subsystem is configured to detect movement of the at least one component of the downhole pumping system comprising at least one rod of the downhole pumping system extending from a surface location into a wellbore, and wherein the processor subsystem is configured to continue sampling the rotational values of the at least one rod over a stroke of the at least one rod.

16. A sensor system for a downhole pumping system, comprising:

an axial motion sensor subsystem comprising a magnetometer to measure axial movement of at least one component of the downhole pumping system and to determine a change in axial direction of the at least one component of the downhole pumping system;

a sensor subsystem for detecting movement of a tubing rotator of the downhole pumping system, the sensor subsystem comprising a rotation sensor subsystem comprising a rotational sensor, the rotational sensor to be coupled to the tubing rotator of the downhole pumping system and to detect rotational movement of the tubing rotator of the downhole pumping system by sampling rotational values with the rotational sensor generated by rotation of the tubing rotator of the downhole pumping system; and

a processor subsystem to receive data from the rotation sensor subsystem, the processor subsystem to determine rotation of the tubing rotator of the downhole pumping system with the rotational values detected by the rotation sensor subsystem, the processor subsystem configured to:

detect the axial movement of the at least one component of the downhole pumping system with the axial motion sensor subsystem;

when the axial movement of the at least one component is detected, begin detecting the rotational movement of the tubing rotator of the downhole pumping system with the rotational sensor;

continue detecting the rotational movement of the tubing rotator of the downhole pumping system through a second direction change of the at least one component of the downhole pumping system; and

cease detecting the rotational movement of the tubing rotator of the downhole pumping system after a third direction change of the at least one component of the downhole pumping system.

17. The sensor system of claim 16, wherein the rotation sensor subsystem comprises at least one of a gyroscope or an accelerometer.

18. The sensor system of claim 16, wherein the rotation sensor subsystem is configured to monitor the rotation of the tubing rotator along a path that extends in a direction substantially perpendicular to a surface upon which the downhole pumping system is positioned.

19. A method of detecting motion of at least one component of a downhole pumping system, the method comprising:

determining a first change in axial direction of at least one component of the downhole pumping system based on magnetic variations detected by an axial motion sensor

15

coupled to the at least one component of the downhole
pumping system generated by translation of the at least
one component of the downhole pumping system;
when detecting no change in the axial direction, ceasing
any sensing of rotation movement; 5
when verifying the first change in the axial direction:
begin detecting rotational movement of the at least one
component of the downhole pumping system with a
rotational sensor generated by rotation of the at least
one component of the downhole pumping system; 10
continuing detecting the rotational movement of the at
least one component of the downhole pumping sys-
tem through a second direction change of the at least
one component of the downhole pumping system;
and 15
ceasing detecting the rotational movement of the at
least one component of the downhole pumping sys-
tem after a third direction change of the at least one
component of the downhole pumping system.

20. The method of claim **19**, further comprising compar- 20
ing a rotational velocity detected with the rotational sensor
with a threshold value to determine a performance charac-
teristic of the at least one component of the downhole
pumping system.

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25

16



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/549,519	12/13/2021	Terry Treiberg	CHX.1002US	4428
184959	7590	11/04/2025		
ChampionX/BKRIP			EXAMINER	
1240B E Stringham Ave #1027			SINGLETON, MICHAEL J	
SALT LAKE CITY, UT 84106				
			ART UNIT	PAPER NUMBER
			2863	
			NOTIFICATION DATE	DELIVERY MODE
			11/04/2025	ELECTRONIC

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APPLICATION NO.	ISSUE DATE	PATENT NO.
17/549,519	04-Nov-2025	12460537

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