Doc Code: MFEE.C.AD
Document Description: Maintenance Fee Address Change

PTO/AIA/47 (11-18)
Approved for use through 09/30/2021. OMB 0651-0016
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no person is required to respond to a collection of information unless it displays a valid OMB control number.

"FEE ADDRESS" INDICATION FORM

Address to:
Mail Stop M Correspondence
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

-OR-

Fax to:
571-273-6500

INSTRUCTIONS: The issue fee must have been paid for the application(s) listed on this form. In addition, only an address represented by a Customer Number can be established as the fee address for maintenance fee purposes (hereafter, fee address). A fee address should be established when correspondence related to maintenance fees should be mailed to a different address than the correspondence address for the application.

When to check the first box below: If you have a Customer Number to represent the fee address.

When to check the second box below: If you have no Customer Number representing the desired fee address, in which case a completed Request for Customer Number (PTO/SB/125) must be attached to this form. For more information on Customer Numbers, see the Manual of Patent Examining Procedure (MPEP) § 403.

For the following listed application(s), please recognize as the "Fee Address" under the provisions of 37 CFR 1.363 the address associated with:

☑ Customer Number: 197

OR

☐ The attached Request for Customer Number form (PTO/SB/125)

PATENT NUMBER (if known)	APPLICATION NUMBER
10,598,258	16/210,807

Completed by (check one):

☐ Applicant/Inventor

☑ Attorney or Agent of record 60506 (Reg. No.)

☐ Assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(c) (Form PTO/AIA/96) is enclosed or was filed on _____ (Date)

/Taylor P. Evans/
Signature

Taylor P. Evans
Typed or printed name

713-632-1400
Requester's telephone number

June 3, 2020
Date

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. If the assignee is a juristic entity, this form must be signed by a patent practitioner (attorney or agent) of record. Submit multiple forms if more than one signature is required, see below*.

☑ *Total of 1 forms are submitted

This collection of information is required by 37 CFR 1.363. The information is required to obtain or retain a benefit by the public, which is to indicate (and for the USPTO to process) a fee address. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 5 minutes to complete, including gathering, preparing, and submitting the completed 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 COMPLETED FORMS TO THE PREVIOUS ADDRESS. **SEND COMPLETED FORMS TO: Mail Stop M Correspondence, 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.

Privacy Act Statement

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

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

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

Electronic Acknowledgement Receipt

EFS ID:	39618764
Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Taylor P. Evans/Karyn Hines
Filer Authorized By:	Taylor P. Evans
Attorney Docket Number:	047158.100035
Receipt Date:	03-JUN-2020
Filing Date:	05-DEC-2018
Time Stamp:	17:31:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Maintenance Fee Address Change	047158-100035-Maintenance-Fee-Address-Change.pdf	141197 c1f4c6013efc5d2c7ef32aaaaddc53274f9c9f98	no	2

Warnings:

Information:	
Total Files Size (in bytes):	141197

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/210,807	03/24/2020	10598258	047158.100035	2654

132858 7590 03/04/2020

Hogan Lovells US LLP
609 Main Street
Suite 4200
Houston, TX 77002

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

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

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

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

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

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

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

Jared Oehring, Houston, TX;
U.S. Well Services, Inc., Houston, TX;
Lon Robinson, Houston, TX;
Brandon N. Hinderliter, Houston, TX;
Alexander James Christinzio, Houston, TX;

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3746
	Examiner Name	
	Attorney Docket Number	047158.100035

	3	20160102537		2016-04-14	Lopez, Miguel Angel	
	4	20140290768		2014-10-02	Randle, Coy	
	5	20140277772		2014-09-18	Lopez, Miguel	
	6	20170096885		2017-04-06	Oehring, Jared	
	7	20070277982		2007-12-06	Shampine	
Change(s) applied to document. /N.W.S./ 1/21/2020	8	20170051732		2017-02-23	Hemandez et al. ~~Baker Hughes Incorporated~~	
	9	20160341281		2016-11-24	Brunvold et al. ~~Onesubsea IP UK Limited~~	
	10	20050274508		2005-12-15	Folk	
	11	20070131410		2007-06-14	Hill	
	12	20090045782		2009-02-19	Datta	
	13	20150097504		2015-04-09	Lamascus	

All References Considered Except Where Lined Through. /D.A./

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

Issue Fee Transmittal Form

Application Number	Filing Date	First Named Inventor	Atty. Docket No.	Confirmation No.
16210807	05-Dec-2018	Jared Oehring	047158.100035	2654

TITLE OF INVENTION :

MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

Entity Status	Application Type	Art Unit	Class - Subclass	EXAMINER
Regular Undiscounted	Utility under 35 USC 111(a)	3672	308100	DAVID ANDREWS

Issue Fee Due	Publication Due	Total Fee(s) Due	Date Due	Prev. Paid Fee
$1000	$0	$1000	21-Feb-2020	$0

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

Current Correspondence Address:	Current Indicated Fee Address :
132858 Hogan Lovells US LLP 609 Main Street Suite 4200 Houston TX 77002 UNITED STATES 713-632-1400 hlusdocketing@hoganlovells.com	
☐ Change of correspondence address requested, system generated AIA/122-EFS form attached	☐ Fee Address indication requested, system generated SB/47-EFS form attached

2.Entity Status

Change in Entity Status

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

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

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

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

3.The Following Fee(s) Are Submitted:

☒ Issue Fee

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

☐ Publication Fee

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

☐ Advance Order - # of copies _____

☒ If **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 501349 . The **issue fee must be submitted** with this form. **If payment of the issue fee does not accompany this form, checking this box and providing a deposit account number will NOT be effective to satisfy full payment of the fee(s) due.**

4.Firm and/or Attorney Names To Be Printed

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

1. HOGAN LOVELLS US LLP
2.
3.

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

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

Name	City	State	Country	Category
U.S. Well Services, LLC	Houston	TEXAS	united states	corporation

6.Signature

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

Signature	/Taylor P. Evans/	**Date**	02-11-2020
Name	Taylor P. Evans	**Registration Number**	60506

Electronic Patent Application Fee Transmittal

Application Number:	16210807
Filing Date:	05-Dec-2018
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Filer:	Taylor P. Evans/Stephanie McDonough
Attorney Docket Number:	047158.100035

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

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

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

Electronic Acknowledgement Receipt

EFS ID:	38550785
Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Taylor P. Evans/Stephanie McDonough
Filer Authorized By:	Taylor P. Evans
Attorney Docket Number:	047158.100035
Receipt Date:	11-FEB-2020
Filing Date:	05-DEC-2018
Time Stamp:	17:57:11
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1000
RAM confirmation Number	E20202AH57085513
Deposit Account	501349
Authorized User	Stephanie McDonough

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	Web85b.pdf	46107 20a1364063806ece623624f6e3be78abf8969b35	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	31925 fb3d88f10fe46db40fcbf74fe073b5093d90bd00	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	78032		

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/210,807	12/05/2018	Jared Oehring	047158.100035	2654

132858 7590 02/11/2020

Hogan Lovells US LLP
609 Main Street
Suite 4200
Houston, TX 77002

EXAMINER	
ANDREWS, DAVID L	

ART UNIT	PAPER NUMBER
3672	

NOTIFICATION DATE	DELIVERY MODE
02/11/2020	ELECTRONIC

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

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

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

hlusdocketing@hoganlovells.com
monica.williams@hoganlovells.com
stephanie.mcdonough@hoganlovells.com

Supplemental ***Notice of Allowability***	**Application No.** 16/210,807	**Applicant(s)** Oehring et al.	
	Examiner D Andrews	**Art Unit** 3672	**AIA (FITF) Status** Yes

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

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

1. ☑ This communication is responsive to the IDS filed 1/28/2020.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

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

3. ☑ The allowed claim(s) is/are 1-20 . 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 _____.

/D. ANDREWS/
Primary Examiner, Art Unit 3672

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	16210807
Filing Date	2018-12-05
First Named Inventor	Jared Oehring
Art Unit	3672
Examiner Name	David L. Andrews
Attorney Docket Number	047158.100035

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	9119326		2015-08-25	McDonnell	
	2	5050673		1991-09-24	Baldridge	
	3	7308933		2007-12-18	Mayfield	
	4	6273193		2001-08-14	Hermann	
	5	5366324		1994-11-22	Arlt	
	6	8646521		2014-02-11	Bowen	
	7	4759674		1988-07-26	Schroder	
	8	1656861		1928-01-17	Leonard	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.A./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

	9	10227854		2019-03-12	Glass	
	10	9932799		2018-04-03	Symchuk	
	11	6936947		2005-08-30	Leijon	
	12	7835140		2010-11-16	Mori	
	13	10393108		2019-08-27	Chong	
	14	10378326		2019-08-13	Morris	
	15	10371012		2019-08-06	Davis	
	16	3302069		1967-01-31	Webster	
	17	9728354		2017-08-08	Skolozdra	
	18	10436026		2019-10-08	Ounadjela	
	19	10246984		2019-04-02	Payne	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D. A./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

	20	10287873		2019-05-14	Filas	
	21	8800652		2014-08-12	Bartko	
	22	9915128		2018-03-13	Hunter	
	23	10196878		2019-02-05	Hunter	
	24	9963961		2018-05-08	Hardin	
	25	10260327		2019-04-16	Kajaria	
	26	7926562		2011-04-19	Poitzsch	
	27	7082993		2006-08-01	Ayoub	
	28	8096354		2012-01-17	Poitzsch	
	29	9976351		2018-05-22	Randall	
	30	10309205		2019-06-04	Randall	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D. A./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

	31	10407990		2019-09-10	Oehring	

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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
	1	20150354322		2015-12-10	Vicknair	
	2	20170016433		2017-01-19	Chong	
	3	20050061548		2005-03-24	Hooper	
	4	20150053426		2015-02-26	Smith	
	5	20120247783		2012-10-04	Berner, Jr.	
	6	20120222865		2012-09-06	Larson	
	7	20090145611		2009-06-11	Pallini Jr.	
	8	20080041596		2008-02-21	Blount	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

	9	20170036872		2017-02-09	Wallace	
	10	20180363437		2018-12-20	Coli	
	11	20080017369		2008-01-24	Sarada	
	12	20190203572		2019-07-04	Morris	
	13	20180245428		2018-08-30	Richards	
	14	20190316447		2019-10-17	Oehring	
	15	20190226317		2019-07-25	Payne	
	16	20190100989		2019-04-04	Stewart	
	17	20190178057		2019-06-13	Hunter	
	18	20180216455		2018-08-02	Andreychuk	
	19	20190203567		2019-07-04	Ross	

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	20	20170146189		2017-05-25	Herman	
	21	20190292891		2019-09-26	Kajaria	
	22	20190292866		2019-09-26	Ross	
	23	20190128080		2019-05-02	Ross	

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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	2787814	CA		2014-02-21	Pawlick		☓
	2	2978706	CA		2016-09-09	Payne		☒
	3	2945579	CA		2019-10-08	Oehring		☒
	4	2944980	CA		2017-02-12	Oehring		☒
	5	2849825	CA		2018-07-17	Bartko		☒

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	6	3000322	CA		2013-04-18	Bartko		☒
	7	2797081	CA		2019-09-10	Hunter		☒
	8	3050131	CA		2011-11-03	Hunter		☒
	9	3018485	CA		2017-08-10	Herman		☒
	10	2482943	CA		2011-05-24	Ayoub		☒
	11	2919649	CA		2019-02-26	Randall		☒
	12	2919666	CA		2019-07-16	Randall		☒
	13	3006422	CA		2017-06-01	Green		☒
	14	2406801	CA		2001-11-01	Demetrius		☒

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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.	T5

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	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

	1	International Search Report and Written Opinion mailed January 2, 2020 in related PCT Application No. PCT/US19/55325	☒
	2	Notice of Allowance mailed January 9, 2020 in related U.S. Patent Application No. 16/570,331	☒
	3	Non-Final Office Action mailed December 23, 2019 in related U.S. Patent Application No. 16/597,008	☒
	4	Non-Final Office Action mailed January 10, 2020 in related U.S. Patent Application No. 16/597,014	☒
	5	Non-Final Office Action mailed December 6, 2019 in related U.S. Patent Application No. 16/564,186	☒

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Examiner Signature	/D. ANDREWS/	Date Considered	02/05/2020

*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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	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

CERTIFICATION STATEMENT

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

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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	/Taylor P. Evans/	Date (YYYY-MM-DD)	2020-01-28
Name/Print	Taylor P. Evans	Registration Number	60506

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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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.

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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)).

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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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16210807
Filing Date	2018-12-05
First Named Inventor	Jared Oehring
Art Unit	3672
Examiner Name	David L. Andrews
Attorney Docket Number	047158.100035

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	9119326		2015-08-25	McDonnell	
	2	5050673		1991-09-24	Baldridge	
	3	7308933		2007-12-18	Mayfield	
	4	6273193		2001-08-14	Hermann	
	5	5366324		1994-11-22	Arlt	
	6	8646521		2014-02-11	Bowen	
	7	4759674		1988-07-26	Schroder	
	8	1656861		1928-01-17	Leonard	

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	9	10227854		2019-03-12	Glass	
	10	9932799		2018-04-03	Symchuk	
	11	6936947		2005-08-30	Leijon	
	12	7835140		2010-11-16	Mori	
	13	10393108		2019-08-27	Chong	
	14	10378326		2019-08-13	Morris	
	15	10371012		2019-08-06	Davis	
	16	3302069		1967-01-31	Webster	
	17	9728354		2017-08-08	Skolozdra	
	18	10436026		2019-10-08	Ounadjela	
	19	10246984		2019-04-02	Payne	

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	20	10287873		2019-05-14	Filas	
	21	8800652		2014-08-12	Bartko	
	22	9915128		2018-03-13	Hunter	
	23	10196878		2019-02-05	Hunter	
	24	9963961		2018-05-08	Hardin	
	25	10260327		2019-04-16	Kajaria	
	26	7926562		2011-04-19	Poitzsch	
	27	7082993		2006-08-01	Ayoub	
	28	8096354		2012-01-17	Poitzsch	
	29	9976351		2018-05-22	Randall	
	30	10309205		2019-06-04	Randall	

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	5	20120247783		2012-10-04	Berner, Jr.	
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	14	2406801	CA		2001-11-01	Demetrius		☒

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☒ See attached certification statement.

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

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SIGNATURE

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Signature	/Taylor P. Evans/	Date (YYYY-MM-DD)	2020-01-28
Name/Print	Taylor P. Evans	Registration Number	60506

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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.

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 Patent Application Fee Transmittal

Application Number:	16210807
Filing Date:	05-Dec-2018
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Filer:	Taylor P. Evans/Stephanie McDonough
Attorney Docket Number:	047158.100035

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

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

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

Electronic Acknowledgement Receipt

EFS ID:	38416714
Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Taylor P. Evans/Stephanie McDonough
Filer Authorized By:	Taylor P. Evans
Attorney Docket Number:	047158.100035
Receipt Date:	28-JAN-2020
Filing Date:	05-DEC-2018
Time Stamp:	11:53:15
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$240
RAM confirmation Number	E20201RB53369339
Deposit Account	501349
Authorized User	Stephanie McDonough

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	100035_IDS_2.pdf	1036412 33ee88e342ee2301f8919acb8aed6f01a2d99c2b	no	10
Warnings:					
Information:					
2	Foreign Reference	CA2406801A1.pdf	7016934 20376d882373813a07b3495cf6cb7a954b5797bd	no	101
Warnings:					
Information:					
3	Foreign Reference	CA2482943A1.pdf	777005 dbb2976ac9fa8c3d06e6225252a248b7137e2ef9	no	12
Warnings:					
Information:					
4	Foreign Reference	CA2787814A1.pdf	2377245 633856df9c7e206d9c3773a8089aeb0e232468ab	no	33
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
5	Foreign Reference	CA2797081A1.pdf	5636164 e3d066693382c2a362553b08dff83afb3e80367a	no	66
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					

6	Foreign Reference	CA2849825A1.pdf	4548042 01fa8220acd32ddbeed2ebc3c29dd806d3addd96	no	48
Warnings:					
Information:					
7	Foreign Reference	CA2919649A1.pdf	10972314 d7007d5c10a3302315126fb758a39e12b0d9593b	no	131
Warnings:					
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Information:					
8	Foreign Reference	CA2919666A1.pdf	11762140 985c4d0e98087f662e43fba91d349998a6a5853f	no	140
Warnings:					
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Information:					
9	Foreign Reference	CA2944980A1.pdf	1541946 e2f0d4dd294a8a7a4158ca1dc8ec5bb86bc06cae	no	25
Warnings:					
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Information:					
10	Foreign Reference	CA2945579A1.pdf	2614379 cfd0c3c497ab708e4aa1a24cbddf466d88ef63fe	no	30
Warnings:					
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Information:					
11	Foreign Reference	CA2978706A1.pdf	4007792 f9e344dcc4928b9e51ecb0eb1e58ce3f492ca945	no	57
Warnings:					
Information:					

12	Foreign Reference	CA3000322A1.pdf	3896522 3de54d3f5d2150e39ee81997cfd6345668f53c30	no	43
Warnings:					
Information:					
13	Foreign Reference	CA3006422A1.pdf	2774965 c6790510cdf308569b86d578ee8c33770f732bc3	no	42
Warnings:					
Information:					
14	Foreign Reference	CA3018485A1.pdf	1431864 b669a867cfad80a69349757b8af3dd5580e3c968	no	23
Warnings:					
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Information:					
15	Foreign Reference	CA3050131A1.pdf	6745417 f043d57fdfbbd89327b5b5f698294363258600d11	no	68
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
16	Other Reference-Patent/App/Search documents	500048_ISR_1-2-2020.pdf	524345 d35cf9b97e618ea680c0150c167ae602c642374d	no	10
Warnings:					
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Information:					
17	Other Reference-Patent/App/Search documents	100046_NOA_1-9-2020.pdf	496865 de0736297cae156177c77132fe7a4f3153298155	no	9
Warnings:					
Information:					

18	Other Reference-Patent/App/Search documents	100047_NFOA_12-23-2019.pdf	504947 e48ecf709c4a1a3c54beca9de2f5cd8a257472b9	no	15
Warnings:					
Information:					
19	Other Reference-Patent/App/Search documents	100048_NFOA_1-10-2020.pdf	426422 697dd19f949f67bf61f892dcc172c3fc0c122e87	no	12
Warnings:					
Information:					
20	Other Reference-Patent/App/Search documents	100063_OA_12-6-2019.pdf	339700 0a2b6e50e243fb971b4f843d1e8761090654b06a	no	10
Warnings:					
Information:					
21	Fee Worksheet (SB06)	fee-info.pdf	30544 5b7c786359c6d5f8457e7a55eb15234aca08de68	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	69461964		

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/210,807	12/05/2018	Jared Oehring	047158.100035	2654

132858 7590 01/02/2020

Hogan Lovells US LLP
609 Main Street
Suite 4200
Houston, TX 77002

EXAMINER	
ANDREWS, DAVID L	

ART UNIT	PAPER NUMBER
3672	

NOTIFICATION DATE	DELIVERY MODE
01/02/2020	ELECTRONIC

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

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

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

hlusdocketing@hoganlovells.com
monica.williams@hoganlovells.com
stephanie.mcdonough@hoganlovells.com

Supplemental ***Notice of Allowability***	**Application No.** 16/210,807	**Applicant(s)** Oehring et al.	
	Examiner D Andrews	**Art Unit** 3672	**AIA (FITF) Status** Yes

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

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

1. ☑ This communication is responsive to the IDS filed 12/5/2019.
   ☐ 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 _____.

/D. ANDREWS/
Primary Examiner, Art Unit 3672

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/210,807	Oehring et al.
	Examiner	Art Unit
	D Andrews	3672

CPC - Searched*		
Symbol	Date	Examiner
E21B 43/26 (text limited as in East history)	06/25/2019	DLA

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

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

Search Notes		
Search Notes	Date	Examiner
see attached East history	06/25/2019	DLA
updated	11/14/2019	DLA
see attached East history	12/30/2019	DLA

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	see attached East history	11/14/2019	DLA
	see attached East history	12/30/2019	DLA

LIBERTY EXHIBIT 1003, Page 44

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/210,807	Oehring et al.
	Examiner	**Art Unit**
	D Andrews	3672

CPC						
Symbol					**Type**	**Version**
F16H	/	3	/	52	F	2013-01-01
F04B	/	17	/	03	I	2013-01-01
F04B	/	23	/	04	I	2013-01-01
E21B	/	43	/	20	I	2013-01-01
F04B	/	15	/	02	I	2013-01-01
F04B	/	47	/	02	I	2013-01-01
E21B	/	43	/	26	I	2013-01-01
E21B	/	37	/	00	I	2013-01-01
F04B	/	49	/	20	I	2013-01-01
F16H	/	39	/	02	I	2013-01-01
F16H	/	2200	/	2007	A	2013-01-01

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

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/D. ANDREWS/ Primary Examiner, Art Unit 3672	30 December 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	15	1

U.S. Patent and Trademark Office

Part of Paper No.: 20191230

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/210,807	Oehring et al.
	Examiner	**Art Unit**
	D Andrews	3672

INTERNATIONAL CLASSIFICATION					
CLAIMED					
E21B43/20	/	43	/	20	

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

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

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/D. ANDREWS/ Primary Examiner, Art Unit 3672	30 December 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	15	1

U.S. Patent and Trademark Office

Part of Paper No.: 20191230

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/210,807	Oehring et al.
	Examiner	**Art Unit**
	D Andrews	3672

☑ 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

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/D. ANDREWS/ Primary Examiner, Art Unit 3672	30 December 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	15	1

U.S. Patent and Trademark Office

Part of Paper No.: 20191230

EAST Search History

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L5	39	(pump planetary simultaneous$2 motor).clm.	US-PGPUB	AND	ON	2019/12/30 06:55

12/ 30/ 2019 7:34:00 AM
C:\ Users\ dandrews\ Documents\ EAST\ Workspaces\ 16210807.wsp

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
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16210807
Filing Date	2018-12-05
First Named Inventor	Jared Oehring
Art Unit	3672
Examiner Name	David L. Andrews
Attorney Docket Number	047158.100035

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	2407796		1946-09-17	Page	
	2	2416848		1947-03-04	Rothery	
	3	7984757		2011-07-26	Keast	

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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
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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							

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.A./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

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NON-PATENT LITERATURE DOCUMENTS **Remove**

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 November 26, 2019 in related PCT Application No. PCT/US19/51018	X

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

EXAMINER SIGNATURE

Examiner Signature	/D. ANDREWS/	Date Considered	12/30/2019

*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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.A./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

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).

X See attached certification statement.

X 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	/Taylor P. Evans/	Date (YYYY-MM-DD)	2019-12-05
Name/Print	Taylor P. Evans	Registration Number	60506

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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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 record s.

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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.A./

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	6	("2407796" "2416848" "7984757").pn.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2019/12/30 05:32

12/ 30/ 2019 7:34:09 AM
C:\ Users\ dandrews\ Documents\ EAST\ Workspaces\ 16210807.wsp

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	16210807
Filing Date	2018-12-05
First Named Inventor	Jared Oehring
Art Unit	3672
Examiner Name	David L. Andrews
Attorney Docket Number	047158.100035

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	2407796		1946-09-17	Page	
	2	2416848		1947-03-04	Rothery	
	3	7984757		2011-07-26	Keast	

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					

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

FOREIGN PATENT DOCUMENTS Remove

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							

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

If you wish to add additional Foreign Patent Document citation information please click the Add button		Add	
NON-PATENT LITERATURE DOCUMENTS		Remove	
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 November 26, 2019 in related PCT Application No. PCT/US19/51018	X
If you wish to add additional non-patent literature document citation information please click the Add button		Add	

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	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

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	/Taylor P. Evans/	Date (YYYY-MM-DD)	2019-12-05
Name/Print	Taylor P. Evans	Registration Number	60506

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 record s.

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)).

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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 Patent Application Fee Transmittal

Application Number:	16210807
Filing Date:	05-Dec-2018
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Filer:	Taylor P. Evans/Stephanie McDonough
Attorney Docket Number:	047158.100035

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

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

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

Electronic Acknowledgement Receipt

EFS ID:	37938686
Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Taylor P. Evans/Stephanie McDonough
Filer Authorized By:	Taylor P. Evans
Attorney Docket Number:	047158.100035
Receipt Date:	05-DEC-2019
Filing Date:	05-DEC-2018
Time Stamp:	12:58:37
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$240
RAM confirmation Number	E2019B5C59132202
Deposit Account	501349
Authorized User	Stephanie McDonough

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	100035_IDS.pdf	1034334 211e84e41ccf0ba85e172a7be0cebfb19c925c3c	no	4
Warnings:					
Information:					
2	Other Reference-Patent/App/Search documents	500046_ISR_11-26-2019.pdf	608590 fb9dc546f5843b3b12fa57939cc323e9fe5c88b1	no	11
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30543 dc4e311258b69887c2a7203303d1d50665d01cd4	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1673467		

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

132858 7590 11/21/2019

Hogan Lovells US LLP
609 Main Street
Suite 4200
Houston, TX 77002

EXAMINER
ANDREWS, DAVID L

ART UNIT	PAPER NUMBER
3672	

DATE MAILED: 11/21/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/210,807	12/05/2018	Jared Oehring	047158.100035	2654

TITLE OF INVENTION: MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	02/21/2020

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

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

HOW TO REPLY TO THIS NOTICE:

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

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

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

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

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

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

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

LIBERTY EXHIBIT 1002, Page 62

PART B - FEE(S) TRANSMITTAL

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

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

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

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

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

132858 7590 11/21/2019

Hogan Lovells US LLP
609 Main Street
Suite 4200
Houston, TX 77002

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

Certificate of Mailing or Transmission

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

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/210,807	12/05/2018	Jared Oehring	047158.100035	2654

TITLE OF INVENTION: MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	02/21/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
ANDREWS, DAVID L	3672	166-308100

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

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

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

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

1 _____
2 _____
3 _____

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

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

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

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

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

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

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

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

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

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

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

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

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/210,807	12/05/2018	Jared Oehring	047158.100035	2654

132858 7590 11/21/2019

Hogan Lovells US LLP
609 Main Street
Suite 4200
Houston, TX 77002

EXAMINER	
ANDREWS, DAVID L	
ART UNIT	PAPER NUMBER
3672	

DATE MAILED: 11/21/2019

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.

LIBERTY EXHIBIT 1002, Page 64

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

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

Notice of Allowability	Application No. 16/210,807	Applicant(s) Oehring et al.	
	Examiner D Andrews	Art Unit 3672	AIA (FITF) Status Yes

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

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

1. ☑ This communication is responsive to the amendment filed 10/3/2019.
   ☐ 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 _____.

/D. ANDREWS/
Primary Examiner, Art Unit 3672

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/210,807	Oehring et al.
	Examiner	Art Unit
	D Andrews	3672

CPC - Searched*		
Symbol	Date	Examiner
E21B 43/26 (text limited as in East history)	06/25/2019	DLA

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

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

Search Notes		
Search Notes	Date	Examiner
see attached East history	06/25/2019	DLA
updated	11/14/2019	DLA

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	see attached East history	11/14/2019	DLA

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/210,807	Oehring et al.
	Examiner	**Art Unit**
	D Andrews	3672

CPC						
Symbol					**Type**	**Version**
F16H	/	3	/	52	F	2013-01-01
F04B	/	17	/	03	I	2013-01-01
F04B	/	23	/	04	I	2013-01-01
E21B	/	43	/	20	I	2013-01-01
F04B	/	15	/	02	I	2013-01-01
F04B	/	47	/	02	I	2013-01-01
E21B	/	43	/	26	I	2013-01-01
E21B	/	37	/	00	I	2013-01-01
F04B	/	49	/	20	I	2013-01-01
F16H	/	39	/	02	I	2013-01-01
F16H	/	2200	/	2007	A	2013-01-01

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

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/D. ANDREWS/ Primary Examiner, Art Unit 3672	14 November 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	15	1

U.S. Patent and Trademark Office

Part of Paper No.: 20191114

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/210,807	Oehring et al.
	Examiner	**Art Unit**
	D Andrews	3672

INTERNATIONAL CLASSIFICATION					
CLAIMED					
E21B43/20	/	43	/	20	
NON-CLAIMED					
	/		/		

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

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

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/D. ANDREWS/ Primary Examiner, Art Unit 3672	14 November 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	15	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/210,807	Oehring et al.
	Examiner	**Art Unit**
	D Andrews	3672

☑ 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

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/D. ANDREWS/ Primary Examiner, Art Unit 3672	14 November 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	15	1

U.S. Patent and Trademark Office

Part of Paper No.: 20191114

PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16210807
Filing Date	2018-12-05
First Named Inventor	Jared Oehring
Art Unit	3672
Examiner Name	David L. Andrews
Attorney Docket Number	047158.100035

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	10280724		2019-05-07	Hinderliter	
	2	10254732		2019-04-09	Oehring	
	3	10232332		2019-03-19	Oehring	
	4	5172009		1992-12-15	Mohan	
	5	6484490		2002-11-26	Olsen	
	6	7581379		2009-09-01	Yoshida	
	7	8616005		2013-12-31	Cousino	
	8	10008880		2018-06-26	Vicknair	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.A./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

	9	5755096		1998-05-26	Holleyman	

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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	20160105022		2016-04-14	Oehring	
	2	20160265457		2016-09-15	Stephenson	
	3	20140219824		2014-08-07	Burnette	
	4	20160281484		2016-09-29	Lestz	
	5	20190010793		2019-01-10	Hinderliter	
	6	20150211512		2015-07-30	Wiegman	
	7	20170234250		2017-08-17	Janik	
	8	20120049625		2012-03-01	Hopwood	

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	9	20190120024		2019-04-25	Oehring	
	10	20190010793		2019-01-10	Hinderliter	
	11	20180028992		2018-02-01	Stegemoeller	
	12	20170218727		2017-08-03	Oehring	
	13	20150136043		2015-05-21	Shaaban	
	14	20190112910		2019-04-18	Oehring	
	15	20170096885		2017-04-06	Oehring	
	16	20100045109		2010-02-25	Arnold	
	17	20030056514		2003-03-27	Lohn	
	18	20080264625		2008-10-30	Ochoa	
	19	20140060658		2014-03-06	Hains	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D. A./

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	Attorney Docket Number	047158.100035

	20	20150027712		2015-01-29	Vicknair	
	21	20160290563		2016-10-06	Diggins	
	22	20170159570		2017-06-08	Bickert	
	23	20140255214		2014-09-11	Burnette	
	24	20190245348		2019-08-08	Hinderliter	
	25	20190211661		2019-07-11	Reckels	
	26	20190169971		2019-06-06	Oehring	
	27	20100038907		2010-02-18	Hunt	
	28	20190162061		2019-05-30	Stephenson	
	29	20190178235		2019-06-13	Coskrey	
	30	20190063309		2019-02-28	Davis	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.A./

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	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

	31	20040167738		2004-08-26	Miller			

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FOREIGN PATENT DOCUMENTS Remove

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	2707269	CA		2010-12-09	Kidd		X

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NON-PATENT LITERATURE DOCUMENTS Remove

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 July 9, 2019 in corresponding PCT Application No. PCT/US2019/027584	X
	2	Office Action mailed June 11, 2019 in corresponding US Application No. 16/210,749	☒
	3	Office Action mailed May 10, 2019 in corresponding US Application No. 16/268,030	☒
	4	Canadian Office Action mailed May 30, 2019 in corresponding CA Application No. 2,833,711	☒
	5	Canadian Office Action mailed June 20, 2019 in corresponding CA Application No. 2,964,597	☒

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.A./

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	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

	6	Office Action mailed June 7, 2019 in corresponding US Application No. 16/268,030	☒
	7	International Search Report and Written Opinion mailed September 11, 2019 in related PCT Application No. PCT/US2019/037493	☒
	8	Office Action mailed August 19, 2019 in related U.S. Patent Application No. 15/356,436	☒
	9	Office Action mailed October 2, 2019 in related U.S. Patent Application No. 16/152,732	☒
	10	Office Action mailed September 11, 2019 in related U.S. Patent Application No. 16/268,030	☒
	11	Office Action mailed October 11, 2019 in related U.S. Patent Application No. 16/385,070	☒
	12	Office Action mailed September 3, 2019 in related U.S. Patent Application No. 15/994,772	☒
	13	Office Action mailed September 20, 2019 in related U.S. Patent Application No. 16/443,273	☒
	14	Canadian Office Action mailed October 1, 2019 in related Canadian Patent Application No. 2,936,997	☒

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EXAMINER SIGNATURE

Examiner Signature	/D. ANDREWS/	Date Considered	11/14/2019

*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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.A./

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	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

[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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	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

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	/Taylor P. Evans/	Date (YYYY-MM-DD)	2019-10-21
Name/Print	Taylor P. Evans	Registration Number	60506

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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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 record s.

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.

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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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.A./

Bibliographic Data

Application No: 16/210,807

Foreign Priority claimed: ○ Yes ◉ No

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

Verified and Acknowledged: /D. ANDREWS/ Examiner's Signature | Initials

Title: MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
12/05/2018	166	3672	047158.100035
RULE			

APPLICANTS

U.S. Well Services, Inc., Houston, TX,

INVENTORS

Jared Oehring Houston, TX, UNITED STATES

Lon Robinson Houston, TX, UNITED STATES

Brandon N. Hinderliter Houston, TX, UNITED STATES

Alexander James Christinzio Houston, TX, UNITED STATES

CONTINUING DATA

This application has PRO of 62594912 12/05/2017

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

03/04/2019

STATE OR COUNTRY

UNITED STATES

ADDRESS

Hogan Lovells US LLP
609 Main Street
Suite 4200
Houston, TX 77002
UNITED STATES

FILING FEE RECEIVED

$5,860

EAST Search History

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L5	38	(pump planetary simultaneous$2 motor).clm.	US-PGPUB	AND	ON	2019/11/14 08:34

11/ 14/ 2019 8:38:33 AM
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U.S.PATENTS Remove

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	3	10232332		2019-03-19	Oehring	
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	9	5755096		1998-05-26	Holleyman	

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	2	20160265457		2016-09-15	Stephenson	
	3	20140219824		2014-08-07	Burnette	
	4	20160281484		2016-09-29	Lestz	
	5	20190010793		2019-01-10	Hinderliter	
	6	20150211512		2015-07-30	Wiegman	
	7	20170234250		2017-08-17	Janik	
	8	20120049625		2012-03-01	Hopwood	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

	9	20190120024		2019-04-25	Oehring	
	10	20190010793		2019-01-10	Hinderliter	
	11	20180028992		2018-02-01	Stegemoeller	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

	20	20150027712		2015-01-29	Vicknair	
	21	20160290563		2016-10-06	Diggins	
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	26	20190169971		2019-06-06	Oehring	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

	31	20040167738		2004-08-26	Miller			

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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	2707269	CA		2010-12-09	Kidd		☒

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NON-PATENT LITERATURE DOCUMENTS Remove

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 July 9, 2019 in corresponding PCT Application No. PCT/US2019/027584	☒
	2	Office Action mailed June 11, 2019 in corresponding US Application No. 16/210,749	☒
	3	Office Action mailed May 10, 2019 in corresponding US Application No. 16/268,030	☒
	4	Canadian Office Action mailed May 30, 2019 in corresponding CA Application No. 2,833,711	☒
	5	Canadian Office Action mailed June 20, 2019 in corresponding CA Application No. 2,964,597	☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

	6	Office Action mailed June 7, 2019 in corresponding US Application No. 16/268,030	☒
	7	International Search Report and Written Opinion mailed September 11, 2019 in related PCT Application No. PCT/US2019/037493	☒
	8	Office Action mailed August 19, 2019 in related U.S. Patent Application No. 15/356,436	☒
	9	Office Action mailed October 2, 2019 in related U.S. Patent Application No. 16/152,732	☒
	10	Office Action mailed September 11, 2019 in related U.S. Patent Application No. 16/268,030	☒
	11	Office Action mailed October 11, 2019 in related U.S. Patent Application No. 16/385,070	☒
	12	Office Action mailed September 3, 2019 in related U.S. Patent Application No. 15/994,772	☒
	13	Office Action mailed September 20, 2019 in related U.S. Patent Application No. 16/443,273	☒
	14	Canadian Office Action mailed October 1, 2019 in related Canadian Patent Application No. 2,936,997	☒

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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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

[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	16210807
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	Art Unit	3672
	Examiner Name	David L. Andrews
	Attorney Docket Number	047158.100035

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	/Taylor P. Evans/	Date (YYYY-MM-DD)	2019-10-21
Name/Print	Taylor P. Evans	Registration Number	60506

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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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:

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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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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.

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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 Patent Application Fee Transmittal

Application Number:	16210807
Filing Date:	05-Dec-2018
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Filer:	Taylor P. Evans/Stephanie McDonough
Attorney Docket Number:	047158.100035

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

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

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

Electronic Acknowledgement Receipt

EFS ID:	37512252
Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Taylor P. Evans/Stephanie McDonough
Filer Authorized By:	Taylor P. Evans
Attorney Docket Number:	047158.100035
Receipt Date:	21-OCT-2019
Filing Date:	05-DEC-2018
Time Stamp:	14:41:43
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$240
RAM confirmation Number	E20190KE44036788
Deposit Account	501349
Authorized User	Stephanie McDonough

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	047158-100035_IDS.pdf	1036017 24c6db23cbdccdb94b79bf377e08282420c73fb5	no	9
Warnings:					
Information:					
2	Other Reference-Patent/App/Search documents	COA_2936997.pdf	207755 dae0c06a8119ed9b687e6c7363ba3834e395c7b8	no	3
Warnings:					
Information:					
3	Other Reference-Patent/App/Search documents	16443273_OA.pdf	527643 d1cdf6ca56f2195651a5db5164d13d2931c0984e	no	11
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	15994772_OA.pdf	302630 4a11bc3747e2a87768f2a4a696e19367efe5248b	no	9
Warnings:					
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5	Other Reference-Patent/App/Search documents	16385070_OA.pdf	242800 128faf4ea2e2bb9488664202e967397494359c4a	no	7
Warnings:					
Information:					
6	Other Reference-Patent/App/Search documents	16268030_OA_9112019.pdf	625568 8b18fa91f4706c88d3310cc571f498303725f328	no	18
Warnings:					
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7	Other Reference-Patent/App/Search documents	16152732_OA.pdf	474139 46bd3842f2368cd060a4dfa5893632e0a5eb82e3	no	11
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8	Other Reference-Patent/App/Search documents	15356436_OA.pdf	929065 47c20f5c953cbc4c306d3c1ddda1fc4da7219f89	no	22
Warnings:					
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9	Other Reference-Patent/App/Search documents	500042_ISR.pdf	551837 e36f52fe4cd688e3def60e909808fe7624d0cbdd	no	11
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10	Other Reference-Patent/App/Search documents	P53041CA00_OA_as-filed.pdf	277907 6611c7d232b3de98e376b2ddc9f91b176ce8140b	no	4
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11	Other Reference-Patent/App/Search documents	P52016CA00_OA_as-filed.pdf	285103 518c95719a4f720bd90ca152af1aa8a15b48ba2d	no	5
Warnings:					
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12	Foreign Reference	CA2707269A1.pdf	2897967 f7ee72a1a6aa3c4c9649dbde6d1c8668ec9e94d2	no	106
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14	Other Reference-Patent/App/Search documents	16268030_OA.pdf	534865 8291f2a91518e612a1611fb951691aa5204cce11	no	16
Warnings:					
Information:					
15	Other Reference-Patent/App/Search documents	16210749_OA.pdf	345039 1d1aa5b51ec9f9ebb313e2156cbf6e2c56fed807	no	10
Warnings:					
Information:					
16	Other Reference-Patent/App/Search documents	16170695_OA.pdf	591575 bd196199b20685aab100a344b5dddca208cae1df	no	19
Warnings:					
Information:					
17	Fee Worksheet (SB06)	fee-info.pdf	30543 8994dbffa4257d24967ef6d373e11da4e0f31119	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	10438635		

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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 a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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

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

New International Application Filed with the USPTO as a Receiving Office

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PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/210,807	Filing Date 12/05/2018	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

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

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	10/03/2019	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))	* 3	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	SLIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/LISA R WRIGHT/
*** 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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If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:	§	
	§	
Jared Oehring et al.	§	
	§	Attorney Docket No.: 047158.100035
	§	
Serial No.: 16/210,807	§	Confirmation No.: 2654
	§	
Filed: December 5, 2018	§	Art Unit: 3672
	§	
For: MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS	§	Examiner: David J. Andrews

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313

AMENDMENT

Dear Sir:

In response to the Non-Final Office Action mailed July 3, 2019, Applicants hereby request reconsideration of the above-referenced application for patent, and reconsideration of the rejections in view of the amendments and the following arguments. If any additional fees are necessary for continued prosecution of this Application, the commissioner is hereby authorized to charge those fees to **Hogan Lovells US LLP's Deposit Account Number 501349**.

Amendments to the Claims are reflected in the listing of claims that begin on page 2 of this paper.

Remarks/Arguments begin on page 7 of this paper.

Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

What is claimed is:

1. (Currently Amended) A hydraulic fracturing system for fracturing a subterranean formation comprising:

a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, the multi-plunger pump configured to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation;

a plurality of motors positioned to simultaneously power the multi-plunger pump; and

a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors,

wherein a gear ratio of the planetary gear train and a speed at which the plurality of motors operates are selected so as to limit a maximum pump speed associated with the multi-plunger pump.

2. (Original) The system of claim 1, the system further comprising a plurality of speed reduction gearboxes positioned between the plurality of input pinion gears and the plurality of motors so as to achieve a desired pump rate.

3. (Original) The system of claim 1, wherein the plurality of motors comprises one of a plurality of electric motors or a plurality of hydraulic motors.

4. (Currently Amended) The system of claim 1, wherein the maximum pump speed correlates to a critical plunger speed associated with ~~each of the plurality of hydraulic pumps~~ the multi-plunger hydraulic fracturing pump.

5. (Currently Amended) The system of claim 1, wherein the maximum pump speed is 5% or less over a critical plunger speed associated with ~~each of the plurality of hydraulic pumps~~ the multi-plunger hydraulic fracturing pump.

6. (Currently Amended) The system of claim 1, wherein ~~the plurality of hydraulic pumps~~ the multi-plunger hydraulic fracturing pump comprises an odd number of plungers greater than or equal to five plungers.

7. (Currently Amended) The system of claim 6, wherein a stroke length of each of the plungers associated with ~~the plurality of hydraulic pumps~~ the multi-plunger hydraulic fracturing pump is selected to inversely relate to a pump speed associated with ~~the plurality of hydraulic pumps~~ the multi-plunger hydraulic fracturing pump so as to achieve a predetermined flow rate.

8. (Currently Amended) The system of claim 1, further comprising:

a variable frequency drive (VFD) connected to the plurality of motors to control the speed of the plurality of motors, wherein the VFD is positioned to accelerate or decelerate pump rotational speeds associated with ~~each of the plurality of hydraulic pumps~~ the multi-plunger hydraulic fracturing pump.

9. (Currently Amended) The system of claim 8, wherein the VFD comprises a plurality of VFDs and wherein the plurality of VFDs are configured to share a load required to power ~~the plurality of hydraulic pumps~~ the multi-plunger hydraulic fracturing pump.

10. (Currently Amended) The system of claim 9, wherein the plurality of VFDs are configured to automatically shut off in the event of an overpressure event with respect to ~~the plurality of hydraulic pumps~~ the multi-plunger hydraulic fracturing pump.

11. (Currently Amended) A hydraulic fracturing system for fracturing a subterranean formation comprising:

a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, the multi-plunger pump configured to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation;

a plurality of motors positioned to simultaneously power the multi-plunger pump;

a variable frequency drive connected to the plurality of motors to control the speeds of the plurality of ~~electric~~ motors; and

a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors,

wherein a gear ratio of the planetary gear train and a speed at which the plurality of motors operates are selected so as to limit a maximum pump speed associated with the multi-plunger pump.

12. (Original) The system of claim 11, the system further comprising a plurality of speed reduction gearboxes positioned between the plurality of input pinion gears and the plurality of motors so as to achieve a desired pump rate.

13. (Original) The system of claim 11, wherein the plurality of motors comprises one of a plurality of electric motors or a plurality of hydraulic motors.

14. (Currently Amended) The system of claim 11, wherein the maximum pump speed correlates to a critical plunger speed associated with ~~each of the plurality of hydraulic pumps~~ the multi-plunger hydraulic fracturing pump.

15. (Currently Amended) A method for pumping fluid into a wellbore associated with a subterranean formation, the method comprising:

fluidly connecting a multi-plunger hydraulic fracturing pump to a well associated with the subterranean formation such that the multi-plunger pump pumps fluid into the wellbore at a high pressure so that fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation;

simultaneously powering the multi-plunger pump with a plurality of motors;

providing a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors so as to translate power from the plurality of motors into a desired pump rate of the multi-plunger pump.

16. (Original) The method of claim 15, further comprising:

positioning a plurality of speed reduction gearboxes between the plurality of input pinion gears and the plurality of motors so as to achieve the desired pump rate.

17. (Original) The method of claim 15, wherein the plurality of motors comprises one of a plurality of electric motors or a plurality of hydraulic motors.

18. (Currently Amended) The method of claim 15, wherein the maximum pump speed correlates to a critical plunger speed associated with ~~each of the plurality of hydraulic pumps~~ the multi-plunger hydraulic fracturing pump.

19. (Currently Amended) The method of claim 15, further comprising:

connecting a variable frequency drive (VFD) to the plurality of motors so as to control the speed of the plurality of motors, wherein the VFD is positioned to accelerate or decelerate pump rotational speeds associated with ~~each of the plurality of hydraulic pumps~~ the multi-plunger hydraulic fracturing pump.

20. (Currently Amended) The method of claim 19, the method further comprising:

detecting an overpressure event with respect to ~~the plurality of hydraulic pumps~~ the multi-plunger hydraulic fracturing pump; and

automatically shutting off ~~the plurality of VFDs~~ the VFD.

REMARKS/ARGUMENTS

This amendment is in response to the Non-Final Office Action mailed July 3, 2019. Claims 1-20 are pending in the application. Claims 1, 4-11, 14, 15, and 18-20 have been amended. No new matter has been added in the amendments.

In the Office Action, the Examiner fist objected to Figs. 4-10 of the drawings as containing significant unreadable text. Applicants submit that the application as submitted included clear, readable text in the portions indicated by the Examiner. Some text, however, was degraded upon scanning by the Patent Office after receipt of the application. Applicants note, however, that all of the text is readable, if the quality of the print is somewhat degraded. Applicants will submit clarified versions of the indicated figures if necessary after agreement is reached on the claims.

The Examiner also objected to the drawings under 37 C.F.R. 1.83(a) as not showing a variable frequency drive (VFD), a feature recited in claims 8-11, 19, and 20. Applicants respectfully traverse the objection. In particular, Applicants note that, as outlined in MPEP 608.02 Drawing [R-07.2015], the statutory requirement for showing the claimed invention only requires that the "applicant shall furnish a drawing where necessary for the understanding of the subject matter to be patented…" (See 35 U.S.C. 113, See also 37 CFR §1.81(a)). In the pending application, Applicants respectfully submit that an express illustration of the VFD is not necessary for understanding by one of ordinary skill in the art of the subject matter to be patented. Accordingly, withdrawal of this objection is respectfully requested.

The Examiner next rejected claims 4-14 and 18-20 under 35 U.S.C. 112(b) for lacking antecedent basis for the feature "the plurality of hydraulic pumps." Claim 11 is rejected as lacking antecedent basis for "the plurality of electric motors," and claim 20 is rejected as lacking

antecedent basis for "the plurality of VFDs." Applicants have amended the claims as appropriate to correct.

The Examiner next rejected claims 1-3, 6, 7, and 15-17 under 35 U.S.C. 103(a) as obvious U.S. Patent Appln. Pub. No. 2017/0051732 to Hernandez et al. ("*Hernandez*") in view of U.S. Patent No. 4,100,822 to Rosman ("*Rosman*"). Claims 4-5, and 18 are rejected as lacking an inventive step over *Hernandez* in view of *Rosman*, and further in view of U.S. Patent No. 8,851,860 to Mail ("*Mail*"). Claims 8-13 and 19-20 are rejected as lacking inventive step over *Hernandez* in view of *Rosman*, and further in view of U.S. Patent Appln. Pub. No. 2016/0258267 to Payne et al. ("*Payne*"), and claim 14 over *Hernandez* in view of *Rosman*, and further in view of *Payne* and *Mail*. In the application, claims 1, 11, and 15 are written in independent form.

Claims 1 and 11 have been amended to recite that the plurality of motors is positioned to "simultaneously" power the multi-plunger pump. Similarly, claim 15 has been amended to recite the step of "simultaneously" powering the multi-plunger pump with a plurality of motors. Applicants respectfully submit that this feature is not described or shown in the prior art as relied on by the Examiner.

Specifically, the Examiner relies on *Hernanez* as showing powering a pump with a plurality of motors. *Hernandez*, however, is structurally different than the system of Applicants' claims. For example, the system of *Hernandez* includes a starting assist motor 58 and a motor 34. The purpose of the starting assist motor 58 is to initiate turning of the driveshaft upon startup, to overcome initial starting friction. After initiation, motor 34 is started up. As stated specifically in the *Hernandez* specification, "[t]he starting assist 54 overcome the Initial starting friction of the pump 50 ***before*** the motor 34 is started up." *Hernandez*, paragraph [0023]. Thus, the operation of the starting assist motor 58 and the motor 34 is sequential.

In stark contrast, the multiple motors of claims 1, 11, and 15 drive the pump ***simultaneously***. That this is the case is clearly stated in the specification, which refers to using multiple motors to drive a single pump so that pump rates "can be increased without exceeding critical plunger speeds." That is, simultaneously during operation. Indeed use of a starting assist motor, such as that described in *Hernandez* would not lead to an increase in pump rate, as described in the specification.

In addition to the above, Applicants respectfully submit that the Examiner has not established a prima facie case of obviousness with respect to claim 15. In fact, the sole reference to claim 15 is the sentence on page 7 of the Office Action where the Examiner states that "[i]n regard to the method claims, the normal use of the combination system above for fracturing as disclosed would encompass the claimed steps." Applicants submit that this one sentence is not an adequate rejection. The Examiner is required to state with particularity where each step of the claimed method is shown in the prior art. Applicants request that the Examiner either allow claim 15 or make a proper prima facie rejection of claim 15 in the next Office Action. Furthermore, since such a rejection of claim 15 will be the first, Applicants respectfully submit that the next Office Action be non-final.

Finally, Applicants respectfully submit that dependent claims 2-10, 12-14, and 16-20 are patentable at least by virtue of their dependence from one or more of claims 1, 11, and 15, as well as for other patentable features recited therein.

Conclusion

The foregoing response is full, complete, and timely filed. Amendments to the claims are made without prejudice, including under the doctrine of equivalents. In addition, the comments made herein are without prejudice. Applicants respectfully request reconsideration of the instant application in light of the foregoing response and amendments. Should the Examiner have any questions, comments or suggestions in furtherance of the prosecution of the application, the Examiner is invited to contact the Applicants' representative by telephone or fax.

Respectfully submitted,

Date: October 3, 2019

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Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
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1		047158-100035_Response.pdf	57744 4cb78fdbfd63b28ab165b6a6f5d90406556f0b19	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	6
	Applicant Arguments/Remarks Made in an Amendment	7	10
Warnings:			
Information:			
	Total Files Size (in bytes):	57744	

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
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132858
Hogan Lovells US LLP
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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.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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132858 7590 07/03/2019

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EXAMINER	
ANDREWS, DAVID L	

ART UNIT	PAPER NUMBER
3672	

NOTIFICATION DATE	DELIVERY MODE
07/03/2019	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):

hlusdocketing@hoganlovells.com
monica.williams@hoganlovells.com
stephanie.mcdonough@hoganlovells.com

Office Action Summary	Application No. 16/210,807	Applicant(s) Oehring et al.	
	Examiner D Andrews	Art Unit 3672	AIA (FITF) Status Yes

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

Period for Reply

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

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

Status

1)☐ Responsive to communication(s) filed on _____.

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

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

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

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

Disposition of Claims*

5) ☑ Claim(s) 1-20 is/are pending in the application.

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

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-20 is/are rejected.

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

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

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

Application Papers

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

11)☑ The drawing(s) filed on 5/3/2019 is/are: a)☐ accepted or b)☑ objected to by the Examiner.

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

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

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

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

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

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

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

Attachment(s)

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

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

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

4) ☐ Other: _____.

DETAILED ACTION

The preliminary amendment filed 5/3/2019 has been entered.

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.

Drawings

The drawings are objected to because figures 4-10 all contain significant unreadable text. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

The drawings are also objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the variable frequency drive (as in claims 8-11, 19 and 20) must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):

(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 4-14, and 18-20 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claims 4-10, 14 and 18-20 all lack antecedent basis for "the plurality of hydraulic pumps".

Claim 11 lacks antecedent basis for "the plurality of electric motors".

Claim 20 lacks antecedent basis for "the plurality of VFDs".

The remaining claims are indefinite as being dependent from an indefinite claim.

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 of filing.

Claims 1-3, 6, 7, and 15-17 is/are rejected under 35 U.S.C. 103 as being unpatentable over Hemandez et al. (US 2017/0051732) in view of Rosman (US 4,100,822). Hemandez et al. discloses a hydraulic fracturing system for fracturing a subterranean formation comprising: a multi-plunger hydraulic fracturing pump (50) fluidly connected to a well associated with the subterranean formation, the multi-plunger pump configured to pump fluid into a wellbore associated with the well at a high

pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation in an adjacent earthen formation for hydraulic fracturing; a plurality of motors positioned to power the multi-plunger pump (34, 58); and a planetary gear train having an input pinion gear in rotational contact with the plurality of motors (170 with input pinion gear 174 in rotational contact with motor 58 through drive shaft 60 and motor 34 through gear train 62 to drive shaft 52; Figures 1 and 4; Paragraph [0024]), wherein a gear ratio of the planetary gear train and a speed at which the plurality of motors operate are selected so as to limit a maximum pump speed associated with the multi plunger pump (the gear ratio of planetary gear system 170 allows for gear reduction, allowing for the rotational speed of the drive shaft 60 to convert to a slower rotational speed on the drive shaft 52 of the pump 50 thereby inherently limiting maximum pump speed, Figures 1 and 4; Paragraph [0024]). Hemandez et al. fails to disclose a plurality of input pinion gears in rotational contact with each of the plurality of motors.

Rosman discloses a plurality of motors and a plurality of input pinion gears in rotational contact with each of the plurality of motors (see Figures 3-5 wherein pinions 23 having gear teeth 34 are connected rotationally to hydraulic drive motors 21).
It would have been obvious to one having ordinary skill in the art at the time of filing to modify the planetary gearing of Hemandez et al. by having a motor for each associated planet gear as taught by Rosman for the purpose of having smaller motors wherein there is an advantage that the system is less expensive with respect to initial capitalization and maintenance (Rosman; Column 4, Lines 57-59).

Regarding claim 2, Hemandez et al. as modified by Rosman discloses the system of claim 1. Hemandez et al. fails to disclose the system further comprising a plurality of speed reduction gearboxes positioned between the plurality of input pinion gears and the plurality of motors so as to achieve a desired pump rate. Rosman discloses a plurality of speed reduction gearboxes positioned between a plurality of input pinion gears and a plurality of motors (gear boxes 22 are positioned between a plurality of pinions 23 having gear teeth 23 and a plurality of hydraulic drive motors 21; gear boxes are designed to increase torque while reducing speed of the output shaft; Figures 3-5; Column 4, Lines 46-62). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the gearing of Hemandez et al. by having a motor for each associated planet gear as well as gear boxes as taught by Rosman resulting in a desired pump rate for the purpose of having smaller motors wherein there is an advantage that the system is less expensive with respect to initial capitalization and maintenance (Rosman; Column 4, Lines 57-59) and developing the amount of torque necessary to rotate ring members with high loads (Rosman; Column 4, Lines 60-62)).

Regarding claim 3, Hemandez et al. as modified by Rosman discloses the system of claim 1. Hemandez et al. fails to disclose wherein a plurality of motors comprises one of a plurality of electric motors or a plurality of hydraulic motors. Rosman discloses wherein a plurality of motors comprises one of a plurality of electric motors or a plurality of hydraulic motors (hydraulic drive motors 21; Figure 4). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the motor of

Hemandez et al. with the plurality of hydraulic motors as taught by Rosman for the purpose of utilizing a motor which can generate high torques without excessive size.

Regarding claim 6, Hemandez et al. as modified by Rosman discloses the system of claim 1. Hemandez et al. further discloses wherein the hydraulic pump comprises an odd number of plungers greater than or equal to five plungers (pump 50 for hydraulic fracturing of a borehole in an adjacent earthen formation (subterranean) with five pistons 146 (plungers); Figure 3; Paragraphs [0016] and [0021]).

Regarding claim 7, Hemandez et al. as modified by Rosman discloses the system of claim 6, wherein a stroke length of each of the plungers associated with the hydraulic pump is selected to inversely relate to a pump speed associated with the hydraulic pump so as to achieve a predetermined flow rate (see Figure 3 wherein the distance the crosshead 148 travels (stroke length) of the piston 146 (plunger) associated with the pump system 10 would be in a inversely related relation to pump speed since the longer the stroke length is, the lower the pump speed required to achieve a given flow rate; Figures 3-5; Paragraphs [0026] and [0019]).

In regard to the method claims, the normal use of the combination system above for fracturing as disclosed would encompass the claimed steps.

Claims 4-5 and 18 lack an inventive step under PCT Article 33(3) as being obvious over Hemandez et al. in view of Rosman and further in view of Mail (US 8,851,860).

Regarding claims 4 and 18, Hemandez et al. as modified by Rosman discloses the system of claim 1. Hemandez et al. fails to disclose wherein the maximum pump

speed correlates to a critical plunger speed associated with the hydraulic pump. Mail discloses wherein a maximum pump speed correlates to a critical plunger speed associated with a hydraulic pump (mainstream methods of subsurface downhole pumping (hydraulic pump) include mounted reciprocating mechanisms (plunger) in a casing tube; optimal speeds of up and down strokes can be defined as maximum speeds that will not cause overstressing of pump rod (critical plunger speed); therefore maximum pumping speed correlates to an operation at optimal up and down stroke speed (critical plunger speed) associated with the hydraulic pump; Column 1, Lines 29-33, 39-48, 53-54, 64-67 and Column 2, Lines 1-3). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the maximum pump speed of Hemandez et al. by correlating it to the critical plunger speed as taught by Mail for the purpose of avoiding overstressing of structural parts and premature damage (Hemandez et al.; Column 1, Lines 64-67 and Column 2, Lines 1-3).

Regarding claim 5, Hemandez et al. as modified by Rosman discloses the system of claim 1. Hemandez et al., Rosman and Mail fail to disclose wherein the maximum pump speed is 5% or less over a critical plunger speed associated with hydraulic pump. However, it would have been obvious to one having ordinary skill in the art at the time of filing to provide the maximum pump speed as 5% or less over a critical plunger speed since one of ordinary skill would choose limits of safe operation for the system.

Claims 8-13 and 19-20 lack an inventive step under PCT Article 33(3) as being obvious over Hemandez et al. in view of Rosman and further in view of Payne et al. (US

2016/0258267). Hemandez et al. as modified by Rosman discloses the system of claim 1, as above. Hemandez et al. further discloses: a variable frequency drive (VFD) connected to a motor to control the speed of the motor, wherein the VFD is positioned to accelerate or decelerate pump rotational speeds associated with the hydraulic pump (variable frequency drive (VFD) 76 connected to motor 34 to control the speed thereof, wherein the VFD is positioned to adjust operating speeds of pump 50; Figure 2; Paragraph [0019-0020]). Hemandez et al. and Rosman fail to disclose a variable frequency drive (VFD) connected to a plurality of motors. Payne et al. discloses a variable frequency drive (VFD) connected to a plurality of motors (controlling, using one or more variable frequency drives (VFDs), a plurality of electrical motors to drive at least one fluid pump of the at least one hydraulic fracturing pump unit; Claim 31). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the other motor of Hemandez et al. to be connected to the VFD as taught by Payne et al. for the purpose of utilizing the benefits of a VFD to the other motors in the system, the benefits including contributing to energy savings, increasing the efficiency and life of the motor, reducing mechanical wear upon the motor and thus the need for repair (Hemandez et al.; Paragraph [0019]).

Regarding claim 9, Hemandez et al. as modified by Rosman and Payne et al. discloses the system of claim 8. Hemandez et al. further discloses a variable frequency drive (VFD), wherein the VFD is positioned to accelerate or decelerate pump rotational speeds associated with the hydraulic pump (variable frequency drive (VFD) 76 connected to motor 34 to control the speed thereof, wherein the VFD is positioned to adjust operating speeds of pump 50; Figure 2; Paragraph [0019-0020]), Hemandez et

al. fails to disclose wherein the VFD comprises a plurality of VFDs connected to a plurality of motors, wherein the plurality of VFDs are configured to share a load required to power the hydraulic pump. Payne et al. discloses wherein the VFD comprises a plurality of VFDs connected to a plurality of motors, wherein the plurality of VFDs are configured to share a load required to power the hydraulic pump (controlling, using one or more (plurality) variable frequency drives (VFDs), a plurality of electrical motors to drive at least one fluid pump of the at least one hydraulic fracturing pump unit (sharing the load); Claim 31). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the other motor of Hemandez et al. to have a VFD for the purpose utilizing the benefits of a VFD to the other motors in the system, the benefits including contributing to energy savings, increasing the efficiency and life of the motor, reducing mechanical wear upon the motor and thus the need for repair (Hemandez et al.; Paragraph [0019]).

Regarding claim 10, Hemandez et al. as modified by Rosman and Payne et al. discloses the system of claim 9. Hemandez et al. fails to disclose wherein a plurality of VFDs are configured to automatically shut off in the event of an overpressure event with respect to the plurality of hydraulic pumps. Payne et al. discloses wherein a plurality of VFDs are configured to automatically shut off in the event of an overpressure event with respect to a hydraulic pump (a RUN/STOP will control the fracturing pump unit 700 in which an e-stop will be supplied to stop the entire fracturing pump unit 700 a, shutting down frac VFDs 410 a, 410 b of motors 411 a, 411 b; the RUN/STOP is initiated when frac VFD 410 a detects the discharge pressure exceeds a overpressure setpoint with respect to hydraulic fracturing pump 710 a, it stops the frac motor 411 as it activates a

shutdown; Figures 3 and 6; Paragraphs [0054] and [0062]). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the VFD of Hemandez et al. to automatically shut down during an overpressure event as taught by Payne et al. for the purpose of avoiding catastrophic failure in the system.

Regarding 11, Hemandez et al. discloses a hydraulic fracturing system for fracturing a subterranean formation comprising: a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation (50, which may be a quintuplex pump having five pistons 146 (plungers); Figure 3; Paragraphs [0016] and [0021]), the multi-plunger pump configured to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation (pump 50 for pumping pressurized fluid into a borehole in an adjacent earthen formation for hydraulic fracturing; Figure 3; Paragraphs [0016] and [0021]): a plurality of motors positioned to power the multi-plunger pump (motors 34, 58 positioned to power the pump 50 (multi-plunger pump); Figure 1); a variable frequency drive connected to a motor to control the speeds of the motor (variable frequency drive (VFD) 76 connected to motor 34 to control the speed thereof, wherein the VFD is positioned to adjust operating speeds of pump 50; Figure 2; Paragraph [0019-0020]); and a planetary gear train having an input pinion gear in rotational contact with the plurality of motors (planetary gear system 170 having a input pinion sun gear 174 in rotational contact with motor 58 through drive shaft 60 and motor 34 through gear train 62 to drive shaft 52; Figure 4; Paragraph [0024]), wherein a gear ratio of the planetary gear train and a speed at which the plurality of motors operates are selected so as to limit a maximum pump

speed associated with the multi-plunger pump (the gear ratio of planetary gear system 170 allows for gear reduction, allowing for the rotational speed of the drive shaft 60 to convert to a slower rotational speed on the drive shaft 52 of the pump 50 (thereby limiting maximum pump speed); Figures 1 and 4; Paragraph [0024]). Hemandez et al. fails to disclose a plurality of input pinion gears in rotational contact with each of the plurality of motors. Hemandez et al. also fails to disclose a variable frequency drive (VFD) connected to a plurality of motors. Rosman discloses a plurality of motors and a plurality of input pinion gears in rotational contact with each of the plurality of motors (see Figures 3-5 wherein pinions 23 having gear teeth 34 are connected rotationally to hydraulic drive motors 21). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the planetary gearing of Hemandez et al. by having a motor for each associated planet gear as taught by Rosman for the purpose of having smaller motors wherein there is an advantage that the system is less expensive with respect to initial capitalization and maintenance (Rosman; Column 4, Lines 57-59). Payne et al. discloses a variable frequency drive (VFD) connected to a plurality of motors (controlling, using one or more variable frequency drives (VFDs), a plurality of electrical motors to drive at least one fluid pump of the at least one hydraulic fracturing pump unit; Claim 31). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the other motor of Hemandez et al. to be connected to the VFD as taught by Payne et al. for the purpose of utilizing the benefits of a VFD to the other motors in the system, the benefits including contributing to energy savings, increasing the efficiency and life of the motor, reducing mechanical wear upon the motor and thus the need for repair (Hemandez et al.; Paragraph [0019]).

Regarding claim 12, Hemandez et al. as modified by Rosman and Payne et al. discloses the system of claim 11. Hemandez et al. fails to disclose the system further comprising a plurality of speed reduction gearboxes positioned between the plurality of input pinion gears and the plurality of motors so as to achieve a desired pump rate. Rosman discloses a plurality of speed reduction gearboxes positioned between a plurality of input pinion gears and a plurality of motors (gear boxes 22 are positioned between a plurality of pinions 23 having gear teeth 23 and a plurality of hydraulic drive motors 21; gear boxes are designed to increase torque while reducing speed of the output shaft; Figures 3-5; Column 4, Lines 46-62). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the gearing of Hemandez et al. by having a motor for each associated planet gear as well as gear boxes as taught by Rosman resulting in a desired pump rate for the purpose of having smaller motors wherein there is an advantage that the system is less expensive with respect to initial capitalization and maintenance (Rosman; Column 4, Lines 57-59) and developing the amount of torque necessary to rotate ring members with high loads (Rosman; Column 4, Lines 60-62)).

Regarding claim 13, Hemandez et al. as modified by Rosman and Payne et al. discloses the system of claim 11. Hemandez et al. fails to disclose wherein a plurality of motors comprises one of a plurality of electric motors or a plurality of hydraulic motors. Rosman discloses wherein a plurality of motors comprises one of a plurality of electric motors or a plurality of hydraulic motors (hydraulic drive motors 21; Figure 4). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the motor of Hemandez et al. with the plurality of hydraulic motors as taught by

Rosman for the purpose for the purpose of utilizing a motor which can generate high torques without excessive size.

Regarding claim 19, Hemandez et al. as modified by Rosman discloses the method of claim 15. Hemandez et al. discloses further comprising: connecting a variable frequency drive (VFD) to the motor so as to control the speed of the motor, wherein the VFD is positioned to accelerate or decelerate pump rotational speeds associated with each of the hydraulic pump (variable frequency drive (VFD) 76 connected to motor 34 to control the speed thereof, wherein the VFD is positioned to adjust operating speeds of pump 50; Figure 2; Paragraph [0019-0020]). Hemandez et al. fails to disclose a variable frequency drive (VFD) connected to a plurality of motors. Payne et al. discloses a variable frequency drive (VFD) connected to a plurality of motors (controlling, using one or more variable frequency drives (VFDs), a plurality of electrical motors to drive at least one fluid pump of the at least one hydraulic fracturing pump unit; Claim 31). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the other motor of Hemandez et al. to be connected to the VFD as taught by Payne et al. for the purpose of utilizing the benefits of a VFD to the other motors in the system, the benefits including contributing to energy savings, increasing the efficiency and life of the motor, reducing mechanical wear upon the motor and thus the need for repair (Hemandez et al.; Paragraph [0019]).

Regarding claim 20, Hemandez et al. as modified by Rosman and Payne et al. discloses the method of claim 19. Hemandez et al. fails to disclose detecting an overpressure event with respect to the hydraulic pump; and automatically shutting off the VFD. Payne et al. discloses wherein a VFD is configured to automatically shut off in

the event of an overpressure event with respect to a hydraulic pump (when frac VFD 410 detects the discharge pressure exceeds a overpressure setpoint with respect to hydraulic fracturing pump 710 a, it stops the frac motor 411 as it activates a shutdown; Figure 6; Paragraph [0062]). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the VFD of Hemandez et al. to automatically shut down during an overpressure event as taught by Payne et al. for the purpose of avoiding catastrophic failure in the system.

Claim 14 lacks an inventive step under PCT Article 33(3) as being obvious over Hemandez et al. in view of Rosman further in view of Payne et al. and further in view of Mail. Hemandez et al. as modified by Rosman and Payne et al. discloses the system of claim 11. Hemandez et al. fails to disclose wherein the maximum pump speed correlates to a critical plunger speed associated with each of the plurality of hydraulic pumps. Mail discloses wherein a maximum pump speed correlates to a critical plunger speed associated with a hydraulic pump (mainstream methods of subsurface downhole pumping (hydraulic pump) include mounted reciprocating mechanisms (plunger) in a casing tube; optimal speeds of up and down strokes can be defined as maximum speeds that will not cause overstressing of pump rod (critical plunger speed); therefore maximum pumping speed correlates to an operation at optimal up and down stroke speed (critical plunger speed) associated with the hydraulic pump; Column 1, Lines 29-33, 39-48, 53-54, 64-67 and Column 2, Lines 1-3). It would have been obvious to one having ordinary skill in the art at the time of filing to modify the maximum pump speed of Hemandez et al. by correlating it to the critical plunger speed as taught by Mail

for the purpose of avoiding overstressing of structural parts and premature damage (Hemandez et al.; Column 1, Lines 64-67 and Column 2, Lines 1-3).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to D Andrews whose telephone number is (571)272-6558. The examiner can normally be reached on M-Th 7-5.

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, David Bagnell can be reached on 571-272-6999. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/D. ANDREWS/
Primary Examiner, Art Unit 3672

6/25/2019

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/210,807	Oehring et al.
	Examiner	Art Unit
	D Andrews	3672

CPC - Searched*		
Symbol	Date	Examiner
E21B 43/26 (text limited as in East history)	06/25/2019	DLA

CPC Combination Sets - Searched*		
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(Not for submission under 37 CFR 1.99)

Application Number	16210807
Filing Date	2018-12-05
First Named Inventor	Jared Oehring
Art Unit	3746
Examiner Name	
Attorney Docket Number	047158.100035

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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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	2	8851860		2014-10-07	Mail	
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	1	20180320483		2018-11-08	Zhang, Yanchai	
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	Examiner Name	
	Attorney Docket Number	047158.100035

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	1	2833711	CA		2014-05-16	Broussard et al.		☒
	2	2955706	CA		2012-10-07	Coli et al.		☒

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	1	Non-Final Office Action mailed February 12, 2019 in related U.S. Patent Application No. 16/170,695	☒
	2	International Search Report and Written Opinion mailed February 15, 2019 in related PCT Application No. PCT/US18/63977	☒
	3	Non-Final Office Action mailed February 25, 2019 in related U.S. Patent Application No. 16/210,749	☒
	4	International Search Report and Written Opinion mailed March 5, 2019 in related PCT Application No. PCT/US18/63970	☒

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	Examiner Name	
	Attorney Docket Number	047158.100035

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	6	Office Action mailed March 1, 2019 in related Canadian Patent Application No. 2,943,275	☒
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See attached certification statement.

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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	/Taylor P. Evans/	Date (YYYY-MM-DD)	2019-03-19
Name/Print	Taylor P. Evans	Registration Number	60506

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	1	4432064		1984-02-14	Barker	
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	3	20150217672		2015-08-06	Shampine	
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	Art Unit	
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	1	2016/144939	WO		2016-09-15	Schlumberger Technologies Corporation		☒
	2	2016/160458	WO		2016-10-06	Schlumberger Technology Corporation		☒

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	1	Office Action mailed December 12, 2018 in related U.S. Patent Application No. 16/160,708	☒
	2	International Search Report and Written Opinion mailed January 2, 2019 in related PCT Patent Application No. PCT/US18/54542	☒
	3	International Search Report and Written Opinion mailed January 2, 2019 in related PCT Patent Application No. PCT/US18/54548	☒
	4	International Search Report and Written Opinion mailed December 31, 2018 in related PCT Patent Application No. PCT/US18/55913	☒
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	
	Examiner Name	
	Attorney Docket Number	047158.100035

EXAMINER SIGNATURE			
Examiner Signature	/D. ANDREWS/	Date Considered	06/25/2019

*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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	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	
	Examiner Name	
	Attorney Docket Number	047158.100035

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

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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	/Taylor P. Evans/	Date (YYYY-MM-DD)	2019-01-22
Name/Print	Taylor P. Evans	Registration Number	60506

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

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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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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16210807
Filing Date	2018-12-05
First Named Inventor	Jared Oehring
Art Unit	3746
Examiner Name	
Attorney Docket Number	047158.100035

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	9206684		2015-12-08	Parra	
	2	9175554		2015-11-03	Watson	
	3	9458687		2016-10-04	Hallundbaek	

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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
	1	20170241221		2017-08-24	Seshadri	
	2	20150330172		2015-11-19	Allmaras	
	3	20110166046		2011-07-07	Weaver	

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	Examiner Name	
	Attorney Docket Number	047158.100035

	4	20060260331		2006-11-23	Andreychuk	
	5	20100101785		2010-04-29	Khvoshchev	
	6	20100200224		2010-08-12	Nguete	
	7	20090090504		2009-04-09	Weightman	
	8	20080264640		2008-10-30	Eslinger	
	9	20080236818		2008-10-02	Dykstra	

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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	2964593	CA		2017-10-15	Oehring		☒
	2	202023547	CN		2011-11-02	Univ China Mining		☒
	3	102602322	CN		2012-07-25	Xi An Bangpu Ind Automation Co Ltd.		☒

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	4	201687513	CN		2010-12-29	Univ Henan Polytechnic		☒
	5	2007340913	AU		2008-07-10	Schlumberger Technology B.V.		☒

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NON-PATENT LITERATURE DOCUMENTS Remove

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 April 10, 2019 in corresponding PCT Application No. PCT/US2019/016635	☒
	2	Notice of Allowance mailed April 23, 2019 in corresponding U.S. Patent Application No. 15/635,028	☒
	3	Schlumberger, "Jet Manual 23, Fracturing Pump Units, SPF/SPS-343, Version 1.0," January 31, 2007, 68 pages	☒
	4	Stewart & Stevenson, "Stimulation Systems," 2007, 20 pages	☒
	5	Luis Gamboa, "Variable Frequency Drives in Oil and Gas Pumping Systems," December 17, 2011, 5 pages	☒
	6	"Griswold Model 811 Pumps: Installation, Operation and Maintenance Manual, ANSI Process Pump," 2010, 60 pages	☒

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Signature	/Taylor P. Evans/	Date (YYYY-MM-DD)	2019-05-29
Name/Print	Taylor P. Evans	Registration Number	60506

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Examiner Name	
Attorney Docket Number	047158.100035

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	3764233		1973-10-09	Strickland	
	2	5879137		1999-03-09	Yie	
	3	7563076		2009-07-21	Brunet	
	4	7683499		2010-03-23	Saucier	
	5	8083504		2011-12-27	Williams	
	6	3334495		1967-08-08	Jensen	
	7	1671436		1928-05-29	Melott	
	8	2004077		1935-06-04	McCartney	

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	9	2220622		1940-11-05	Aitken	
	10	3066503		1962-12-04	Fleming	
	11	3837179		1974-09-24	Barth	
	12	4037431		1977-07-26	Sugimoto	
	13	5907970		1999-06-01	Havlovick et al.	
	14	6142878		2000-11-07	Barin	
	15	8789601		2014-07-29	Broussard	
	16	6271637		2001-08-07	Kushion	
	17	6529135		2003-03-04	Bowers et al.	
	18	6931310		2005-08-16	Shimizu et al.	
	19	7755310		2010-07-13	West et al.	

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	20	8054084		2011-11-08	Schulz et al.	
	21	8310272		2012-11-13	Quarto	
	22	8354817		2013-01-15	Yeh et al.	
	23	8838341		2014-09-16	Kumano	
	24	9018881		2015-04-28	Mao et al.	
	25	2248051		1941-07-08	Armstrong	
	26	3722595		1973-03-27	Kiel	
	27	7312593		2007-12-25	Streicher et al.	
	28	4226299		1980-10-07	Hansen	
	29	4456092		1984-06-26	Kubozuka	
	30	5655361		1997-08-12	Kishi	

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	31	6254462		2001-07-03	Kelton	
	32	3061039		1962-10-30	Peters	
	33	3773140		1973-11-20	Mahajan	
	34	5548093		1996-08-20	Sato	
	35	6202702		2001-03-20	Ohira	
	36	6802690		2004-10-12	Han	
	37	8534235		2013-09-17	Chandler	
	38	8727068		2014-05-20	Bruin	
	39	9103193		2015-08-11	Coli	
	40	6164910		2000-12-26	Mayleben	
	41	7500642		2009-03-10	Cunningham	

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	42	8899940		2014-12-02	Laugemors	
	43	8905056		2004-12-09	Kendrick	
	44	4151575		1979-04-24	Hogue	
	45	5130628		1992-07-14	Owen	
	46	6315523		2001-11-13	Mills	
	47	7336514		2008-02-26	Amarillas	
	48	7525264		1999-04-28	Dodge	
	49	8096891		2012-01-17	Lochtefeld	
	50	9160168		2015-10-13	Chapel	
	51	8146665		2012-04-03	Neal	
	52	8474521		2013-07-02	Kajaria	

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	53	9067182		2015-06-30	Nichols	
	54	8807960		2014-08-19	Stephenson	
	55	5025861		1991-06-25	Huber et al.	
	56	7170262		2007-01-30	Pettigrew	
	57	8997904		2015-04-07	Cryer	
	58	9051822		2015-06-09	Ayan	
	59	9366114		2016-06-14	Coli et al.	
	60	9140110		2015-09-22	Coli et al.	
	61	5422550		1995-06-06	McClanahan	
	62	5865247		1999-02-02	Paterson	
	63	7845413		2010-12-07	Shampine et al.	

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	64	8596056		2013-12-03	Woodmansee	
	65	8774972		2014-07-08	Rusnak et al.	
	66	8905138		2014-12-09	Lundstedt et al.	
	67	9410410		2016-08-09	Broussard et al.	
	68	3881551		1975-05-06	Terry	
	69	4512387		1985-04-23	Rodriguez	
	70	4845981		1989-07-11	Pearson	
	71	6776227		2004-08-17	Beida	
	72	8037936		2011-10-18	Neuroth	
	73	8760657		2014-06-24	Pope	
	74	8857506		2014-10-14	Stone, Jr.	

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	75	5131472		1992-07-21	Dees et al.	
	76	5894888		1999-04-20	Wiemers	
	77	6491098		2002-12-10	Dallas	
	78	7173399		2007-02-06	Sihler	
	79	7445041		2008-11-04	O'Brien	
	80	7807048		2010-10-05	Collette	
	81	8272439		2012-09-25	Strickland	
	82	8573303		2013-11-05	Kerfoot	
	83	9322239		2016-04-26	Angeles Boza et al.	
	84	4506982		1985-03-26	Smithers et al.	
	85	4538916		1985-09-03	Zimmerman, Harold M.	

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	1	UK Power Networks - Transformers to Supply Heat to Tate Modern - from Press Releases May 16, 2013.	☒
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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	/Taylor P. Evans/	Date (YYYY-MM-DD)	2018-12-07
Name/Print	Taylor P. Evans	Registration Number	60506

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.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.A./

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 record s.

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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.A./

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	6159	e21b43/26.cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2019/06/25 06:17
L2	170	("20020169523" | "20070201305" | "20080112802" | "20080217024" | "20090078410" | "20090260826" | "20100051272" | "20100250139" | "20110272158" | "20120127635" | "20130009469" | "20130025706" | "20130233542" | "20130341029" | "20140096974" | "20150144336" | "20160177678" | "20160186531" | "20160221220" | "20160290114" | "20160369609" | "20170030177" | "20170226842" | "2220622" | "2753940" | "3764233" | "3773140" | "4529887" | "5131472" | "5548093" | "6254462" | "6802690" | "7312593" | "7683499" | "7807048" | "8083504" | "8154419" | "8760657" | "8905056" | "9322239" | "9840901" | "20110247878" | "20140095114" | "9206684" | "9458687" | "20090093317" | "20100172202" | "20100293973" | "20130175039" | "20140246211" | "20150114652" | "20160105022" | "20160319650" | "20170028368" | "20170222409" | "3061039" | "4151575" | "4845981" | "5130628" | "6164910" | "6477852" | "6776227" | "6931310" | "7717193" | "8354817" | "8857506" | "9018881" | "9475021" | "9650879" | "20040040746" | "20150075778" | "5006044" | "20140277772" | "20180038216" | "20190003329" | "20100200224" | "20100019574" | "20110017468" | "20120232728" | "20130343858" | "20140174717" | "20150068754" | "20150083426" | "20150176386" | "20150252661" | "20150300145" | "20160160889" | "20160177675" | "20160230525" | "20170037718" | "20170218843" | "20180156210" | "3722595" | "4226299" | "4265266" | "6808303" | "7675189" | "8146665" | "8596056" | "8616274" | "8774972" | "8997904" | "9051822" | "20140379300" | "20150217672" | "20160208595" | "20150097504" | "5189388" | "20090090504" | "2004077" | "20080264649" | "20090188181" | "20090200035" | "20100000508" |	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2019/06/25 06:28

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L4	27	planetary and 1	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2019/06/25 06:28
L5	0	multi-plunger and 1	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2019/06/25 06:31
L6	1	("20170051732").pn.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2019/06/25 06:37
L7	2	"4100822".pn.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2019/06/25 06:41
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L10	3058	pump with speed same plunger with speed	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2019/06/25 07:35
L11	2679	pump with speed with plunger with speed	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2019/06/25 07:35
L12	90	11 and fracturing	US-PGPUB; USPAT; USOCR; EPO;	OR	ON	2019/06/25 07:35

			JPO			
L13	0	(15/316963).APP.	USPAT; USOCR	OR	ON	2019/06/25 07:38
L14	0	(15/191136).APP.	USPAT; USOCR	OR	ON	2019/06/25 07:39
L15	1	(15/191042).APP.	USPAT; USOCR	OR	ON	2019/06/25 07:39
L16	0	planetary and 12	USPAT; USOCR	OR	ON	2019/06/25 07:42
L17	4	multiplex with planetary	USPAT; USOCR	OR	ON	2019/06/25 07:43
L18	0	multiplunger with planetary	USPAT; USOCR	OR	ON	2019/06/25 07:44
L19	18	multiplex and 1	USPAT; USOCR	OR	ON	2019/06/25 07:45
L20	0	19 and planetary	USPAT; USOCR	OR	ON	2019/06/25 07:45
L21	699	multiplex and planetary	US-PGPUB; USPAT; USOCR	OR	ON	2019/06/25 07:46
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L23	1	"20160258267".pn.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2019/06/25 07:57

6/ 25/ 2019 9:08:25 AM
C:\ Users\ dandrews\ Documents\ EAST\ Workspaces\ 16210807.wsp

Electronic Acknowledgement Receipt

EFS ID:	36143285
Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Taylor P. Evans/Stephanie McDonough
Filer Authorized By:	Taylor P. Evans
Attorney Docket Number:	047158.100035
Receipt Date:	29-MAY-2019
Filing Date:	05-DEC-2018
Time Stamp:	14:35:34
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	047158-100035_IDS.pdf	1035523 03c630d6d12d51e05b5a7d35f7b9db401fc9733c	no	6

Warnings:

Information:					
2	Foreign Reference	AU2007340913A1.pdf	1351624 101a4d4491bcfb8cb322f11c91a32fec4999bd3b	no	38
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5	Foreign Reference	CN201687513U.pdf	226387 bd1aa982c8e9e1b3d3f9b75a38ad666796b36e4e	no	9
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6	Foreign Reference	CN202023547U.pdf	242077 ae7f12a5e0111626416ac63d9496c328546482dc	no	8
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7	Non Patent Literature	NPL_1.pdf	569979 fa07922bb2ee2d542cee7270b6bc9a01575ef50a	no	12
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8	Non Patent Literature	NPL_2.pdf	445182 339ddab7193a4c87d8a87d76d732f7c3f8ad7fbd	no	9
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9	Non Patent Literature	NPL_3.pdf	2634600 5cb5a23f980f25c78b9c04c432b8659abd56aebb	no	68
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11	Non Patent Literature	NPL_5.pdf	152937 ee9d31e30faee015704fe45bc3fff0913f8c8df8	no	5
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12	Non Patent Literature	NPL_6.pdf	4115633 58fd5f51e7bdea0ba14aeba1f86b04988b9a9817	no	60
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13	Non Patent Literature	NPL_7.pdf	356270 d5002fc782514d02cc3f46821f8c466c4963f67a	no	5
Warnings:					
Information:					
		Total Files Size (in bytes):	17781507		

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/210,807	12/05/2018	Jared Oehring	047158.100035	2654

132858 7590 05/09/2019

Hogan Lovells US LLP
609 Main Street
Suite 4200
Houston, TX 77002

EXAMINER	

ART UNIT	PAPER NUMBER
3746	

NOTIFICATION DATE	DELIVERY MODE
05/09/2019	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):

hlusdocketing@hoganlovells.com
monica.williams@hoganlovells.com
stephanie.mcdonough@hoganlovells.com

Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 16/210,807	**Applicant(s)** Oehring et al.	
	Examiner Liana Walsh	**Art Unit** OPET	**AIA (FITF) Status** No

1. THE REQUEST FILED 05 December 2018 IS **GRANTED** .

The above-identified application has met the requirements for prioritized examination

A. ☑ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination**. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;

B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;

C. filing a **request for continued examination** ;

D. filing a notice of appeal;

E. filing a request for suspension of action;

F. mailing of a notice of allowance;

G. mailing of a final Office action;

H. completion of examination as defined in 37 CFR 41.102; or

I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to Liana Walsh at (571)272-3206. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/LIANA S WALSH/ Lead Paralegal Specialist, OPET	

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/210,807	12/05/2018	Jared Oehring	047158.100035

CONFIRMATION NO. 2654

132858
Hogan Lovells US LLP
609 Main Street
Suite 4200
Houston, TX 77002

POA ACCEPTANCE LETTER

OC00000107963444

Date Mailed: 05/08/2019

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 01/16/2019.

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**.

/zretta/

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/210,807

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	660
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 460 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1720

APPLICATION AS AMENDED - PART II

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

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

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

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/210,807	12/05/2018	3746	1880	047158.100035	20	3

CONFIRMATION NO. 2654

UPDATED FILING RECEIPT

132858
Hogan Lovells US LLP
609 Main Street
Suite 4200
Houston, TX 77002

OC000000107983575

Date Mailed: 05/08/2019

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

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Assignment For Published Patent Application

U.S. Well Services, Inc., Houston, TX

Power of Attorney: The patent practitioners associated with Customer Number 132858

Domestic Priority data as claimed by applicant

This appln claims benefit of 62/594,912 12/05/2017

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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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/210,807**

Projected Publication Date: 08/15/2019

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Early Publication Request: No

Title

MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

Preliminary Class

417

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

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:		§	
		§	
	Jared Oehring	§	
		§	Attorney Docket No.: 047158.100035
		§	
Serial No.:	16/210,807	§	Confirmation No.: 2654
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Filed:	December 5, 2018	§	Art Unit: Unassigned
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For:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS	§	Examiner: Unassigned

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

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

Sirs:

In response to the Notice to File Corrected Application Papers mailed March 6, 2019, please amend the above-referenced application as follows. If any additional fees are necessary for continued prosecution of this Application, the commissioner is hereby authorized to charge those fees to **Hogan Lovells US LLP's Deposit Account Number 501349**.

Amendments to the Specification are reflected on page 2 of this paper.

Amendments to the Drawings are reflected on page 3 of this paper.

Remarks/Arguments begin on page 4 of this paper.

PATENT APPLICATION

ATTORNEY DOCKET NO.: 047158.100035

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MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of U.S. Provisional Patent Application No. 62/594,912, filed December 5, 2017, the full disclosure of which is hereby incorporated by reference herein for all purposes.

BACKGROUND

[0002] 1. Technical Field

[0003] This disclosure relates generally to drive systems for reciprocating plunger-style pumps used in hydraulic fracturing operations, and more particularly to multi-plunger hydraulic fracturing pumps and associated drive systems.

[0004] 2. Background

[0005] With advancements in technology over the past few decades, the ability to reach unconventional sources of hydrocarbons has tremendously increased. Horizontal drilling and hydraulic fracturing are two such ways that new developments in technology have led to hydrocarbon production from previously unreachable shale formations. Hydraulic fracturing (fracking) operations typically require powering numerous components in order to recover oil and gas resources from the ground. For example, hydraulic fracturing usually includes pumps that inject fracking fluid down the wellbore, blenders that mix proppant into the fluid, cranes, wireline units, and many other components that all must perform different functions to carry out fracking operations.

[0006] Hydraulic fracturing operations commonly use diesel-powered pumps to transmit fluid media down the well bore, the transmissions for the diesel-powered pumps often having seven

speeds or more. When one or more pumps go offline during operation, for example due to system failure or for scheduled maintenance, the speed of the remaining operating pumps is increased accordingly. However, many of the top gears in these diesel transmissions provide speeds that are above the critical speed for the associated plunger pumps. Thus, compensating for the downed pump or pumps by up-shifting operation of the remaining pumps to these higher gears, above the critical speed for the pumps, can result in damage to the pumps. There is a need for hydraulic fracturing pumps that are capable of operation at or below the critical speed, without sacrificing pump rate, efficiency, and efficacy.

SUMMARY

[0007] One of the most common transmissions utilized in hydraulic fracturing pump applications is a nine-speed transmission, often driven by a diesel-powered engine. When this transmission is in fifth gear and the engine is running at 1700 rotations per minute (rpm), for example, the critical speed of 120 rpm on an associated 8-inch stroke pump is reached. Therefore, running the pump with the transmission operating in any of gears six through nine, above the critical speed reached at gear five, could cause pump cavitation and damage accumulation to the fluid end of the pump.

[0008] It has historically been believed that pump cavitation is caused by air entering the pump. Through testing and data-gathering, however, Applicants have observed that pump cavitation and damage are caused by the formation of vacuum bubbles as a result of fluid being accelerated too fast through the pump. A heightened speed of operation creates low pressure within the pumps, creating vacuum bubbles. As the pump plungers retract, the vacuum bubbles implode, causing damage (cavitation) to the pump and engine systems. Although the risks of operating the pumps at too great of speeds may be known, concerns about lowered pump rates and lost

efficiency resulting from maintaining slower transmission speeds commonly lead to disregard of the risks as an unavoidable consequence of maintaining pump efficiency.

[0009] In seeking to avoid such pump damage, Applicants have observed that, by operating transmissions such that pumps are maintained at or below critical pump speeds, such formation of vacuum bubbles and resulting pump cavitation and damage may be avoided. Further still, Applicants have observed that use of electric- or hydraulic-powered pumps may allow for better control of pump speeds at or below the critical speed due to the smaller increments between gear speeds as compared to those of pumps driven by diesel-powered engines.

[0010] Operation below critical pump speeds has previously been avoided as being considered inefficient and ineffective for pump usage in fracking, as slower pump speeds are historically believed to be directly tied to pump rates. Applicant has observed, however, that the introduction of multiple electric- or hydraulic-powered motors driving planetary gear trains can provide effective and efficient pumping power, thereby maintaining a consistent pump rate for fluid transfer, while also sustaining a pumping speed at or below the critical speed for the plungers. For example, Applicant discovered that varying pump bore sizes and stroke lengths, as well as number of plungers, allowed for operation at slower pump speeds while maintaining or increasing fluid pump rates. Applicant also discovered, through testing and analysis, that certain bore size, stroke length, and plunger number combinations provided maximum pump rate efficiency at a usable and economically effective overall pump size.

[0011] The present disclosure is directed to hydraulic fracturing system for fracturing a subterranean formation, according to various embodiments. In an embodiment, the hydraulic fracturing system can include a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, and the multi-plunger pump can be configured

to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation. In an embodiment, the system can further include a plurality of motors positioned to power the multi-plunger pump, and a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors. In an embodiment, a gear ratio of the planetary gear train and a speed at which the plurality of motors operates can be selected so as to limit a maximum pump speed associated with the multi-plunger pump.

[0012] In an embodiment, the system can include a plurality of speed reduction gearboxes positioned between the plurality of input pinion gears and the plurality of motors so as to achieve a desired pump rate.

[0013] In an embodiment, the plurality of motors can include one of a plurality of electric motors or a plurality of hydraulic motors.

[0014] In an embodiment, the maximum pump speed can correlate to a critical plunger speed associated with each of the plurality of hydraulic pumps.

[0015] In an embodiment, the maximum pump speed can be 5% or less over a critical plunger speed associated with each of the plurality of hydraulic pumps.

[0016] In an embodiment, the plurality of hydraulic pumps includes an odd number of plungers greater than or equal to five plungers.

[0017] In an embodiment, a stroke length of each of the plungers associated with the plurality of hydraulic pumps can be selected to inversely relate to a pump speed associated with the plurality of hydraulic pumps so as to achieve a predetermined flow rate.

[0018] In an embodiment, the system can include a variable frequency drive (VFD) connected to the plurality of motors to control the speed of the plurality of motors. The VFD can be positioned

to accelerate or decelerate pump rotational speeds associated with each of the plurality of hydraulic pumps, according to an embodiment.

[0019] In an embodiment, the VFD can include a plurality of VFDs, and the plurality of VFDs can be configured to share a load required to power the plurality of hydraulic pumps.

[0020] In an embodiment, the plurality of VFDs can be configured to automatically shut off in the event of an overpressure event with respect to the plurality of hydraulic pumps.

[0021] The present disclosure is also related to a hydraulic fracturing system for fracturing a subterranean formation, according to an embodiment. In an embodiment, the system can include a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, and the multi-plunger pump can be configured to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation. In an embodiment, a plurality of motors can be positioned to power the multi-plunger pump. The system can further include a variable frequency drive connected to the plurality of motors to control the speeds of the plurality of electric motors, according to an embodiment. In an embodiment, the system can include a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors. In an embodiment, a gear ratio of the planetary gear train and a speed at which the plurality of motors operates can be selected so as to limit a maximum pump speed associated with the multi-plunger pump.

[0022] The present disclosure is also directed to a method for pumping fluid into a wellbore associated with a subterranean formation. In an embodiment, the method can include fluidly connecting a multi-plunger hydraulic fracturing pump to a well associated with the subterranean formation such that the multi-plunger pump pumps fluid into the wellbore at a high pressure so

that fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation. In an embodiment, the method can include powering the multi-plunger pump with a plurality of motors. In an embodiment, the method can further include providing a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors so as to translate power from the plurality of motors into a desired pump rate of the multi-plunger pump.

[0023] Other aspects and features of the present disclosure will become apparent to those of ordinary skill in the art after reading the detailed description herein and the accompanying figures.

BRIEF DESCRIPTION OF DRAWINGS

[0024] Some of the features and benefits of the present invention having been stated, others will become apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

[0025] FIG. 1 is an exploded schematic example of a planetary gear train having multiple input pinions for direct connection to an electric motor, according to an embodiment.

[0026] FIG. 2 is an exploded schematic example of a planetary gear train having a speed reduction gearbox mounting for connection to an electric motor, according to an embodiment.

[0027] FIG. 3 is a schematic example of a multi-plunger pump having nine plungers and four electric motors mounted for driving the multi-plunger pump, according to an embodiment.

[0028] FIG. 4 is a table showing calculations of plunger pump critical speeds according to embodiments of the present technology.

[0029] FIG. 5 is a table showing data related to certain pumps and transmissions in an example application, meant to highlight certain embodiments of the present technology.

[0030] FIGS. 6-10 are tables showing additional data related to certain pumps and transmissions in further example applications, meant to further highlight embodiments of the present technology.

~~[0027]~~[0031] While the invention will be described in connection with the preferred embodiments, it will be understood that the included description is not intended to limit the invention to the described preferred embodiments. On the contrary, the description is intended to cover all alternatives, modifications, and equivalents, as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF INVENTION

~~[0028]~~[0032] The method and system of the present disclosure will now be described more fully hereinafter with reference to the accompanying drawings in which embodiments are shown. The method and system of the present disclosure may be in many different forms and should not be construed as limited to the illustrated embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey its scope to those skilled in the art. Like numbers refer to like elements throughout.

~~[0029]~~[0033] It is to be further understood that the scope of the present disclosure is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. In the drawings and specification, there have been disclosed illustrative embodiments and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation.

~~[0030]~~[0034] Described herein is an example of a method and system for providing reciprocating, plunger-style pumps as part of a multi-plunger system for use in hydraulic fracturing operations. Also described are various drive systems for use with the described reciprocating, plunger-style pumps. In various embodiments, the pumps and drive systems may be utilized by conventionally powered (i.e., diesel engine-driven) hydraulic fracturing pumping systems, or in other embodiments by hydraulically powered or electrically powered hydraulic fracturing pumping systems.

~~[0031]~~[0035] Multi-plunger hydraulic fracturing pumps, though known in the art, are typically limited to either triplex (three plungers) or quintuplex (five plungers) arrangements. Common hydraulic fracturing pumps often utilize 8-inch, 10-inch, and 11-inch stroke triplex and quintuplex hydraulic fracturing pumps. Hydraulic fracturing pumps are commonly driven by an engine (usually a 2500 horsepower (HP) diesel engine) and a multiple speed transmission, usually having seven speeds or more. However, many of the top gears, depending on the manufacturer and gear ratios, provide speeds that are above the critical speed of a plunger pump. ~~Table 1, below,~~ FIG. 4 details calculations of such plunger critical speeds.

~~Plunger Critical Speed Calculations~~

Plunger Critical Speed = 32 in/sec (based on 120 rpm crankshaft speed on 8" stroke pump)
Plunger Maximum Speed = 40 in/sec (based on 150 rpm crankshaft speed on 8" stroke pump)

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
2.75" Bore	8	0.01469	0.02449	0.04408	0.05397	120.00	150.00	1.76	2.94	5.29	7.84	2.20	3.67	6.61	9.55
	9	0.01652	0.02755	0.04959	0.07163	106.67	133.33								
	10	0.01837	0.03061	0.05510	0.07956	96.00	120.00								
	11	0.02020	0.03367	0.06061	0.08754	87.27	109.09								
	12	0.02204	0.03673	0.06612	0.09550	80.00	100.00								
	13	0.02388	0.03979	0.07163	0.10346	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
3.0" Bore	8	0.01749	0.02914	0.05246	0.07577	120.00	150.00	2.10	3.50	6.29	9.09	2.62	4.37	7.87	11.37
	9	0.01967	0.03279	0.05901	0.08524	106.67	133.33								
	10	0.02186	0.03643	0.06557	0.09471	96.00	120.00								
	11	0.02404	0.04007	0.07213	0.10419	87.27	109.09								
	12	0.02623	0.04371	0.07868	0.11366	80.00	100.00								
	13	0.02841	0.04736	0.08524	0.12313	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
3.25" Bore	8	0.02052	0.03420	0.06156	0.08892	120.00	150.00	2.46	4.10	7.38	10.67	3.08	5.13	9.23	13.34
	9	0.02309	0.03848	0.06926	0.10004	106.67	133.33								
	10	0.02565	0.04275	0.07696	0.11116	96.00	120.00								
	11	0.02822	0.04703	0.08465	0.12227	87.27	109.09								
	12	0.03078	0.05130	0.09235	0.13339	80.00	100.00								
	13	0.03335	0.05558	0.10004	0.14450	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
3.5" Bore	8	0.02380	0.03967	0.07140	0.10313	120.00	150.00	2.86	4.76	8.57	12.38	3.57	5.95	10.71	15.47
	9	0.02677	0.04462	0.08032	0.11602	106.67	133.33								
	10	0.02975	0.04958	0.08925	0.12892	96.00	120.00								
	11	0.03272	0.05454	0.09817	0.14181	87.27	109.09								
	12	0.03570	0.05950	0.10710	0.15470	80.00	100.00								
	13	0.03867	0.06446	0.11602	0.16759	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
4.0" Bore	8	0.03109	0.05181	0.09326	0.13470	120.00	150.00	3.73	6.22	11.19	16.16	4.66	7.77	13.99	20.21
	9	0.03497	0.05829	0.10493	0.15159	106.67	133.33								
	10	0.03886	0.06476	0.11657	0.16848	96.00	120.00								
	11	0.04274	0.07124	0.12823	0.18537	87.27	109.09								
	12	0.04663	0.07771	0.13988	0.20206	80.00	100.00								
	13	0.05051	0.08419	0.15154	0.21889	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
4.5" Bore	8	0.03934	0.06557	0.11803	0.17049	120.00	150.00	4.72	7.87	14.16	20.46	5.90	9.84	17.70	25.57
	9	0.04426	0.07377	0.13278	0.19180	106.67	133.33								
	10	0.04918	0.08196	0.14754	0.21311	96.00	120.00								
	11	0.05410	0.09016	0.16229	0.23442	87.27	109.09								
	12	0.05901	0.09836	0.17704	0.25573	80.00	100.00								
	13	0.06393	0.10655	0.19180	0.27704	73.85	92.31								

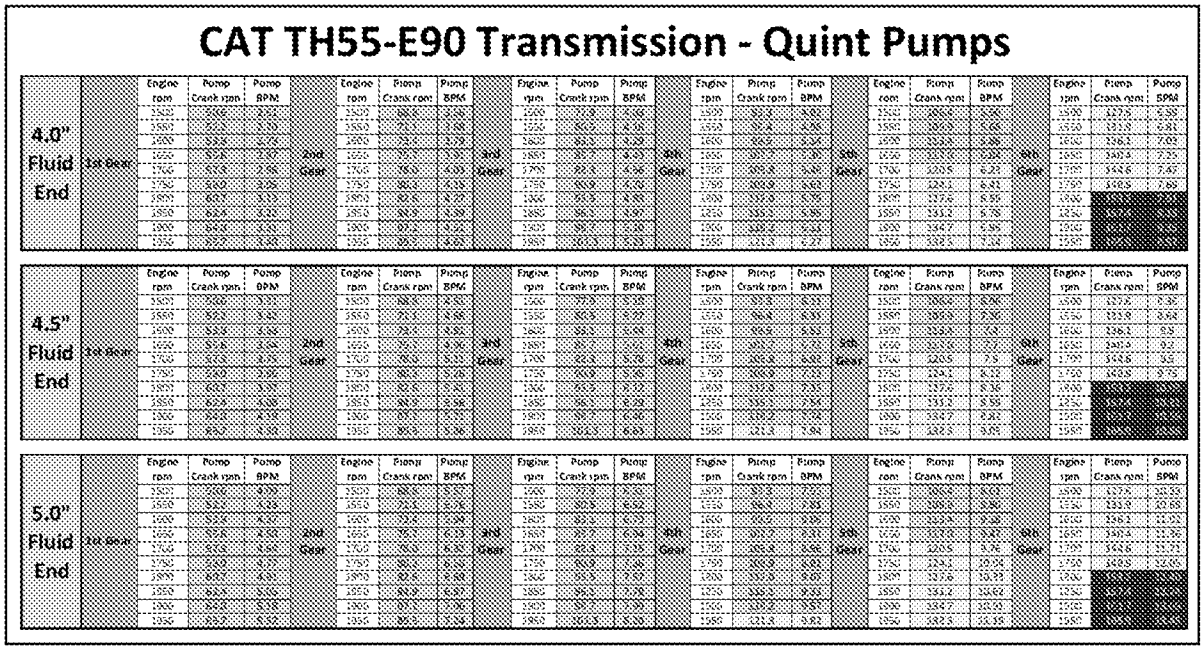
	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
5.0" Bore	8	0.04857	0.08095	0.14571	0.21048	120.00	150.00	5.83	9.71	17.49	25.26	7.29	12.14	21.86	31.57
	9	0.05464	0.09107	0.16393	0.23678	106.67	133.33								
	10	0.06071	0.10119	0.18214	0.26309	96.00	120.00								
	11	0.06679	0.11131	0.20036	0.28940	87.27	109.09								
	12	0.07286	0.12143	0.21857	0.31571	80.00	100.00								
	13	0.07893	0.13155	0.23680	0.34202	73.85	92.31								

~~Table 1 – Plunger Critical Speed Calculations~~

~~[0032]~~[0036] For example, one of the most common transmissions utilized in hydraulic fracturing pump applications is the Caterpillar model TH55-E90, which is a 9-speed transmission. As shown in ~~Table 2 below~~FIG. 5, when this transmission is in 5th gear and the engine is operating at 1700 rpm, the critical speed of 120 rpm on an 8-inch stroke pump is reached. Therefore, running the pump with the transmission in any of gears 6 through 9 could cause pump cavitation and damage accumulation to the fluid end.

Transmission	
CAT TH55-E90 Ratios	
1st Gear	4.87
2nd Gear	3.43
3rd Gear	3.03
4th Gear	2.13
5th Gear	2.26
6th Gear	1.85
7th Gear	1.63
8th Gear	1.36
9th Gear	1.00

Frac Pump	
Fluid End Bore	Quint GPR/rev
4.0"	0.085157
4.5"	0.108540
5.0"	0.134095



~~**Table 2 – Critical Plunger Speed reached in 4th and 5th gears**~~

~~[0033]~~[0037] Similarly, the common hydraulic fracturing application transmissions known in the art may exhibit the same issues in higher gears, as shown below in ~~Tables 3-7~~FIGS. 6-10. For example, as shown in ~~Tables 3 and 4~~FIG. 6 and FIG. 7, the critical plunger speed is reached in the 3rd gear, such that use of gears 4-7 may cause cavitation and damage accumulation. Similarly, as shown in ~~Tables 5 and 6~~FIG. 8 and FIG. 9, the critical plunger speed is reached in the 4th gear, such that use of gears 5-7 may cause cavitation and damage accumulation. In ~~Table 7~~FIG. 10, the critical plunger speed is reached in the 4th gear, such that use of gears 5-9 may result in cavitation and damage accumulation.

Transmission	
Allison 9800 Ratios	
1st Gear	3.75
2nd Gear	2.69
3rd Gear	2.20
4th Gear	1.77
5th Gear	1.58
6th Gear	1.27
7th Gear	1.00

Frac Pump	
Fluid End Bore	Triplex BBL/rev
4.0"	0.031107
4.5"	0.039383
5.0"	0.048605

Allison 9800 Transmission, Triplex Pumps

	TRIPLEX 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.5"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	89.0	2.68	2nd Gear	1500	87.8	2.99	3rd Gear	1500	107.3	3.93	4th Gear	1500	133.4	4.14
		1550	89.1	2.69		1550	90.7	3.09		1550	110.9	4.06		1550	137.8	4.28
		1600	97.0	2.09		1600	93.6	2.91		1600	114.5	3.96		1600	142.3	4.42
		1650	99.3	2.15		1650	96.6	3.00		1650	118.1	4.01		1650	146.7	4.56
		1700	71.4	2.22		1700	99.5	3.06		1700	121.6	4.78		1700	[illegible]	[illegible]
		1750	73.5	2.28		1750	102.4	3.16		1750	125.2	3.89		1750	[illegible]	[illegible]
		1800	75.6	2.35		1800	105.3	3.27		1800	128.8	4.00		1800	[illegible]	[illegible]
		1850	77.7	2.41		1850	108.3	3.36		1850	132.4	4.11		1850	[illegible]	[illegible]
		1900	79.8	2.48		1900	111.2	3.45		1900	135.9	4.22		1900	[illegible]	[illegible]
		1950	81.9	2.54		1950	114.1	3.55		1950	139.5	4.33		1950	[illegible]	[illegible]

	TRIPLEX 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.5"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	89.0	2.89	2nd Gear	1500	87.8	3.23	3rd Gear	1500	107.3	4.22	4th Gear	1500	133.4	5.25
		1550	89.1	2.90		1550	90.7	3.37		1550	110.9	4.36		1550	137.8	5.42
		1600	97.0	3.04		1600	93.6	3.48		1600	114.5	4.50		1600	142.3	5.60
		1650	99.3	3.12		1650	96.6	3.60		1650	118.1	4.64		1650	146.7	5.77
		1700	71.4	2.81		1700	99.5	3.91		1700	121.6	4.78		1700	[illegible]	[illegible]
		1750	73.5	2.89		1750	102.4	4.03		1750	125.2	4.92		1750	[illegible]	[illegible]
		1800	75.6	2.97		1800	105.3	4.14		1800	128.8	5.07		1800	[illegible]	[illegible]
		1850	77.7	3.06		1850	108.3	4.26		1850	132.4	5.21		1850	[illegible]	[illegible]
		1900	79.8	3.14		1900	111.2	4.37		1900	135.9	5.35		1900	[illegible]	[illegible]
		1950	81.9	3.22		1950	114.1	4.49		1950	139.5	5.49		1950	[illegible]	[illegible]

	TRIPLEX 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.5"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	89.0	3.06	2nd Gear	1500	87.8	3.42	3rd Gear	1500	107.3	4.22	4th Gear	1500	133.4	5.48
		1550	89.1	3.18		1550	90.7	3.60		1550	110.9	4.36		1550	137.8	6.05
		1600	97.0	3.28		1600	93.6	3.69		1600	114.5	4.50		1600	142.3	6.03
		1650	99.3	3.36		1650	96.6	3.85		1650	118.1	4.64		1650	146.7	7.12
		1700	71.4	2.98		1700	99.5	4.07		1700	121.6	5.97		1700	[illegible]	[illegible]
		1750	73.5	3.07		1750	102.4	4.19		1750	125.2	6.08		1750	[illegible]	[illegible]
		1800	75.6	3.16		1800	105.3	4.31		1800	128.8	6.25		1800	[illegible]	[illegible]
		1850	77.7	3.25		1850	108.3	4.44		1850	132.4	6.43		1850	[illegible]	[illegible]
		1900	79.8	3.34		1900	111.2	4.56		1900	135.9	6.60		1900	[illegible]	[illegible]
		1950	81.9	3.43		1950	114.1	4.68		1950	139.5	6.77		1950	[illegible]	[illegible]

~~Table 3 – Critical Plunger Speed reached in 3rd gear~~

Transmission	
Allison 9800 Ratios	
1st Gear	3.75
2nd Gear	2.69
3rd Gear	2.20
4th Gear	1.77
5th Gear	1.58
6th Gear	1.27
7th Gear	1.00

Frac Pump	
Fluid End Bore	Quint BBL/rev
4.0"	0.05167
4.5"	0.06542
5.0"	0.08085

Allison 9800 Transmission, Quint Pumps

	QUINT 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 5.5"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	89.0	3.25	2nd Gear	1500	87.8	3.64	3rd Gear	1500	107.3	4.85	4th Gear	1500	133.4	6.03
		1550	89.1	3.36		1550	90.7	4.69		1550	110.9	5.75		1550	137.8	7.12
		1600	97.0	3.47		1600	93.6	4.84		1600	114.5	5.93		1600	142.3	7.35
		1650	99.3	3.58		1650	96.6	4.99		1650	118.1	6.10		1650	146.7	7.58
		1700	71.4	3.09		1700	99.5	5.14		1700	121.6	6.28		1700	[illegible]	[illegible]
		1750	73.5	3.20		1750	102.4	5.29		1750	125.2	6.47		1750	[illegible]	[illegible]
		1800	75.6	3.30		1800	105.3	5.44		1800	128.8	6.65		1800	[illegible]	[illegible]
		1850	77.7	4.01		1850	108.3	5.59		1850	132.4	6.84		1850	[illegible]	[illegible]
		1900	79.8	4.12		1900	111.2	5.74		1900	135.9	7.02		1900	[illegible]	[illegible]
		1950	81.9	4.23		1950	114.1	5.89		1950	139.5	7.21		1950	[illegible]	[illegible]

	QUINT 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 5.5"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	89.0	4.12	2nd Gear	1500	87.8	4.75	3rd Gear	1500	107.3	7.01	4th Gear	1500	133.4	8.73
		1550	89.1	4.26		1550	90.7	4.94		1550	110.9	7.26		1550	137.8	9.03
		1600	97.0	4.40		1600	93.6	5.13		1600	114.5	7.50		1600	142.3	9.32
		1650	99.3	4.54		1650	96.6	5.32		1650	118.1	7.73		1650	146.7	9.61
		1700	71.4	4.07		1700	99.5	5.51		1700	121.6	7.96		1700	[illegible]	[illegible]
		1750	73.5	4.19		1750	102.4	5.73		1750	125.2	8.20		1750	[illegible]	[illegible]
		1800	75.6	4.30		1800	105.3	5.90		1800	128.8	8.43		1800	[illegible]	[illegible]
		1850	77.7	5.08		1850	108.3	7.08		1850	132.4	8.67		1850	[illegible]	[illegible]
		1900	79.8	5.22		1900	111.2	7.28		1900	135.9	8.90		1900	[illegible]	[illegible]
		1950	81.9	5.36		1950	114.1	7.47		1950	139.5	9.14		1950	[illegible]	[illegible]

	QUINT 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 5.5"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	89.0	4.50	2nd Gear	1500	87.8	5.25	3rd Gear	1500	107.3	7.69	4th Gear	1500	133.4	10.00
		1550	89.1	4.65		1550	90.7	5.44		1550	110.9	7.96		1550	137.8	10.18
		1600	97.0	4.80		1600	93.6	5.63		1600	114.5	8.22		1600	142.3	10.52
		1650	99.3	5.01		1650	96.6	5.83		1650	118.1	8.50		1650	146.7	10.88
		1700	71.4	4.78		1700	99.5	6.03		1700	121.6	9.85		1700	[illegible]	[illegible]
		1750	73.5	4.90		1750	102.4	6.29		1750	125.2	10.14		1750	[illegible]	[illegible]
		1800	75.6	5.12		1800	105.3	6.59		1800	128.8	10.43		1800	[illegible]	[illegible]
		1850	77.7	5.29		1850	108.3	6.76		1850	132.4	10.71		1850	[illegible]	[illegible]
		1900	79.8	5.46		1900	111.2	6.99		1900	135.9	11.00		1900	[illegible]	[illegible]
		1950	81.9	5.63		1950	114.1	7.24		1950	139.5	11.29		1950	[illegible]	[illegible]

~~Table 4 – Critical Plunger Speed reached in 3rd gear~~

Transmission	
CAT TH55-E70 Ratios	
1st Gear	5.25
2nd Gear	4.55
3rd Gear	3.22
4th Gear	2.45
5th Gear	1.85
6th Gear	1.20
7th Gear	1.00

Frac Pump	
Fluid End Bore	Triplex SR/rev
4.0"	0.02307
4.5"	0.02922
5.0"	0.04555

CAT TH55-E70 Transmission, Triplex Pumps

	TRIPLEX 4.0	Engine rpm	Pump Crank rpm	Pump SPM	TRIPLEX 4.0	Engine rpm	Pump Crank rpm	Pump SPM	TRIPLEX 4.0	Engine rpm	Pump Crank rpm	Pump SPM	TRIPLEX 4.0	Engine rpm	Pump Crank rpm	Pump SPM	TRIPLEX 4.0	Engine rpm	Pump Crank rpm	Pump SPM
CAT TH55-E70 Transmission	1st Gear	1500	[illegible]	[illegible]	2nd Gear	1500	[illegible]	[illegible]	3rd Gear	1500	[illegible]	[illegible]	4th Gear	1500	[illegible]	[illegible]	5th Gear	1500	125.0	4.01
		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	135.3	4.14
		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	127.5	4.35
		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	141.9	4.41
		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	145.2	4.54
		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	3.45		1750	[illegible]	[illegible]
		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]
		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]
		1900	[illegible]	[illegible]		1900	[illegible]	[illegible]		1900	[illegible]	[illegible]		1900	120.5	3.75		1900	[illegible]	[illegible]
		1950	[illegible]	[illegible]		1950	[illegible]	[illegible]		1950	[illegible]	[illegible]		1950	123.8	3.95		1950	[illegible]	[illegible]

	TRIPLEX 4.5	Engine rpm	Pump Crank rpm	Pump SPM	TRIPLEX 4.5	Engine rpm	Pump Crank rpm	Pump SPM	TRIPLEX 4.5	Engine rpm	Pump Crank rpm	Pump SPM	TRIPLEX 4.5	Engine rpm	Pump Crank rpm	Pump SPM	TRIPLEX 4.5	Engine rpm	Pump Crank rpm	Pump SPM
CAT TH55-E70 Transmission	1st Gear	1500	[illegible]	[illegible]	2nd Gear	1500	[illegible]	[illegible]	3rd Gear	1500	[illegible]	[illegible]	4th Gear	1500	[illegible]	[illegible]	5th Gear	1500	125.0	5.07
		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	135.3	5.24
		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	127.5	5.41
		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	141.9	5.58
		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	146.2	5.75
		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]
		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]
		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]
		1900	[illegible]	[illegible]		1900	[illegible]	[illegible]		1900	[illegible]	[illegible]		1900	120.5	4.74		1900	[illegible]	[illegible]
		1950	[illegible]	[illegible]		1950	[illegible]	[illegible]		1950	[illegible]	[illegible]		1950	123.2	4.87		1950	[illegible]	[illegible]

	TRIPLEX 5.0	Engine rpm	Pump Crank rpm	Pump SPM	TRIPLEX 5.0	Engine rpm	Pump Crank rpm	Pump SPM	TRIPLEX 5.0	Engine rpm	Pump Crank rpm	Pump SPM	TRIPLEX 5.0	Engine rpm	Pump Crank rpm	Pump SPM	TRIPLEX 5.0	Engine rpm	Pump Crank rpm	Pump SPM
CAT TH55-E70 Transmission	1st Gear	1500	[illegible]	[illegible]	2nd Gear	1500	[illegible]	[illegible]	3rd Gear	1500	[illegible]	[illegible]	4th Gear	1500	[illegible]	[illegible]	5th Gear	1500	125.0	6.26
		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	135.5	6.47
		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	137.5	6.68
		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	141.9	6.82
		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	146.2	7.15
		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]
		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]
		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]
		1900	[illegible]	[illegible]		1900	[illegible]	[illegible]		1900	[illegible]	[illegible]		1900	120.5	5.85		1900	[illegible]	[illegible]
		1950	[illegible]	[illegible]		1950	[illegible]	[illegible]		1950	[illegible]	[illegible]		1950	123.8	6.01		1950	[illegible]	[illegible]

~~**Table 5 – Critical Plunger Speed reached in 4th gear**~~

Transmission	
CAT TH55-E70 Ratios	
1st Gear	5.25
2nd Gear	4.55
3rd Gear	3.32
4th Gear	2.45
5th Gear	1.85
6th Gear	1.36
7th Gear	1.00

Frac Pump	
Fluid End Bore	Quint SR/rev
4.0"	0.05157
4.5"	0.06542
5.0"	0.08035

CAT TH55-E70 Transmission, Quint Pumps

	QUINT 4.0	Engine rpm	Pump Crank rpm	Pump SPM	QUINT 4.0	Engine rpm	Pump Crank rpm	Pump SPM	QUINT 4.0	Engine rpm	Pump Crank rpm	Pump SPM	QUINT 4.0	Engine rpm	Pump Crank rpm	Pump SPM	QUINT 4.0	Engine rpm	Pump Crank rpm	Pump SPM
CAT TH55-E70 Transmission	1st Gear	1500	[illegible]	[illegible]	2nd Gear	1500	[illegible]	[illegible]	3rd Gear	1500	[illegible]	[illegible]	4th Gear	1500	[illegible]	[illegible]	5th Gear	1500	125.0	6.67
		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	135.2	6.89
		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	137.5	7.11
		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	141.5	7.33
		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	145.2	7.56
		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]
		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]
		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	6.07		1850	[illegible]	[illegible]
		1900	[illegible]	[illegible]		1900	[illegible]	[illegible]		1900	[illegible]	[illegible]		1900	120.5	6.25		1900	[illegible]	[illegible]
		1950	[illegible]	[illegible]		1950	[illegible]	[illegible]		1950	[illegible]	[illegible]		1950	123.2	6.40		1950	[illegible]	[illegible]

	QUINT 4.5	Engine rpm	Pump Crank rpm	Pump SPM	QUINT 4.5	Engine rpm	Pump Crank rpm	Pump SPM	QUINT 4.5	Engine rpm	Pump Crank rpm	Pump SPM	QUINT 4.5	Engine rpm	Pump Crank rpm	Pump SPM	QUINT 4.5	Engine rpm	Pump Crank rpm	Pump SPM
CAT TH55-E70 Transmission	1st Gear	1500	[illegible]	[illegible]	2nd Gear	1500	[illegible]	[illegible]	3rd Gear	1500	[illegible]	[illegible]	4th Gear	1500	[illegible]	[illegible]	5th Gear	1500	125.0	8.45
		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	135.2	8.72
		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	[illegible]	8.65		1600	137.5	9.0
		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	141.9	9.3
		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	145.2	9.6
		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]
		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]
		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]
		1900	[illegible]	[illegible]		1900	[illegible]	[illegible]		1900	[illegible]	[illegible]		1900	120.5	7.90		1900	[illegible]	[illegible]
		1950	[illegible]	[illegible]		1950	[illegible]	[illegible]		1950	[illegible]	[illegible]		1950	123.2	8.00		1950	[illegible]	[illegible]

	QUINT 5.0	Engine rpm	Pump Crank rpm	Pump SPM	QUINT 5.0	Engine rpm	Pump Crank rpm	Pump SPM	QUINT 5.0	Engine rpm	Pump Crank rpm	Pump SPM	QUINT 5.0	Engine rpm	Pump Crank rpm	Pump SPM	QUINT 5.0	Engine rpm	Pump Crank rpm	Pump SPM
CAT TH55-E70 Transmission	1st Gear	1500	[illegible]	[illegible]	2nd Gear	1500	[illegible]	[illegible]	3rd Gear	1500	[illegible]	[illegible]	4th Gear	1500	[illegible]	[illegible]	5th Gear	1500	125.0	10.44
		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	[illegible]	[illegible]		1550	135.5	10.79
		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	[illegible]	[illegible]		1600	137.5	11.14
		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	[illegible]	[illegible]		1650	141.9	11.45
		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	[illegible]	[illegible]		1700	145.2	11.84
		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]		1750	[illegible]	[illegible]
		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]		1800	[illegible]	[illegible]
		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]		1850	[illegible]	[illegible]
		1900	[illegible]	[illegible]		1900	[illegible]	[illegible]		1900	[illegible]	[illegible]		1900	120.5	9.76		1900	[illegible]	[illegible]
		1950	[illegible]	[illegible]		1950	[illegible]	[illegible]		1950	[illegible]	[illegible]		1950	123.2	10.03		1950	[illegible]	[illegible]

~~**Table 6 – Critical Plunger Speed reached in 4th gear**~~

Transmission TA90-8501 Ratios	
1st Gear	4.47
2nd Gear	3.57
3rd Gear	2.85
4th Gear	2.41
5th Gear	1.92
6th Gear	1.54
7th Gear	1.25
8th Gear	1.00
9th Gear	0.80

Frac Pump	
Fluid End Bore	Quint BBL/rev
4.0"	0.05387
4.5"	0.06548
5.0"	0.08095

Twin Disc TA90-8501 Transmission - Quint Pumps

4.0" Fluid End

1st Gear				2nd Gear				3rd Gear				4th Gear				5th Gear		
Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM
1500	62.8	3.77		1500	80.1	3.42		1500	83.9	4.28		1500	98.0	5.06		1500	123.0	6.35
1550	64.8	3.89		1550	82.7	3.53		1550	86.6	4.42		1550	101.2	5.23		1550	127.1	6.57
1600	66.9	4.01		1600	85.3	3.65		1600	89.4	4.57		1600	104.5	5.40		1600	131.2	6.78
1650	68.9	4.13		1650	87.9	3.76		1650	92.1	4.71		1650	107.8	5.57		1650	135.3	6.99
1700	70.9	4.26		1700	90.6	3.87		1700	94.9	4.85		1700	111.0	5.74		1700	139.4	7.20
1750	72.9	4.38		1750	93.2	3.98		1750	97.7	4.99		1750	114.3	5.91		1750	143.5	7.41
1800	74.9	4.50		1800	95.8	4.10		1800	100.4	5.14		1800	117.6	6.07		1800	147.6	7.62
1850	76.9	4.62		1850	98.4	4.21		1850	103.2	5.28		1850	120.8	6.24		1850	[illegible]	[illegible]
1900	78.9	4.74		1900	101.0	4.33		1900	105.9	5.42		1900	124.1	6.41		1900	[illegible]	[illegible]
1950	80.9	4.86		1950	103.6	4.44		1950	108.7	5.56		1950	127.4	6.58		1950	[illegible]	[illegible]

4.5" Fluid End

1st Gear				2nd Gear				3rd Gear				4th Gear				5th Gear		
Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM
1500	62.8	3.66		1500	80.1	4.38		1500	83.9	5.07		1500	98.0	6.03		1500	123.0	8.05
1550	64.8	3.77		1550	82.7	4.48		1550	86.6	5.23		1550	101.2	6.23		1550	127.1	8.32
1600	66.9	3.89		1600	85.3	4.63		1600	89.4	5.40		1600	104.5	6.44		1600	131.2	8.6
1650	68.9	4.00		1650	87.9	4.76		1650	92.1	5.57		1650	107.8	6.66		1650	135.3	8.9
1700	70.9	4.12		1700	90.6	4.91		1700	94.9	6.15		1700	111.0	7.27		1700	139.4	9.1
1750	72.9	4.24		1750	93.2	5.05		1750	97.7	6.34		1750	114.3	7.48		1750	143.5	9.39
1800	74.9	4.35		1800	95.8	5.20		1800	100.4	6.52		1800	117.6	7.70		1800	147.6	9.66
1850	76.9	4.47		1850	98.4	5.34		1850	103.2	6.69		1850	120.8	7.91		1850	[illegible]	[illegible]
1900	78.9	4.59		1900	101.0	5.49		1900	105.9	6.87		1900	124.1	8.13		1900	[illegible]	[illegible]
1950	80.9	4.70		1950	103.6	5.63		1950	108.7	7.05		1950	127.4	8.34		1950	[illegible]	[illegible]

5.0" Fluid End

1st Gear				2nd Gear				3rd Gear				4th Gear				5th Gear		
Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM
1500	62.8	4.28		1500	80.1	5.35		1500	83.9	6.21		1500	98.0	7.36		1500	123.0	9.85
1550	64.8	4.42		1550	82.7	5.53		1550	86.6	6.40		1550	101.2	8.20		1550	127.1	10.28
1600	66.9	4.56		1600	85.3	5.71		1600	89.4	7.37		1600	104.5	8.46		1600	131.2	10.62
1650	68.9	4.70		1650	87.9	5.89		1650	92.1	7.58		1650	107.8	8.72		1650	135.3	10.95
1700	70.9	4.84		1700	90.6	6.07		1700	94.9	7.80		1700	111.0	8.98		1700	139.4	11.28
1750	72.9	4.98		1750	93.2	6.25		1750	97.7	7.82		1750	114.3	9.25		1750	143.5	11.61
1800	74.9	5.12		1800	95.8	6.42		1800	100.4	8.05		1800	117.6	9.52		1800	147.6	11.95
1850	76.9	5.27		1850	98.4	6.60		1850	103.2	8.27		1850	120.8	9.78		1850	[illegible]	[illegible]
1900	78.9	5.41		1900	101.0	6.78		1900	105.9	8.49		1900	124.1	10.05		1900	[illegible]	[illegible]
1950	80.9	5.55		1950	103.6	6.96		1950	108.7	8.72		1950	127.4	10.31		1950	[illegible]	[illegible]

~~Table 7 – Critical Plunger Speed reached in 4th gear~~

~~[0034]~~[0038] Use of the multi-plunger hydraulic fracturing pumps according to the present disclosure may eliminate the need for a diesel engine and transmission. As shown above, diesel engines and transmissions often include multiple gears that accelerate the plunger speed above critical operating speeds. This elimination of the typical engine and transmission from hydraulic fracturing pump units may enable the pumps to be driven by multiple electric motors, according to some embodiments, or multiple hydraulic motors according to other embodiments. These electric or hydraulic motors may have fewer gears such that operation in gears that increase the plunger speeds above their critical speeds can be avoided. By using multiple motors, whether

hydraulic or electric, to drive a single pump, pump rates can be increased without exceeding critical plunger speeds.

~~[0035]~~[0039] Use of electric or hydraulic motors, rather than diesel motors, may also make maintenance, repair, and replacement of the electric motors safer and faster than single or double electric motor-driven pumps. This configuration may prevent the fracturing pumps from being run at speeds higher than the critical plunger speed, which may help to minimize pump cavitation and damage accumulation, thus greatly extending the usable life of the pump fluid ends. For example, as discussed in more detail below, the system could be designed to allow only a slight overspeed of the pumps beyond the identified critical pump speed as a safety margin in the event that one of the fleet's pumps were taken offline for repairs or maintenance, and an additional rate of the remaining online pumps were required to complete the stage being pumped.

~~[0036]~~[0040] In the multiple electric motor-driven embodiment of the present disclosure, the electric motors may directly drive the pump, and the gear ratios of the planetary drive along with the electric motor-rated speeds may be chosen to limit the maximum pump speed, so as to not exceed the plunger critical speed. However, the gear ratios and electric motor-rated speeds may also be chosen to allow only a slight percentage of overspeed (higher than critical plunger speed) as a safe margin to enable a fleet of operating pumps to achieve a desired pump rate, for example when one pump is taken off line, as is often the case in hydraulic fracturing. For example, the gear ratios and electric motor-rated speeds may be chosen to operate 5% or less above the critical plunger speed according to some examples; 10% or less above the critical plunger speed according to some examples; or any other acceptable range as will be readily understood by one having ordinary skill in the art. Repairs or maintenance are generally performed as quickly as possible so that the offline pump is available by the next sequential fracturing stage. This same

logic could be applied to the hydraulic motor driven system or the system that utilizes speed reduction gearboxes driving a single ring gear.

~~[0037]~~[0041] By the present disclosure, multi-plunger hydraulic fracturing pumps utilizing higher multiples of plungers, such as 7, 9, 11, 13, etc. (septenplex, novenplex, undenplex, tredenplex, etc.), are described. In some embodiments, more than 13 plungers may be utilized, as will be readily understood by one having ordinary skill in the art. In some embodiments, odd numbers of plungers may be chosen so that the pump flow ripple magnitude is minimized. For example, in multi-plunger hydraulic fracturing pumps having higher numbers of plungers, the plunger ripple frequency may be increased, thereby reducing the amount of time between ripples, which may provide a smoother pressure performance for the pumps.

~~[0038]~~[0042] In some embodiments, longer stroke lengths of the plunger pumps may be utilized to reduce plunger speed. For example, a 10-inch stroke pump of a given plunger size may be run at a slower speed than an 8-inch stroke pump of the same plunger size, in order to accomplish the same flow rate. Slowing the plunger down may also decrease the possibility of pump cavitation. For example, when triplex and quintuplex pumps, as are known in the art, are operated at higher rates, conditions for cavitation to occur are measurably higher. According to an embodiment, a critical pump speed may be 120 rpm of the pump crankshaft. With this pump speed, on the currently used 8-inch stroke pumps, the rotational speed translates to an average linear speed of the plungers at a velocity of 32 inches per second. At higher speeds, with every stroke of the plungers, fluid is accelerated into and out of the pump fluid end, creating a likelihood of low pressure regions within the fluid end that approach or dip below vapor pressure values for the fluid, thereby causing cavitation, and ultimately damage accumulation, to occur. The use of longer stroke plungers accordingly contributes critically to longer fluid end life.

~~[0039]~~[0043] Various drive systems for powering multi-plunger hydraulic fracturing pumps are contemplated. According to an embodiment, multiple electric motors may be utilized to power the multi-plunger hydraulic fracturing pump. The number of motors utilized may be selected based on the output hydraulic horsepower for which the pump is designed, in some examples. In other examples, the number of motors could be determined on an "n plus 1" basis, in which "n" number of motors would be adequate to provide enough input power according to the output hydraulic horsepower for which the pump is designed, and one ("1") additional motor would be included to allow for a single motor failure or maintenance situation. In such a situation, the failed motor (or motor purposefully removed for maintenance) could be disconnected from the electrical circuit and allowed to freewheel, while the remaining operational motors would still provide adequate power for the pump, according to an embodiment.

~~[0040]~~[0044] In the example illustrated in FIG. 1, an exploded schematic view shows an embodiment of a planetary gear train 100 in which the multiple input pinion gears 135 are directly connected to the electric motors 130. According to the illustrated embodiment, both ends of the pump crankshaft 105 may be powered with an identical planetary gear train 120 and electric motors 130 to enable the motors 130 to be sized small enough to simplify motor removal and installation as compared to a larger single electric motor, or a double electric motor drive system.

~~[0041]~~[0045] In the illustrated embodiment of FIG. 1, eight electric motors 130 may correspond to and drive eight input pinion gears 135 associated with a single main planetary gear 125. The main planetary gear 125 may in turn drive the sun gear 115 positioned central to three planetary gears 120. The final drive gear 110 may have internal gear teeth positioned to catch the external gear teeth of the three planetary gears 120, which may cause rotation of the pump crankshaft

105. In this way, a plurality of electric motors 130 may provide power to a pump crankshaft 105, which may in turn drive a multi-plunger pump, for example as illustrated in FIG. 3 and discussed in greater detail below.

~~[0042]~~[0046] In another embodiment, multiple hydraulic motors may be utilized to power a multi-plunger hydraulic fracturing pump, in which a planetary gear train system 100 similar to that illustrated in FIG. 1 could also be utilized. In an example, a planetary gear train system may be utilized on one or both ends of the pump crankshaft to allow for smaller hydraulic motors to be utilized.

~~[0043]~~[0047] According to an alternate embodiment, for example as illustrated in FIG. 2, a plurality of electric motors or hydraulic motors 230 each may be mounted to a plurality of speed reduction gearboxes 245. FIG. 2 illustrates an exploded schematic example of a planetary gear train 200 having a plurality of speed reduction gearbox 245 mountings for connection to a plurality of electric motors 230, according to an embodiment. The speed reduction gearboxes 245 may, in turn, power a single ring gear 240 to turn the pump crankshaft 205 at the proper rpm needed to drive the multi-plunger pumps at the desired pump rate. In some examples, this configuration may not require use of a multi-planetary gear train system as described above and illustrated in FIG. 1, for example. For example, as illustrated in the embodiment of FIG. 2, the plurality of electric motors 230 may drive the main planetary gear in the form of a ring gear 240 through speed reduction gearboxes 245, and the ring gear 240 may directly turn the pump crankshaft 205. In such an example additional planetary gears 120, as illustrated in the embodiment of FIG. 1, for example, may not be included.

~~[0044]~~[0048] In an embodiment utilizing multiple electric motors, the fleet of fracturing pumps may be powered by multiple electric motors, and overall electric power may be generated by one

or more diesel or gas turbines. When the pumps are being brought online to pump fluids into the well, the power may be switched via appropriate switchgear to the electric motors.

~~[0045]~~[0049] In some embodiments, the speed of the motors may be controlled by one or more variable frequency drives (VFD), which may accelerate or decelerate the pump rotational speeds using an S curve. The pump operator may select the various pump speeds via a human-machine interface (HMI) according to some embodiments, for example from inside a data van, or from a "suitcase," which is a portable, standalone HMI. The HMI or suitcase may allow on/off control of the pumps as well as speed control of the pumps, to allow the pumps to run at speeds from zero crankshaft rpm up to the maximum speed, which would correlate with the plunger critical speed.

~~[0046]~~[0050] According to an embodiment, one of the VFDs may be designated as the master VFD, and the remaining VFDs may be designed to share the load required to power the pump under all load conditions. In the case of an overpressure event, the hydraulic fracturing controls may automatically turn the VFD off using the on/off signal for rapid shutdown, instead of using the rpm command, which uses an S curve to control the acceleration and/or deceleration. A manual emergency shutdown may also be included, which uses an HMI (such as a push button or other HMI, which may be electronic and/or manual) to shut off the VFD using the on/off function. This manual emergency shutdown feature may be configured to shut down all VFDs simultaneously, thereby shutting down the entire site. The emergency shutdown may also be configured to stop the VFD on the blender discharge pumps, and may or may not be tied into the electrical microgrid to open breakers, thereby stopping the flow and/or generation of electricity and/or gas compression.

~~[0047]~~[0051] The HMI may be designed to allow only a slight percentage of overspeed (higher than critical plunger speed) as a safe margin to enable a fleet of operating pumps to achieve a desired pump rate when one pump is taken offline, for example, as is often the case in hydraulic fracturing. Repairs or maintenance are generally performed as quickly as possible so that the offline pump is available by the next sequential fracturing stage. This same logic could be applied to the hydraulic motor driven system or the system that utilizes speed reduction gearboxes driving a single ring gear.

~~[0048]~~[0052] FIG. 3 illustrates a schematic example of a multi-plunger pump 300 with four electric motors mounted to the pump for driving the multi-plunger pump, according to an embodiment. In the illustrated embodiment, the multi-plunger pump 300 may include nine plungers positioned at the multi-plunger fluid end 350 of the multi-plunger pump 300. In other embodiments, various other numbers of plungers may be included, as will be readily understood by one having ordinary skill in the art.

~~[0049]~~[0053] A crankshaft centerline 360 may bisect the multi-plunger pump 300 between the multi-plunger fluid end 350 and the pump power end 355. Two electric motors 330 may be positioned on opposing sides of the multi-plunger pump 300, across the crankshaft centerline 360. The four total electric motors 330 may drive the crankshaft associated with the nine plungers, as described above with respect to FIGS. 1 and 2. For example, in some embodiments the four electric motors 330 may drive the crankshaft via one or more planetary gear trains. In some embodiments, a plurality of speed reduction gearboxes may be positioned between the electric motors 330 and the one or more planetary gear trains so as to control the rotational speed of the one or more planetary gear trains and, ultimately, the pump rate of the plungers.

~~[0050]~~[0054] The present invention described herein, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned, as well as others inherent therein. While a presently preferred embodiment of the invention has been given for purposes of disclosure, numerous changes exist in the details of procedures for accomplishing the desired results. These and other similar modifications will readily suggest themselves to those skilled in the art, and are intended to be encompassed within the spirit of the present invention disclosed herein and the scope of the appended claims.

ABSTRACT

A hydraulic fracturing system for fracturing a subterranean formation is described according to various embodiments. In an embodiment, the system can include a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, the multi-plunger pump configured to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation. In an embodiment, a plurality of motors can be positioned to power the multi-plunger pump, and a planetary gear train can have a plurality of pinion gears in rotational contact with each of the plurality of motors. In an embodiment, a gear ratio of the planetary gear train and a speed at which the plurality of motors operates can be selected so as to limit a maximum pump speed associated with the multi-plunger pump.

ABSTRACT

A hydraulic fracturing system for fracturing a subterranean formation is described according to various embodiments. In an embodiment, the system can include a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, the multi-plunger pump configured to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation. In an embodiment, a plurality of motors can be positioned to power the multi-plunger pump, and a planetary gear train can have a plurality of pinion gears in rotational contact with each of the plurality of motors. In an embodiment, a gear ratio of the planetary gear train and a speed at which the plurality of motors operates can be selected so as to limit a maximum pump speed associated with the multi-plunger pump.

PATENT APPLICATION

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MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of U.S. Provisional Patent Application No. 62/594,912, filed December 5, 2017, the full disclosure of which is hereby incorporated by reference herein for all purposes.

BACKGROUND

[0002] 1. Technical Field

[0003] This disclosure relates generally to drive systems for reciprocating plunger-style pumps used in hydraulic fracturing operations, and more particularly to multi-plunger hydraulic fracturing pumps and associated drive systems.

[0004] 2. Background

[0005] With advancements in technology over the past few decades, the ability to reach unconventional sources of hydrocarbons has tremendously increased. Horizontal drilling and hydraulic fracturing are two such ways that new developments in technology have led to hydrocarbon production from previously unreachable shale formations. Hydraulic fracturing (fracking) operations typically require powering numerous components in order to recover oil and gas resources from the ground. For example, hydraulic fracturing usually includes pumps that inject fracking fluid down the wellbore, blenders that mix proppant into the fluid, cranes, wireline units, and many other components that all must perform different functions to carry out fracking operations.

[0006] Hydraulic fracturing operations commonly use diesel-powered pumps to transmit fluid media down the well bore, the transmissions for the diesel-powered pumps often having seven

speeds or more. When one or more pumps go offline during operation, for example due to system failure or for scheduled maintenance, the speed of the remaining operating pumps is increased accordingly. However, many of the top gears in these diesel transmissions provide speeds that are above the critical speed for the associated plunger pumps. Thus, compensating for the downed pump or pumps by up-shifting operation of the remaining pumps to these higher gears, above the critical speed for the pumps, can result in damage to the pumps. There is a need for hydraulic fracturing pumps that are capable of operation at or below the critical speed, without sacrificing pump rate, efficiency, and efficacy.

SUMMARY

[0007] One of the most common transmissions utilized in hydraulic fracturing pump applications is a nine-speed transmission, often driven by a diesel-powered engine. When this transmission is in fifth gear and the engine is running at 1700 rotations per minute (rpm), for example, the critical speed of 120 rpm on an associated 8-inch stroke pump is reached. Therefore, running the pump with the transmission operating in any of gears six through nine, above the critical speed reached at gear five, could cause pump cavitation and damage accumulation to the fluid end of the pump.

[0008] It has historically been believed that pump cavitation is caused by air entering the pump. Through testing and data-gathering, however, Applicants have observed that pump cavitation and damage are caused by the formation of vacuum bubbles as a result of fluid being accelerated too fast through the pump. A heightened speed of operation creates low pressure within the pumps, creating vacuum bubbles. As the pump plungers retract, the vacuum bubbles implode, causing damage (cavitation) to the pump and engine systems. Although the risks of operating the pumps at too great of speeds may be known, concerns about lowered pump rates and lost

efficiency resulting from maintaining slower transmission speeds commonly lead to disregard of the risks as an unavoidable consequence of maintaining pump efficiency.

[0009] In seeking to avoid such pump damage, Applicants have observed that, by operating transmissions such that pumps are maintained at or below critical pump speeds, such formation of vacuum bubbles and resulting pump cavitation and damage may be avoided. Further still, Applicants have observed that use of electric- or hydraulic-powered pumps may allow for better control of pump speeds at or below the critical speed due to the smaller increments between gear speeds as compared to those of pumps driven by diesel-powered engines.

[0010] Operation below critical pump speeds has previously been avoided as being considered inefficient and ineffective for pump usage in fracking, as slower pump speeds are historically believed to be directly tied to pump rates. Applicant has observed, however, that the introduction of multiple electric- or hydraulic-powered motors driving planetary gear trains can provide effective and efficient pumping power, thereby maintaining a consistent pump rate for fluid transfer, while also sustaining a pumping speed at or below the critical speed for the plungers. For example, Applicant discovered that varying pump bore sizes and stroke lengths, as well as number of plungers, allowed for operation at slower pump speeds while maintaining or increasing fluid pump rates. Applicant also discovered, through testing and analysis, that certain bore size, stroke length, and plunger number combinations provided maximum pump rate efficiency at a usable and economically effective overall pump size.

[0011] The present disclosure is directed to hydraulic fracturing system for fracturing a subterranean formation, according to various embodiments. In an embodiment, the hydraulic fracturing system can include a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, and the multi-plunger pump can be configured

to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation. In an embodiment, the system can further include a plurality of motors positioned to power the multi-plunger pump, and a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors. In an embodiment, a gear ratio of the planetary gear train and a speed at which the plurality of motors operates can be selected so as to limit a maximum pump speed associated with the multi-plunger pump.

[0012] In an embodiment, the system can include a plurality of speed reduction gearboxes positioned between the plurality of input pinion gears and the plurality of motors so as to achieve a desired pump rate.

[0013] In an embodiment, the plurality of motors can include one of a plurality of electric motors or a plurality of hydraulic motors.

[0014] In an embodiment, the maximum pump speed can correlate to a critical plunger speed associated with each of the plurality of hydraulic pumps.

[0015] In an embodiment, the maximum pump speed can be 5% or less over a critical plunger speed associated with each of the plurality of hydraulic pumps.

[0016] In an embodiment, the plurality of hydraulic pumps includes an odd number of plungers greater than or equal to five plungers.

[0017] In an embodiment, a stroke length of each of the plungers associated with the plurality of hydraulic pumps can be selected to inversely relate to a pump speed associated with the plurality of hydraulic pumps so as to achieve a predetermined flow rate.

[0018] In an embodiment, the system can include a variable frequency drive (VFD) connected to the plurality of motors to control the speed of the plurality of motors. The VFD can be positioned

to accelerate or decelerate pump rotational speeds associated with each of the plurality of hydraulic pumps, according to an embodiment.

[0019] In an embodiment, the VFD can include a plurality of VFDs, and the plurality of VFDs can be configured to share a load required to power the plurality of hydraulic pumps.

[0020] In an embodiment, the plurality of VFDs can be configured to automatically shut off in the event of an overpressure event with respect to the plurality of hydraulic pumps.

[0021] The present disclosure is also related to a hydraulic fracturing system for fracturing a subterranean formation, according to an embodiment. In an embodiment, the system can include a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, and the multi-plunger pump can be configured to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation. In an embodiment, a plurality of motors can be positioned to power the multi-plunger pump. The system can further include a variable frequency drive connected to the plurality of motors to control the speeds of the plurality of electric motors, according to an embodiment. In an embodiment, the system can include a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors. In an embodiment, a gear ratio of the planetary gear train and a speed at which the plurality of motors operates can be selected so as to limit a maximum pump speed associated with the multi-plunger pump.

[0022] The present disclosure is also directed to a method for pumping fluid into a wellbore associated with a subterranean formation. In an embodiment, the method can include fluidly connecting a multi-plunger hydraulic fracturing pump to a well associated with the subterranean formation such that the multi-plunger pump pumps fluid into the wellbore at a high pressure so

that fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation. In an embodiment, the method can include powering the multi-plunger pump with a plurality of motors. In an embodiment, the method can further include providing a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors so as to translate power from the plurality of motors into a desired pump rate of the multi-plunger pump.

[0023] Other aspects and features of the present disclosure will become apparent to those of ordinary skill in the art after reading the detailed description herein and the accompanying figures.

BRIEF DESCRIPTION OF DRAWINGS

[0024] Some of the features and benefits of the present invention having been stated, others will become apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

[0025] FIG. 1 is an exploded schematic example of a planetary gear train having multiple input pinions for direct connection to an electric motor, according to an embodiment.

[0026] FIG. 2 is an exploded schematic example of a planetary gear train having a speed reduction gearbox mounting for connection to an electric motor, according to an embodiment.

[0027] FIG. 3 is a schematic example of a multi-plunger pump having nine plungers and four electric motors mounted for driving the multi-plunger pump, according to an embodiment.

[0028] FIG. 4 is a table showing calculations of plunger pump critical speeds according to embodiments of the present technology.

[0029] FIG. 5 is a table showing data related to certain pumps and transmissions in an example application, meant to highlight certain embodiments of the present technology.

[0030] FIGS. 6-10 are tables showing additional data related to certain pumps and transmissions in further example applications, meant to further highlight embodiments of the present technology.

[0031] While the invention will be described in connection with the preferred embodiments, it will be understood that the included description is not intended to limit the invention to the described preferred embodiments. On the contrary, the description is intended to cover all alternatives, modifications, and equivalents, as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF INVENTION

[0032] The method and system of the present disclosure will now be described more fully hereinafter with reference to the accompanying drawings in which embodiments are shown. The method and system of the present disclosure may be in many different forms and should not be construed as limited to the illustrated embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey its scope to those skilled in the art. Like numbers refer to like elements throughout.

[0033] It is to be further understood that the scope of the present disclosure is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. In the drawings and specification, there have been disclosed illustrative embodiments and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation.

[0034] Described herein is an example of a method and system for providing reciprocating, plunger-style pumps as part of a multi-plunger system for use in hydraulic fracturing operations. Also described are various drive systems for use with the described reciprocating, plunger-style pumps. In various embodiments, the pumps and drive systems may be utilized by conventionally powered (i.e., diesel engine-driven) hydraulic fracturing pumping systems, or in other embodiments by hydraulically powered or electrically powered hydraulic fracturing pumping systems.

[0035] Multi-plunger hydraulic fracturing pumps, though known in the art, are typically limited to either triplex (three plungers) or quintuplex (five plungers) arrangements. Common hydraulic fracturing pumps often utilize 8-inch, 10-inch, and 11-inch stroke triplex and quintuplex hydraulic fracturing pumps. Hydraulic fracturing pumps are commonly driven by an engine (usually a 2500 horsepower (HP) diesel engine) and a multiple speed transmission, usually having seven speeds or more. However, many of the top gears, depending on the manufacturer and gear ratios, provide speeds that are above the critical speed of a plunger pump. FIG. 4 details calculations of such plunger critical speeds.

[0036] For example, one of the most common transmissions utilized in hydraulic fracturing pump applications is the Caterpillar model TH55-E90, which is a 9-speed transmission. As shown in FIG. 5, when this transmission is in 5th gear and the engine is operating at 1700 rpm, the critical speed of 120 rpm on an 8-inch stroke pump is reached. Therefore, running the pump with the transmission in any of gears 6 through 9 could cause pump cavitation and damage accumulation to the fluid end.

[0037] Similarly, the common hydraulic fracturing application transmissions known in the art may exhibit the same issues in higher gears, as shown below in FIGS. 6-10. For example, as shown in FIG. 6 and FIG. 7, the critical plunger speed is reached in the 3rd gear, such that use of gears 4-7 may cause cavitation and damage accumulation. Similarly, as shown in FIG. 8 and FIG. 9, the critical plunger speed is reached in the 4th gear, such that use of gears 5-7 may cause cavitation and damage accumulation. In FIG. 10, the critical plunger speed is reached in the 4th gear, such that use of gears 5-9 may result in cavitation and damage accumulation.

[0038] Use of the multi-plunger hydraulic fracturing pumps according to the present disclosure may eliminate the need for a diesel engine and transmission. As shown above, diesel engines and transmissions often include multiple gears that accelerate the plunger speed above critical operating speeds. This elimination of the typical engine and transmission from hydraulic fracturing pump units may enable the pumps to be driven by multiple electric motors, according to some embodiments, or multiple hydraulic motors according to other embodiments. These electric or hydraulic motors may have fewer gears such that operation in gears that increase the plunger speeds above their critical speeds can be avoided. By using multiple motors, whether hydraulic or electric, to drive a single pump, pump rates can be increased without exceeding critical plunger speeds.

[0039] Use of electric or hydraulic motors, rather than diesel motors, may also make maintenance, repair, and replacement of the electric motors safer and faster than single or double electric motor-driven pumps. This configuration may prevent the fracturing pumps from being run at speeds higher than the critical plunger speed, which may help to minimize pump cavitation and damage accumulation, thus greatly extending the usable life of the pump fluid ends. For example, as discussed in more detail below, the system could be designed to allow only a slight

overspeed of the pumps beyond the identified critical pump speed as a safety margin in the event that one of the fleet's pumps were taken offline for repairs or maintenance, and an additional rate of the remaining online pumps were required to complete the stage being pumped.

[0040] In the multiple electric motor-driven embodiment of the present disclosure, the electric motors may directly drive the pump, and the gear ratios of the planetary drive along with the electric motor-rated speeds may be chosen to limit the maximum pump speed, so as to not exceed the plunger critical speed. However, the gear ratios and electric motor-rated speeds may also be chosen to allow only a slight percentage of overspeed (higher than critical plunger speed) as a safe margin to enable a fleet of operating pumps to achieve a desired pump rate, for example when one pump is taken off line, as is often the case in hydraulic fracturing. For example, the gear ratios and electric motor-rated speeds may be chosen to operate 5% or less above the critical plunger speed according to some examples; 10% or less above the critical plunger speed according to some examples; or any other acceptable range as will be readily understood by one having ordinary skill in the art. Repairs or maintenance are generally performed as quickly as possible so that the offline pump is available by the next sequential fracturing stage. This same logic could be applied to the hydraulic motor driven system or the system that utilizes speed reduction gearboxes driving a single ring gear.

[0041] By the present disclosure, multi-plunger hydraulic fracturing pumps utilizing higher multiples of plungers, such as 7, 9, 11, 13, etc. (septenplex, novenplex, undenplex, tredenplex, etc.), are described. In some embodiments, more than 13 plungers may be utilized, as will be readily understood by one having ordinary skill in the art. In some embodiments, odd numbers of plungers may be chosen so that the pump flow ripple magnitude is minimized. For example, in multi-plunger hydraulic fracturing pumps having higher numbers of plungers, the plunger ripple

frequency may be increased, thereby reducing the amount of time between ripples, which may provide a smoother pressure performance for the pumps.

[0042] In some embodiments, longer stroke lengths of the plunger pumps may be utilized to reduce plunger speed. For example, a 10-inch stroke pump of a given plunger size may be run at a slower speed than an 8-inch stroke pump of the same plunger size, in order to accomplish the same flow rate. Slowing the plunger down may also decrease the possibility of pump cavitation. For example, when triplex and quintuplex pumps, as are known in the art, are operated at higher rates, conditions for cavitation to occur are measurably higher. According to an embodiment, a critical pump speed may be 120 rpm of the pump crankshaft. With this pump speed, on the currently used 8-inch stroke pumps, the rotational speed translates to an average linear speed of the plungers at a velocity of 32 inches per second. At higher speeds, with every stroke of the plungers, fluid is accelerated into and out of the pump fluid end, creating a likelihood of low pressure regions within the fluid end that approach or dip below vapor pressure values for the fluid, thereby causing cavitation, and ultimately damage accumulation, to occur. The use of longer stroke plungers accordingly contributes critically to longer fluid end life.

[0043] Various drive systems for powering multi-plunger hydraulic fracturing pumps are contemplated. According to an embodiment, multiple electric motors may be utilized to power the multi-plunger hydraulic fracturing pump. The number of motors utilized may be selected based on the output hydraulic horsepower for which the pump is designed, in some examples. In other examples, the number of motors could be determined on an “n plus 1” basis, in which “n” number of motors would be adequate to provide enough input power according to the output hydraulic horsepower for which the pump is designed, and one (“1”) additional motor would be included to allow for a single motor failure or maintenance situation. In such a situation, the

failed motor (or motor purposefully removed for maintenance) could be disconnected from the electrical circuit and allowed to freewheel, while the remaining operational motors would still provide adequate power for the pump, according to an embodiment.

[0044] In the example illustrated in FIG. 1, an exploded schematic view shows an embodiment of a planetary gear train 100 in which the multiple input pinion gears 135 are directly connected to the electric motors 130. According to the illustrated embodiment, both ends of the pump crankshaft 105 may be powered with an identical planetary gear train 120 and electric motors 130 to enable the motors 130 to be sized small enough to simplify motor removal and installation as compared to a larger single electric motor, or a double electric motor drive system.

[0045] In the illustrated embodiment of FIG. 1, eight electric motors 130 may correspond to and drive eight input pinion gears 135 associated with a single main planetary gear 125. The main planetary gear 125 may in turn drive the sun gear 115 positioned central to three planetary gears 120. The final drive gear 110 may have internal gear teeth positioned to catch the external gear teeth of the three planetary gears 120, which may cause rotation of the pump crankshaft 105. In this way, a plurality of electric motors 130 may provide power to a pump crankshaft 105, which may in turn drive a multi-plunger pump, for example as illustrated in FIG. 3 and discussed in greater detail below.

[0046] In another embodiment, multiple hydraulic motors may be utilized to power a multi-plunger hydraulic fracturing pump, in which a planetary gear train system 100 similar to that illustrated in FIG. 1 could also be utilized. In an example, a planetary gear train system may be utilized on one or both ends of the pump crankshaft to allow for smaller hydraulic motors to be utilized.

[0047] According to an alternate embodiment, for example as illustrated in FIG. 2, a plurality of electric motors or hydraulic motors 230 each may be mounted to a plurality of speed reduction gearboxes 245. FIG. 2 illustrates an exploded schematic example of a planetary gear train 200 having a plurality of speed reduction gearbox 245 mountings for connection to a plurality of electric motors 230, according to an embodiment. The speed reduction gearboxes 245 may, in turn, power a single ring gear 240 to turn the pump crankshaft 205 at the proper rpm needed to drive the multi-plunger pumps at the desired pump rate. In some examples, this configuration may not require use of a multi-planetary gear train system as described above and illustrated in FIG. 1, for example. For example, as illustrated in the embodiment of FIG. 2, the plurality of electric motors 230 may drive the main planetary gear in the form of a ring gear 240 through speed reduction gearboxes 245, and the ring gear 240 may directly turn the pump crankshaft 205. In such an example additional planetary gears 120, as illustrated in the embodiment of FIG. 1, for example, may not be included.

[0048] In an embodiment utilizing multiple electric motors, the fleet of fracturing pumps may be powered by multiple electric motors, and overall electric power may be generated by one or more diesel or gas turbines. When the pumps are being brought online to pump fluids into the well, the power may be switched via appropriate switchgear to the electric motors.

[0049] In some embodiments, the speed of the motors may be controlled by one or more variable frequency drives (VFD), which may accelerate or decelerate the pump rotational speeds using an S curve. The pump operator may select the various pump speeds via a human-machine interface (HMI) according to some embodiments, for example from inside a data van, or from a "suitcase," which is a portable, standalone HMI. The HMI or suitcase may allow on/off control of the pumps as well as speed control of the pumps, to allow the pumps to run at speeds from

zero crankshaft rpm up to the maximum speed, which would correlate with the plunger critical speed.

[0050] According to an embodiment, one of the VFDs may be designated as the master VFD, and the remaining VFDs may be designed to share the load required to power the pump under all load conditions. In the case of an overpressure event, the hydraulic fracturing controls may automatically turn the VFD off using the on/off signal for rapid shutdown, instead of using the rpm command, which uses an S curve to control the acceleration and/or deceleration. A manual emergency shutdown may also be included, which uses an HMI (such as a push button or other HMI, which may be electronic and/or manual) to shut off the VFD using the on/off function. This manual emergency shutdown feature may be configured to shut down all VFDs simultaneously, thereby shutting down the entire site. The emergency shutdown may also be configured to stop the VFD on the blender discharge pumps, and may or may not be tied into the electrical microgrid to open breakers, thereby stopping the flow and/or generation of electricity and/or gas compression.

[0051] The HMI may be designed to allow only a slight percentage of overspeed (higher than critical plunger speed) as a safe margin to enable a fleet of operating pumps to achieve a desired pump rate when one pump is taken offline, for example, as is often the case in hydraulic fracturing. Repairs or maintenance are generally performed as quickly as possible so that the offline pump is available by the next sequential fracturing stage. This same logic could be applied to the hydraulic motor driven system or the system that utilizes speed reduction gearboxes driving a single ring gear.

[0052] FIG. 3 illustrates a schematic example of a multi-plunger pump 300 with four electric motors mounted to the pump for driving the multi-plunger pump, according to an embodiment.

In the illustrated embodiment, the multi-plunger pump 300 may include nine plungers positioned at the multi-plunger fluid end 350 of the multi-plunger pump 300. In other embodiments, various other numbers of plungers may be included, as will be readily understood by one having ordinary skill in the art.

[0053] A crankshaft centerline 360 may bisect the multi-plunger pump 300 between the multi-plunger fluid end 350 and the pump power end 355. Two electric motors 330 may be positioned on opposing sides of the multi-plunger pump 300, across the crankshaft centerline 360. The four total electric motors 330 may drive the crankshaft associated with the nine plungers, as described above with respect to FIGS. 1 and 2. For example, in some embodiments the four electric motors 330 may drive the crankshaft via one or more planetary gear trains. In some embodiments, a plurality of speed reduction gearboxes may be positioned between the electric motors 330 and the one or more planetary gear trains so as to control the rotational speed of the one or more planetary gear trains and, ultimately, the pump rate of the plungers.

[0054] The present invention described herein, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned, as well as others inherent therein. While a presently preferred embodiment of the invention has been given for purposes of disclosure, numerous changes exist in the details of procedures for accomplishing the desired results. These and other similar modifications will readily suggest themselves to those skilled in the art, and are intended to be encompassed within the spirit of the present invention disclosed herein and the scope of the appended claims.

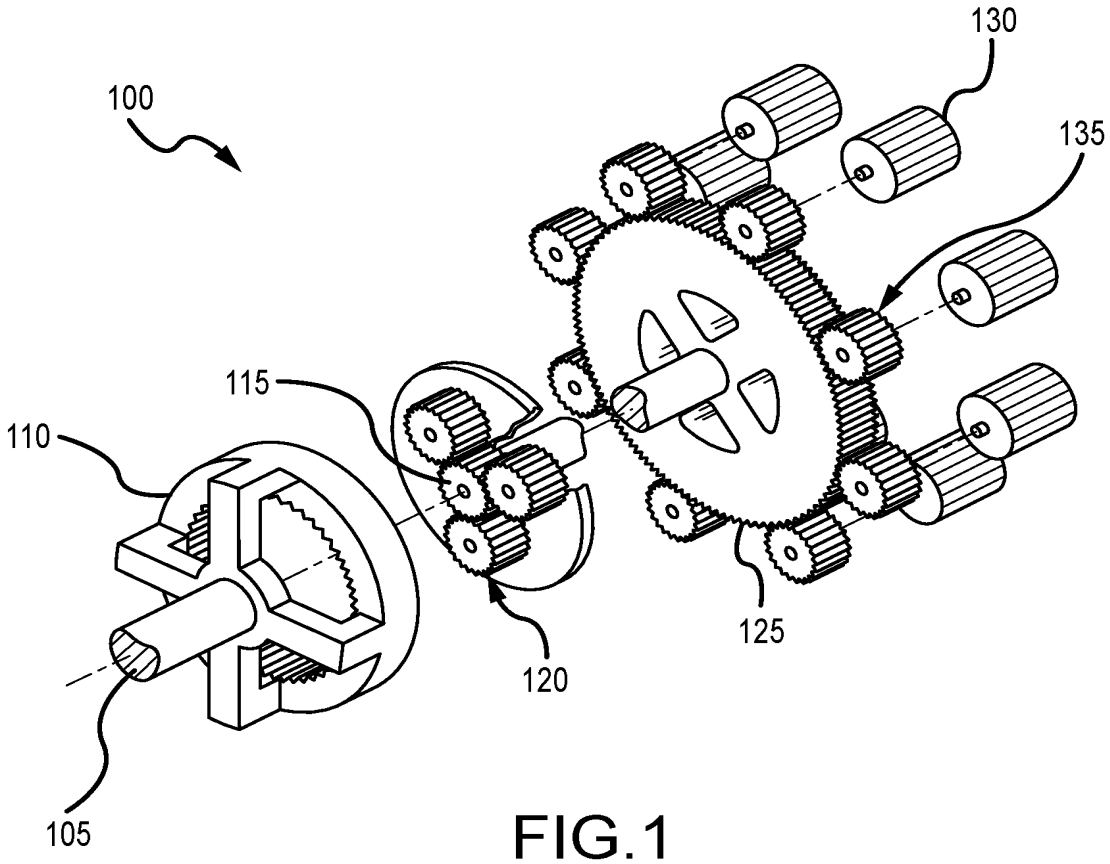


FIG.1

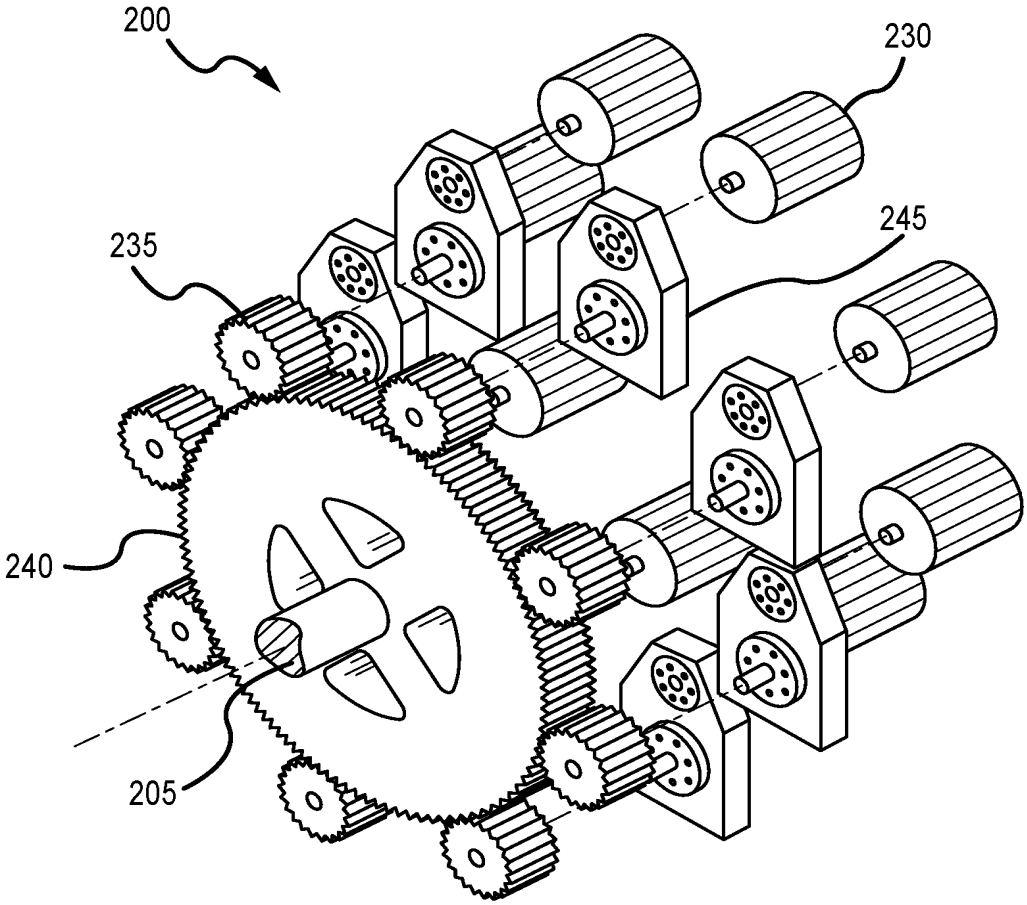


FIG.2

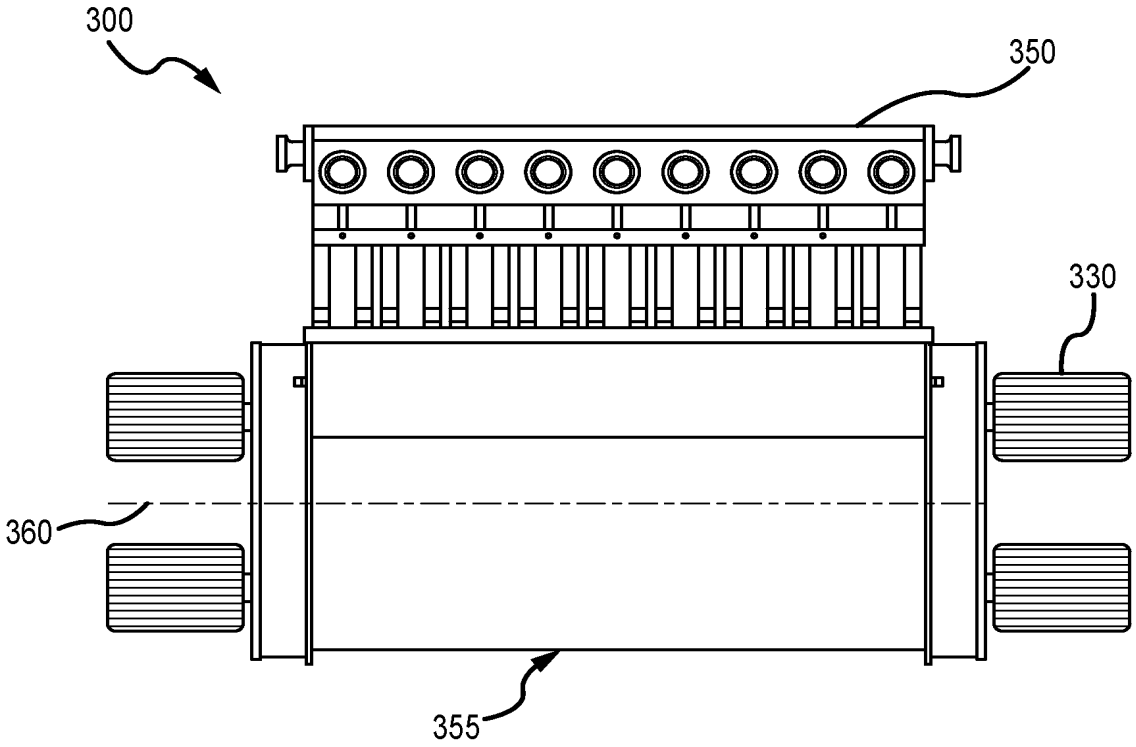


FIG.3

Plunger Critcal Speed Calculations

Plunger Critical Speed = 32 in/sec (based on 120 rpm crankshaft speed on 8" stroke pump)
Plunger Maximum Speed = 40 in/sec (based on 150 rpm crankshaft speed on 8" stroke pump)

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
2.75" Bore	8	0.01666	0.02449	0.04408	0.06367	120.00	150.00	1.76	2.94	5.29	7.64	2.20	3.67	6.61	9.55
	9	0.01653	0.02755	0.04959	0.07162	106.67	133.33								
	10	0.01837	0.03061	0.05510	0.07959	96.00	120.00								
	11	0.02020	0.03367	0.06061	0.08754	87.27	109.09								
	12	0.02204	0.03673	0.06612	0.09550	80.00	100.00								
	13	0.02388	0.03979	0.07163	0.10346	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
3.0" Bore	8	0.01749	0.02914	0.05246	0.07577	120.00	150.00	2.10	3.50	6.29	9.09	2.62	4.37	7.87	11.37
	9	0.01967	0.03279	0.05901	0.08524	106.67	133.33								
	10	0.02186	0.03643	0.06557	0.09471	96.00	120.00								
	11	0.02404	0.04007	0.07213	0.10419	87.27	109.09								
	12	0.02623	0.04371	0.07869	0.11366	80.00	100.00								
	13	0.02841	0.04736	0.08524	0.12313	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
3.25" Bore	8	0.02052	0.03420	0.06156	0.08893	120.00	150.00	2.46	4.10	7.39	10.67	3.08	5.13	9.23	13.34
	9	0.02309	0.03848	0.06926	0.10004	106.67	133.33								
	10	0.02565	0.04275	0.07696	0.11116	96.00	120.00								
	11	0.02822	0.04703	0.08465	0.12227	87.27	109.09								
	12	0.03078	0.05130	0.09235	0.13339	80.00	100.00								
	13	0.03335	0.05558	0.10004	0.14450	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
3.5" Bore	8	0.02380	0.03967	0.07140	0.10313	120.00	150.00	2.86	4.76	8.57	12.38	3.57	5.95	10.71	15.47
	9	0.02677	0.04462	0.08032	0.11602	106.67	133.33								
	10	0.02975	0.04958	0.08925	0.12892	96.00	120.00								
	11	0.03272	0.05454	0.09817	0.14181	87.27	109.09								
	12	0.03570	0.05950	0.10710	0.15470	80.00	100.00								
	13	0.03867	0.06446	0.11602	0.16759	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
4.0" Bore	8	0.03109	0.05181	0.09326	0.13476	120.00	150.00	3.73	6.22	11.19	16.16	4.66	7.77	13.99	20.21
	9	0.03497	0.05829	0.10491	0.15154	106.67	133.33								
	10	0.03886	0.06476	0.11657	0.16832	96.00	120.00								
	11	0.04274	0.07124	0.12822	0.18509	87.27	109.09								
	12	0.04663	0.07771	0.13989	0.20206	80.00	100.00								
	13	0.05051	0.08419	0.15154	0.21885	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
4.5" Bore	8	0.03934	0.06557	0.11803	0.17049	120.00	150.00	4.72	7.87	14.16	20.46	5.90	9.84	17.70	25.57
	9	0.04426	0.07377	0.13278	0.19180	106.67	133.33								
	10	0.04918	0.08196	0.14754	0.21311	96.00	120.00								
	11	0.05410	0.09016	0.16229	0.23442	87.27	109.09								
	12	0.05901	0.09836	0.17704	0.25573	80.00	100.00								
	13	0.06393	0.10655	0.19180	0.27704	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
5.0" Bore	8	0.04857	0.08095	0.14571	0.21048	120.00	150.00	5.83	9.71	17.49	25.26	7.29	12.14	21.86	31.57
	9	0.05464	0.09107	0.16393	0.23678	106.67	133.33								
	10	0.06071	0.10119	0.18214	0.26309	96.00	120.00								
	11	0.06679	0.11131	0.20036	0.28940	87.27	109.09								
	12	0.07286	0.12143	0.21857	0.31571	80.00	100.00								
	13	0.07893	0.13155	0.19180	0.34202	73.85	92.31								

FIG. 4

Transmission CAT TH55-E90 Ratios	
1st Gear	4.67
2nd Gear	3.45
3rd Gear	2.65
4th Gear	1.98
5th Gear	1.52
6th Gear	1.00
7th Gear	0.79
8th Gear	0.56
9th Gear	0.40

Frac Pump	
Plunger Bore	Quint GAL/rev
4.0"	0.051167
4.5"	0.065548
5.0"	0.080988

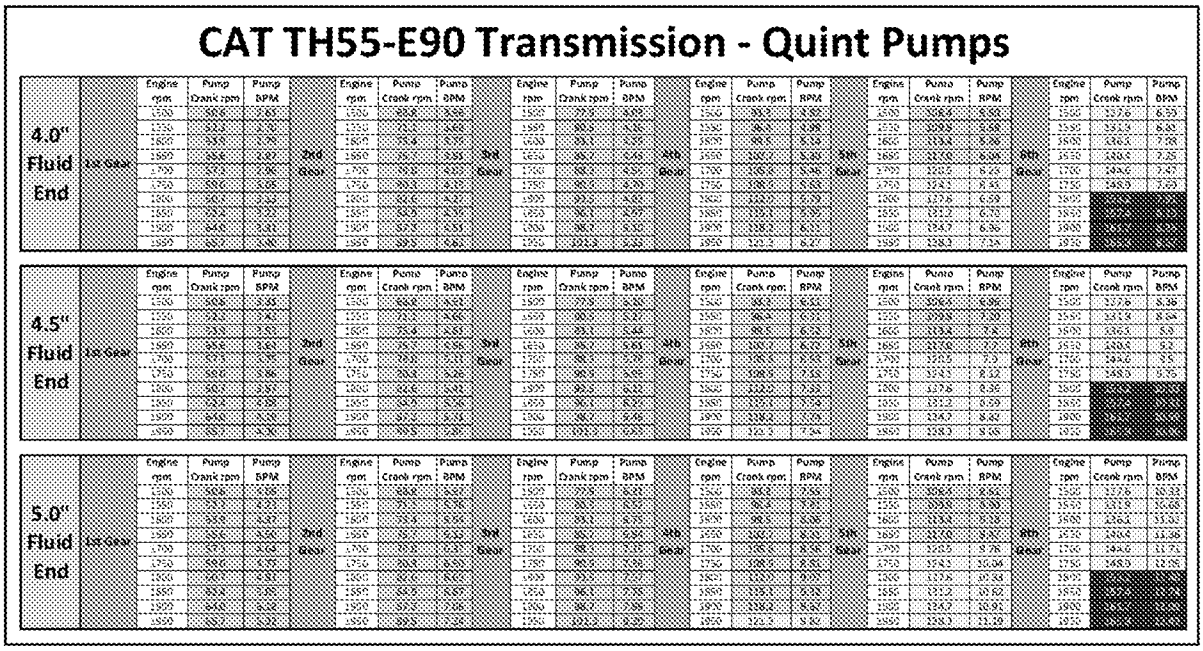


FIG. 5

Transmission	
Allison 9800 Ratios	
1st Gear	3.75
2nd Gear	2.69
3rd Gear	2.20
4th Gear	1.77
5th Gear	1.58
6th Gear	1.27
7th Gear	1.00

Frac Pump	
Fluid End Bore	Triplex BBL/rev
4.0"	0.03107
4.5"	0.03933
5.0"	0.04855

Allison 9800 Transmission, Triplex Pumps

	TRIPLEX 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	92.0	2.46	2nd Gear	1500	97.8	2.73	3rd Gear	1500	107.9	3.03	4th Gear	1500	135.4	4.14
		1550	95.1	2.55		1550	90.7	2.82		1550	110.9	3.02		1550	137.8	4.28
		1600	98.2	2.63		1600	93.6	2.61		1600	114.5	3.56		1600	142.3	4.42
		1650	101.3	2.71		1650	96.6	3.60		1650	118.1	3.67		1650	146.7	4.56
		1700	104.4	2.79		1700	99.5	3.69		1700	121.6	3.78		1700	[illegible]	[illegible]
		1750	107.5	2.88		1750	102.4	3.78		1750	125.2	3.89		1750	[illegible]	[illegible]
		1800	110.6	2.96		1800	105.3	3.87		1800	128.8	4.00		1800	[illegible]	[illegible]
		1850	113.7	3.04		1850	108.3	3.96		1850	132.4	4.11		1850	[illegible]	[illegible]
		1900	116.8	3.13		1900	111.2	3.45		1900	136.0	4.22		1900	[illegible]	[illegible]
		1950	119.9	3.21		1950	114.1	3.55		1950	139.5	4.33		1950	[illegible]	[illegible]

	TRIPLEX 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	88.0	2.48	2nd Gear	1500	87.8	3.05	3rd Gear	1500	107.9	4.03	4th Gear	1500	135.4	5.35
		1550	90.1	2.56		1550	90.7	3.07		1550	110.9	4.08		1550	137.8	5.42
		1600	92.2	2.64		1600	93.6	4.66		1600	114.5	4.50		1600	142.3	5.60
		1650	94.3	2.72		1650	96.6	4.60		1650	118.1	4.64		1650	146.7	5.77
		1700	96.4	2.81		1700	99.5	4.91		1700	121.6	4.78		1700	[illegible]	[illegible]
		1750	98.5	2.89		1750	102.4	4.03		1750	125.2	4.92		1750	[illegible]	[illegible]
		1800	100.6	2.97		1800	105.3	4.15		1800	128.8	5.07		1800	[illegible]	[illegible]
		1850	102.7	3.05		1850	108.3	4.26		1850	132.4	5.21		1850	[illegible]	[illegible]
		1900	104.8	3.14		1900	111.2	4.37		1900	135.9	5.35		1900	[illegible]	[illegible]
		1950	106.9	3.22		1950	114.1	4.49		1950	139.5	5.49		1950	[illegible]	[illegible]

	TRIPLEX 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	88.0	3.06	2nd Gear	1500	87.8	3.88	3rd Gear	1500	107.9	5.21	4th Gear	1500	135.4	6.48
		1550	90.1	3.16		1550	90.7	3.40		1550	110.9	5.38		1550	137.8	6.69
		1600	92.2	3.26		1600	93.6	4.05		1600	114.5	5.56		1600	142.3	6.93
		1650	94.3	3.36		1650	96.6	4.69		1650	118.1	5.73		1650	146.7	7.12
		1700	96.4	3.46		1700	99.5	4.83		1700	121.6	5.91		1700	[illegible]	[illegible]
		1750	98.5	3.57		1750	102.4	4.97		1750	125.2	6.08		1750	[illegible]	[illegible]
		1800	100.6	3.67		1800	105.3	5.11		1800	128.8	6.25		1800	[illegible]	[illegible]
		1850	102.7	3.77		1850	108.3	5.26		1850	132.4	6.43		1850	[illegible]	[illegible]
		1900	104.8	3.87		1900	111.2	5.40		1900	135.9	6.60		1900	[illegible]	[illegible]
		1950	106.9	3.97		1950	114.1	5.54		1950	139.5	6.77		1950	[illegible]	[illegible]

FIG. 6

Transmission	
Allison 9800 Ratios	
1st Gear	3.75
2nd Gear	2.68
3rd Gear	2.20
4th Gear	1.77
5th Gear	1.58
6th Gear	1.27
7th Gear	1.00

Frac Pump	
Fluid End Bore	Quint BBL/rev
4.0"	0.083657
4.5"	0.085846
5.0"	0.088095

Allison 9800 Transmission, Quint Pumps

	QUINT 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.0"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	68.0	5.05	2nd Gear	1500	87.8	4.84	3rd Gear	1500	107.3	5.93	4th Gear	1500	133.4	6.89
		1550	68.3	5.06		1550	90.7	4.93		1550	110.9	6.05		1550	137.8	7.12
		1600	67.2	5.47		1600	93.6	5.24		1600	114.5	6.32		1600	142.3	7.35
		1650	69.3	5.58		1650	96.6	5.65		1650	118.1	6.39		1650	146.7	7.58
		1700	71.4	5.69		1700	99.5	5.14		1700	121.6	6.23		1700	[illegible]	[illegible]
		1750	73.5	5.80		1750	102.4	5.29		1750	125.2	6.47		1750	[illegible]	[illegible]
		1800	75.6	5.90		1800	105.3	5.44		1800	128.8	6.65		1800	[illegible]	[illegible]
		1850	77.7	6.01		1850	108.3	5.59		1850	132.4	6.84		1850	[illegible]	[illegible]
		1900	79.8	6.12		1900	111.2	5.74		1900	135.9	7.02		1900	[illegible]	[illegible]
		1950	81.9	6.23		1950	114.1	5.90		1950	139.5	7.21		1950	[illegible]	[illegible]

	QUINT 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.5"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	68.0	4.42	2nd Gear	1500	87.8	4.45	3rd Gear	1500	107.3	5.93	4th Gear	1500	133.4	8.73
		1550	68.3	4.76		1550	90.7	4.94		1550	110.9	7.06		1550	137.8	9.03
		1600	67.2	4.46		1600	93.6	5.13		1600	114.5	6.50		1600	142.3	9.32
		1650	69.3	4.58		1650	96.6	5.32		1650	118.1	7.78		1650	146.7	9.61
		1700	71.4	4.67		1700	99.5	4.91		1700	121.6	7.96		1700	[illegible]	[illegible]
		1750	73.5	4.81		1750	102.4	4.75		1750	125.2	8.20		1750	[illegible]	[illegible]
		1800	75.6	4.95		1800	105.3	5.80		1800	128.8	8.43		1800	[illegible]	[illegible]
		1850	77.7	5.06		1850	108.3	7.09		1850	132.4	8.67		1850	[illegible]	[illegible]
		1900	79.8	5.22		1900	111.2	7.28		1900	135.9	8.90		1900	[illegible]	[illegible]
		1950	81.9	5.36		1950	114.1	7.47		1950	139.5	9.14		1950	[illegible]	[illegible]

	QUINT 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 5.0"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	68.0	3.98	2nd Gear	1500	87.8	7.11	3rd Gear	1500	107.3	8.69	4th Gear	1500	133.4	10.80
		1550	68.3	4.27		1550	90.7	7.34		1550	110.9	8.98		1550	137.8	11.16
		1600	67.2	4.44		1600	93.6	7.58		1600	114.5	9.27		1600	142.3	11.52
		1650	69.3	4.61		1650	96.6	7.82		1650	118.1	9.56		1650	146.7	11.88
		1700	71.4	4.79		1700	99.5	8.06		1700	121.6	9.85		1700	[illegible]	[illegible]
		1750	73.5	4.96		1750	102.4	8.29		1750	125.2	10.14		1750	[illegible]	[illegible]
		1800	75.6	5.12		1800	105.3	8.53		1800	128.8	10.43		1800	[illegible]	[illegible]
		1850	77.7	5.29		1850	108.3	8.78		1850	132.4	10.71		1850	[illegible]	[illegible]
		1900	79.8	5.46		1900	111.2	9.02		1900	135.9	11.00		1900	[illegible]	[illegible]
		1950	81.9	5.63		1950	114.1	9.24		1950	139.5	11.29		1950	[illegible]	[illegible]

FIG. 7

Transmission	
CAT TH55-E70 Ratios	
1st Gear	6.25
2nd Gear	4.09
3rd Gear	2.68
4th Gear	1.48
5th Gear	1.00
6th Gear	0.76
7th Gear	0.61

Fan Pump	
Hydd Fan	Triplex
rpm	cc/rev
4.0"	0.051407
4.5"	0.065065
5.0"	0.080356

CAT TH55-E70 Transmission, Triplex Pumps

CAT TH55-E70 Transmission	1st Gear 6.25	Engine rpm	Pump Crank rpm	Pump GPM	2nd Gear 4.09	Engine rpm	Pump Crank rpm	Pump GPM	3rd Gear 2.68	Engine rpm	Pump Crank rpm	Pump GPM	4th Gear 1.48	Engine rpm	Pump Crank rpm	Pump GPM	5th Gear 1.00	Engine rpm	Pump Crank rpm	Pump GPM
		1500	90.0	3.00		1500	60.0	3.00		1500	40.0	3.00		1500	22.2	3.00		1500	15.0	4.01
		1550	93.0	3.10		1550	62.0	3.10		1550	41.4	3.10		1550	23.0	3.10		1550	15.5	4.14
		1600	96.0	3.20		1600	64.0	3.20		1600	42.8	3.20		1600	23.7	3.20		1600	15.9	4.28
		1650	99.0	3.30		1650	66.0	3.30		1650	44.2	3.30		1650	24.5	3.30		1650	16.3	4.41
		1700	102.0	3.40		1700	68.0	3.40		1700	45.5	3.40		1700	25.2	3.40		1700	16.8	4.54
		1750	105.0	3.50		1750	70.0	3.50		1750	46.9	3.50		1750	26.0	3.50		1750		
		1800	108.0	3.60		1800	72.0	3.60		1800	48.3	3.60		1800	26.7	3.60		1800		
		1850	111.0	3.70		1850	74.0	3.70		1850	49.6	3.70		1850	27.5	3.70		1850		
		1900	114.0	3.80		1900	76.0	3.80		1900	51.0	3.80		1900	28.2	3.80		1900		
		1950	117.0	3.90		1950	78.0	3.90		1950	52.3	3.90		1950	29.0	3.90		1950		

CAT TH55-E70 Transmission	1st Gear 6.25	Engine rpm	Pump Crank rpm	Pump GPM	2nd Gear 4.09	Engine rpm	Pump Crank rpm	Pump GPM	3rd Gear 2.68	Engine rpm	Pump Crank rpm	Pump GPM	4th Gear 1.48	Engine rpm	Pump Crank rpm	Pump GPM	5th Gear 1.00	Engine rpm	Pump Crank rpm	Pump GPM
		1500	93.8	3.00		1500	61.2	3.00		1500	41.0	3.00		1500	22.6	3.00		1500	15.0	4.07
		1550	96.9	3.10		1550	63.2	3.10		1550	42.4	3.10		1550	23.4	3.10		1550	15.5	4.21
		1600	100.0	3.20		1600	65.3	3.20		1600	43.8	3.20		1600	24.1	3.20		1600	15.9	4.34
		1650	103.1	3.30		1650	67.3	3.30		1650	45.2	3.30		1650	24.9	3.30		1650	16.3	4.48
		1700	106.2	3.40		1700	69.3	3.40		1700	46.6	3.40		1700	25.7	3.40		1700	16.8	4.61
		1750	109.3	3.50		1750	71.3	3.50		1750	48.0	3.50		1750	26.4	3.50		1750		
		1800	112.5	3.60		1800	73.4	3.60		1800	49.4	3.60		1800	27.2	3.60		1800		
		1850	115.6	3.70		1850	75.4	3.70		1850	50.8	3.70		1850	28.0	3.70		1850		
		1900	118.7	3.80		1900	77.4	3.80		1900	52.2	3.80		1900	28.7	3.80		1900		
		1950	121.8	3.90		1950	79.4	3.90		1950	53.5	3.90		1950	29.5	3.90		1950		

CAT TH55-E70 Transmission	1st Gear 6.25	Engine rpm	Pump Crank rpm	Pump RPM	2nd Gear 4.09	Engine rpm	Pump Crank rpm	Pump RPM	3rd Gear 2.68	Engine rpm	Pump Crank rpm	Pump RPM	4th Gear 1.48	Engine rpm	Pump Crank rpm	Pump RPM	5th Gear 1.00	Engine rpm	Pump Crank rpm	Pump RPM
		1500	97.5	3.00		1500	63.6	3.00		1500	42.6	3.00		1500	23.5	3.00		1500	15.0	4.14
		1550	100.6	3.10		1550	65.7	3.10		1550	44.0	3.10		1550	24.3	3.10		1550	15.5	4.28
		1600	103.8	3.20		1600	67.8	3.20		1600	45.5	3.20		1600	25.1	3.20		1600	15.9	4.42
		1650	107.0	3.30		1650	69.9	3.30		1650	46.9	3.30		1650	25.9	3.30		1650	16.3	4.56
		1700	110.2	3.40		1700	72.0	3.40		1700	48.3	3.40		1700	26.7	3.40		1700	16.8	4.70
		1750	113.4	3.50		1750	74.1	3.50		1750	49.8	3.50		1750	27.4	3.50		1750		
		1800	116.6	3.60		1800	76.2	3.60		1800	51.2	3.60		1800	28.2	3.60		1800		
		1850	119.8	3.70		1850	78.3	3.70		1850	52.6	3.70		1850	29.0	3.70		1850		
		1900	123.0	3.80		1900	80.4	3.80		1900	54.1	3.80		1900	29.8	3.80		1900		
		1950	126.2	3.90		1950	82.5	3.90		1950	55.5	3.90		1950	30.6	3.90		1950		

FIG. 8

Transmission	
CAT TH55-E70 Ratios	
1st Gear	6.25
2nd Gear	4.55
3rd Gear	3.38
4th Gear	2.42
5th Gear	1.83
6th Gear	1.36
7th Gear	1.00

Star Pump	
Fluid End Bore	Quint Bbl/rev
4.0"	0.005150
4.5"	0.006646
5.0"	0.008205

CAT TH55-E70 Transmission, Quint Pumps

	1st Gear				2nd Gear				3rd Gear				4th Gear				5th Gear			
	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM
CAT TH55-E70 Transmission		1500	57.6	5.76		1500	82.4	8.24		1500	111.0	11.10		1500	144.9	14.49		1500	184.0	18.40
		1550	59.5	5.95		1550	85.1	8.51		1550	114.6	11.46		1550	149.7	14.97		1550	190.1	19.01
		1600	61.4	6.14		1600	87.9	8.79		1600	118.3	11.83		1600	154.5	15.45		1600	196.2	19.62
		1650	63.4	6.34		1650	90.6	9.06		1650	122.0	12.20		1650	159.3	15.93		1650		
		1700	65.3	6.53		1700	93.4	9.34		1700	125.7	12.57		1700	164.2	16.42		1700		
		1750	67.2	6.72		1750	96.2	9.62		1750	129.4	12.94		1750	169.0	16.90		1750		
		1800	69.1	6.91		1800	98.9	9.89		1800	133.1	13.31		1800	173.8	17.38		1800		
		1850	71.0	7.10		1850	101.7	10.17		1850	136.8	13.68		1850	178.7	17.87		1850		
		1900	72.9	7.29		1900	104.4	10.44		1900	140.5	14.05		1900	183.5	18.35		1900		
		1950	74.8	7.48		1950	107.2	10.72		1950	144.2	14.42		1950	188.3	18.83		1950		

	1st Gear				2nd Gear				3rd Gear				4th Gear				5th Gear			
	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM
CAT TH55-E70 Transmission		1500	57.6	5.76		1500	82.4	8.24		1500	111.0	11.10		1500	144.9	14.49		1500	184.0	18.40
		1550	59.5	5.95		1550	85.1	8.51		1550	114.6	11.46		1550	149.7	14.97		1550	190.1	19.01
		1600	61.4	6.14		1600	87.9	8.79		1600	118.3	11.83		1600	154.5	15.45		1600	196.2	19.62
		1650	63.4	6.34		1650	90.6	9.06		1650	122.0	12.20		1650	159.3	15.93		1650		
		1700	65.3	6.53		1700	93.4	9.34		1700	125.7	12.57		1700	164.2	16.42		1700		
		1750	67.2	6.72		1750	96.2	9.62		1750	129.4	12.94		1750	169.0	16.90		1750		
		1800	69.1	6.91		1800	98.9	9.89		1800	133.1	13.31		1800	173.8	17.38		1800		
		1850	71.0	7.10		1850	101.7	10.17		1850	136.8	13.68		1850	178.7	17.87		1850		
		1900	72.9	7.29		1900	104.4	10.44		1900	140.5	14.05		1900	183.5	18.35		1900		
		1950	74.8	7.48		1950	107.2	10.72		1950	144.2	14.42		1950	188.3	18.83		1950		

	1st Gear				2nd Gear				3rd Gear				4th Gear				5th Gear			
	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM	Output Shaft RPM	Engine rpm	Pump Crank rpm	Pump SPM
CAT TH55-E70 Transmission		1500	57.6	5.76		1500	82.4	8.24		1500	111.0	11.10		1500	144.9	14.49		1500	184.0	18.40
		1550	59.5	5.95		1550	85.1	8.51		1550	114.6	11.46		1550	149.7	14.97		1550	190.1	19.01
		1600	61.4	6.14		1600	87.9	8.79		1600	118.3	11.83		1600	154.5	15.45		1600	196.2	19.62
		1650	63.4	6.34		1650	90.6	9.06		1650	122.0	12.20		1650	159.3	15.93		1650		
		1700	65.3	6.53		1700	93.4	9.34		1700	125.7	12.57		1700	164.2	16.42		1700		
		1750	67.2	6.72		1750	96.2	9.62		1750	129.4	12.94		1750	169.0	16.90		1750		
		1800	69.1	6.91		1800	98.9	9.89		1800	133.1	13.31		1800	173.8	17.38		1800		
		1850	71.0	7.10		1850	101.7	10.17		1850	136.8	13.68		1850	178.7	17.87		1850		
		1900	72.9	7.29		1900	104.4	10.44		1900	140.5	14.05		1900	183.5	18.35		1900		
		1950	74.8	7.48		1950	107.2	10.72		1950	144.2	14.42		1950	188.3	18.83		1950		

FIG. 9

Transmission	
TA90-8501 Ratios	
1st Gear	4.47
2nd Gear	3.57
3rd Gear	2.85
4th Gear	2.41
5th Gear	1.92
6th Gear	1.54
7th Gear	1.25
8th Gear	1.00
9th Gear	0.80

Frac Pump	
Fluid End Bore	Quint BBL/rev
4.0"	0.095167
4.5"	0.096548
5.0"	0.08086

Twin Disc TA90-8501 Transmission - Quint Pumps

4.0" Fluid End

1st Gear				2nd Gear				3rd Gear				4th Gear				5th Gear		
Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM
1500	52.8	5.55		1500	66.3	3.43		1500	82.8	4.28		1500	98.0	5.06		1500	123.0	6.35
1550	54.6	5.82		1550	68.5	3.53		1550	85.6	4.42		1550	101.3	5.23		1550	127.1	6.57
1600	56.3	5.98		1600	70.5	3.65		1600	88.4	4.57		1600	104.5	5.40		1600	131.2	6.78
1650	58.1	6.00	2nd	1650	72.8	3.76	3rd	1650	91.1	4.71	4th	1650	107.8	5.57	5th	1650	135.3	6.99
1700	59.9	5.99	Gear	1700	75.0	3.87	Gear	1700	93.9	4.85	Gear	1700	111.0	5.74	Gear	1700	139.4	7.20
1750	61.6	5.98		1750	77.2	3.99		1750	96.7	4.99		1750	114.3	5.91		1750	143.5	7.41
1800	63.4	5.98		1800	79.4	4.10		1800	99.4	5.14		1800	117.6	6.07		1800	147.6	7.62
1850	65.2	5.97		1850	81.6	4.21		1850	102.2	5.28		1850	120.8	6.24		1850	151.8	7.84
1900	66.9	5.96		1900	83.8	4.33		1900	104.9	5.42		1900	124.1	6.41		1900	155.9	8.05
1950	68.7	5.95		1950	86.0	4.44		1950	107.7	5.56		1950	127.4	6.58		1950	160.0	8.26

4.5" Fluid End

1st Gear				2nd Gear				3rd Gear				4th Gear				5th Gear		
Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM
1500	52.8	5.46		1500	66.3	4.33		1500	82.8	5.42		1500	98.0	6.42		1500	123.0	8.05
1550	54.6	5.57		1550	68.5	4.48		1550	85.6	5.61		1550	101.3	6.63		1550	127.1	8.32
1600	56.3	5.68		1600	70.5	4.62		1600	88.4	5.78		1600	104.5	6.86		1600	131.2	8.6
1650	58.1	5.80	2nd	1650	72.8	4.76	3rd	1650	91.1	5.97	4th	1650	107.8	7.06	5th	1650	135.3	8.9
1700	59.9	5.92	Gear	1700	75.0	4.91	Gear	1700	93.9	6.15	Gear	1700	111.0	7.29	Gear	1700	139.4	9.1
1750	61.6	6.04		1750	77.2	5.05		1750	96.7	6.33		1750	114.3	7.48		1750	143.5	9.39
1800	63.4	6.15		1800	79.4	5.20		1800	99.4	6.51		1800	117.6	7.70		1800	147.6	9.66
1850	65.2	6.27		1850	81.6	5.34		1850	102.2	6.68		1850	120.8	7.91		1850	151.8	9.93
1900	66.9	6.38		1900	83.8	5.49		1900	104.9	6.87		1900	124.1	8.13		1900	155.9	10.2
1950	68.7	6.50		1950	86.0	5.63		1950	107.7	7.05		1950	127.4	8.34		1950	160.0	10.47

5.0" Fluid End

1st Gear				2nd Gear				3rd Gear				4th Gear				5th Gear		
Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM
1500	52.8	4.99		1500	66.3	5.35		1500	82.8	6.71		1500	98.0	7.95		1500	123.0	9.95
1550	54.6	5.12		1550	68.5	5.53		1550	85.6	6.93		1550	101.3	8.20		1550	127.1	10.29
1600	56.3	5.26		1600	70.5	5.71		1600	88.4	7.15		1600	104.5	8.46		1600	131.2	10.62
1650	58.1	5.40	2nd	1650	72.8	5.89	3rd	1650	91.1	7.38	4th	1650	107.8	8.73	5th	1650	135.3	10.95
1700	59.9	5.53	Gear	1700	75.0	6.07	Gear	1700	93.9	7.60	Gear	1700	111.0	8.96	Gear	1700	139.4	11.28
1750	61.6	5.66		1750	77.2	6.25		1750	96.7	7.82		1750	114.3	9.25		1750	143.5	11.61
1800	63.4	5.79		1800	79.4	6.42		1800	99.4	8.05		1800	117.6	9.52		1800	147.6	11.95
1850	65.2	5.92		1850	81.6	6.60		1850	102.2	8.27		1850	120.8	9.78		1850	151.8	12.28
1900	66.9	6.05		1900	83.8	6.78		1900	104.9	8.49		1900	124.1	10.05		1900	155.9	12.61
1950	68.7	6.18		1950	86.0	6.96		1950	107.7	8.72		1950	127.4	10.31		1950	160.0	12.94

FIG. 10

Electronic Acknowledgement Receipt

EFS ID:	35909892
Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Taylor P. Evans/Stephanie McDonough
Filer Authorized By:	Taylor P. Evans
Attorney Docket Number:	047158.100035
Receipt Date:	03-MAY-2019
Filing Date:	05-DEC-2018
Time Stamp:	11:56:42
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		047158-100035_Response.pdf	32653 250ea58847ec438a63a1b4142d98d3c36be40137	yes	5

	Multipart Description/PDF files in .zip description			
	Document Description	**Start**	**End**	
	Applicant Arguments/Remarks Made in an Amendment	3	5	
	Specification	2	2	
	Applicant Response to Pre-Exam Formalities Notice	1	1	
Warnings:				
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2	Applicant Arguments/Remarks Made in an Amendment	047158-100035_Substitute-Specification_marked-up.pdf	2786391 1b89e100219b7feb7acf1d29662ff2ce962fd1f8	no 22
Warnings:				
Information:				
3		047158-100035_Substitute-Specification_clean-copy.pdf	89255 49dcbfd84497fe20708a58f7401d0c5c3d09ea87	yes 17
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	Document Description	**Start**	**End**	
	Abstract	17	17	
	Specification	1	16	
Warnings:				
Information:				
4	Drawings-only black and white line drawings	047158-100035_Figures.pdf	3352783 51586e37b6925e0f6cadaa2167b3c4b20c927544	no 10
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Information:				
		Total Files Size (in bytes):	6261082	

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

AMENDMENTS TO THE SPECIFICATION

Please amend the specification as follows:

Please replace the Specification with the Substitute Specification attached hereto, which is filed in compliance with 37 C.F.R. 1.52, 1.121(b)(3) and 1.125. Applicant has provided both a clean copy and a marked-up copy, showing the changes relative to the originally filed Specification. No new matter has been introduced by these amendments.

AMENDMENTS TO THE DRAWINGS

Please amend the drawings as follows:

Please replace the previously submitted Figs. 1, 2, and 3 with the attached drawing sheets labeled Replacement Sheets. Please add Figs. 4-10 with the attached drawing sheets labeled New Sheets. The drawings are submitted in accordance with 37 C.F.R. 1.84 and 1.121(d). No new matter has been added.

REMARKS/ARGUMENTS

The Notice to File Corrected Application Papers ("Notice") mailed March 6, 2019 has been received and its contents carefully noted. The Notice stated that the specification is not in compliance with 37 CFR 1.52 because pages 12-14 allegedly contain text that is unreadable or of insufficient clarity. The text highlighted by the Examiner principally consists of tables that were embedded in the detailed description when the application was submitted.

Initially, Applicant submits herein a Substitute Specification, including marked-up and clean copies. In the amended specification, Applicant has removed certain tables from the detailed description, for the sake of clarity. The information provided in such tables has been added to the drawings in new Figures 4-10. No new matter has been added.

In addition, Applicant submits replacement and new drawing sheets to replace Figs. 1-3 and add Figs. 4-10. No new matter has been introduced by these amendments. Applicant respectfully submits that these Replacement Sheets and New Sheets are in compliance with 37 C.F.R. 1.84 and 37 C.F.R. 1.121(d). Applicant respectfully requests that the Application be examined on the merits.

The Notice indicated that a properly executed inventor's oath or declaration had not yet been received for the inventors Jared Oehring, Lon Robinson, and Brandon N. Hinderliter. The Applicant will file fully executed inventor declarations before the issue fee payment date, as required by 37 CFR 1.53(f).

CONCLUSION

Applicant has endeavored to address all of the Office's concerns as expressed in the Notice. Should the Office have any remaining concerns which might prevent the prompt allowance of the application, the Office is respectfully invited to contact the undersigned at the telephone number appearing below.

No additional fees are believed due; however, the Commissioner is authorized to charge any fees due in connection with the filing of this response to our Deposit Account No. 50-1349.

Respectfully submitted,

Date: May 3, 2019

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DocCode – SCORE

SCORE Placeholder Sheet for IFW Content

Application Number: 16210807 Document Date: 05/03/2019

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16210807
Filing Date	2018-12-05
First Named Inventor	Jared Oehring
Art Unit	3746
Examiner Name	
Attorney Docket Number	047158.100035

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	4100822		1978-07-18	Rosman	
	2	8851860		2014-10-07	Mail	
	3	6208098		2001-03-27	Kume	
	4	5189388		1993-02-23	Mosley	

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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
	1	20180320483		2018-11-08	Zhang, Yanchai	
	2	20180038216		2018-02-08	Zhang, Yanchai	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3746
	Examiner Name	
	Attorney Docket Number	047158.100035

	3	20160102537		2016-04-14	Lopez, Miguel Angel	
	4	20140290768		2014-10-02	Randle, Coy	
	5	20140277772		2014-09-18	Lopez, Miguel	
	6	20170096885		2017-04-06	Oehring, Jared	
	7	20070277982		2007-12-06	Shampine	
	8	20170051732		2017-02-23	Baker Hughes Incorporated	
	9	20160341281		2016-11-24	Onesubsea IP UK Limited	
	10	20050274508		2005-12-15	Folk	
	11	20070131410		2007-06-14	Hill	
	12	20090045782		2009-02-19	Datta	
	13	20150097504		2015-04-09	Lamascus	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3746
	Examiner Name	
	Attorney Docket Number	047158.100035

	14	20190003329		2019-01-03	Morris			

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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	2833711	CA		2014-05-16	Broussard et al.		☒
	2	2955706	CA		2012-10-07	Coli et al.		☒

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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	Non-Final Office Action mailed February 12, 2019 in related U.S. Patent Application No. 16/170,695	☒
	2	International Search Report and Written Opinion mailed February 15, 2019 in related PCT Application No. PCT/US18/63977	☒
	3	Non-Final Office Action mailed February 25, 2019 in related U.S. Patent Application No. 16/210,749	☒
	4	International Search Report and Written Opinion mailed March 5, 2019 in related PCT Application No. PCT/US18/63970	☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3746
	Examiner Name	
	Attorney Docket Number	047158.100035

	5	Non-Final Office Action mailed March 6, 2019 in related U.S. Patent Application No. 15/183,387	☒
	6	Office Action mailed March 1, 2019 in related Canadian Patent Application No. 2,943,275	☒
	7	Office Action mailed January 30, 2019 in related Canadian Patent Application No. 2,936,997	☒

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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	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	3746
	Examiner Name	
	Attorney Docket Number	047158.100035

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	/Taylor P. Evans/	Date (YYYY-MM-DD)	2019-03-19
Name/Print	Taylor P. Evans	Registration Number	60506

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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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:

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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:	35462654
Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Taylor P. Evans/Stephanie McDonough
Filer Authorized By:	Taylor P. Evans
Attorney Docket Number:	047158.100035
Receipt Date:	19-MAR-2019
Filing Date:	05-DEC-2018
Time Stamp:	11:40:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	047158-100035_IDS.pdf	1035396 e0604ca56c04a17325efc9a1ce39493c92a504cf	no	6

Warnings:

Information:					
2	Foreign Reference	CA2833711A1.pdf	739512 e1128f7f4deda30ec9d49369571c9de7d6525686	no	24
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
3	Foreign Reference	CA2955706A1.pdf	1560333 7a56e2fb9d8d67729700c2cf21a4049546f85401	no	46
Warnings:					
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Information:					
4	Other Reference-Patent/App/Search documents	NPL.pdf	525140 e2d27885e640663c4c557ca419b56b14b16ff618	no	16
Warnings:					
Information:					
5	Other Reference-Patent/App/Search documents	NPL2.pdf	614235 ea5d6da1e4f084a6ff03eaa3338bdf5908f28e76	no	13
Warnings:					
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Information:					
6	Other Reference-Patent/App/Search documents	NPL3.pdf	291386 d47df5a4343cde8839c857746827e9466edc16d6	no	9
Warnings:					
Information:					
7	Other Reference-Patent/App/Search documents	NPL4.pdf	589124 eb5e7aa2178ef3188004acf9d9cdec98383d39e6	no	11
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Information:					

8	Other Reference-Patent/App/Search documents	NPL5.pdf	254035 f9e4d9dbeeb5db1ff93fad2164d580669784a45c	no	8
Warnings:					
Information:					
9	Other Reference-Patent/App/Search documents	NPL6.pdf	191754 1ec9a64cedf4d439ccc5d68864249c23ffd5741d	no	4
Warnings:					
Information:					
10	Other Reference-Patent/App/Search documents	NPL7.pdf	169683 2c9185c3afce9bea1ed978846116a35631002a87	no	3
Warnings:					
Information:					
			Total Files Size (in bytes):	5970598	

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/210,807

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	660
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 460 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1720

APPLICATION AS AMENDED - PART II

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

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/210,807	12/05/2018	Jared Oehring	047158.100035

CONFIRMATION NO. 2654

132858
Hogan Lovells US LLP
609 Main Street
Suite 4200
Houston, TX 77002

FORMALITIES LETTER

OC000000106328345

Date Mailed: 03/06/2019

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given TWO MONTHS from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The required item(s) identified below must be timely submitted to avoid abandonment:

- A substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required. The substitute specification must be submitted with markings and be accompanied by a clean version (without markings) as set forth in 37 CFR 1.125(c) and a statement that the substitute specification contains no new matter (see 37 CFR 1.125(b)). The specification, claims, and/or abstract page(s) submitted is not acceptable and cannot be scanned or properly stored because:
  - The application papers (including any electronically submitted papers) are not in compliance with 37 CFR 1.52 because pages 12-14 contain text that is unreadable or of insufficient clarity.
    Application papers (including any electronically submitted papers) must be presented in a form having sufficient clarity and contrast between the background of the paper and the writing thereon to permit the Office to electronically reproduce the papers by use of digital imaging and optical character recognition. See 37 CFR 1.52(a)(1)(v).

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
  Jared Oehring
  Lon Robinson
  Brandon N. Hinderliter

Alexander James Christinzio

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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Commissioner for Patents
P.O. Box 1450
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". https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at http://www.uspto.gov/ebc.

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**.

/sareebuddin/

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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
16/210,807	12/05/2018	3746	1880	047158.100035	20	3

CONFIRMATION NO. 2654

132858
Hogan Lovells US LLP
609 Main Street
Suite 4200
Houston, TX 77002

FILING RECEIPT

OC000000106328344

Date Mailed: 03/06/2019

Receipt is acknowledged of this non-provisional 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 APPLICANT, 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 Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections 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**

Inventor(s)

Jared Oehring, Houston, TX;
Lon Robinson, Houston, TX;
Brandon N. Hinderliter, Houston, TX;
Alexander James Christinzio, Houston, TX;

Applicant(s)

U.S. Well Services, Inc., Houston, TX;

Assignment For Published Patent Application

U.S. Well Services, Inc., Houston, TX

Power of Attorney: None

Domestic Priority data as claimed by applicant

This appln claims benefit of 62/594,912 12/05/2017

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: 03/04/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/210,807**

Projected Publication Date: To Be Determined - pending completion of Corrected Papers

Non-Publication Request: No

Early Publication Request: No

Title

MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

Preliminary Class

417

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).

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Title 35, United States Code, Section 184

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PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16210807
Filing Date	2018-12-05
First Named Inventor	Jared Oehring
Art Unit	
Examiner Name	
Attorney Docket Number	047158.100035

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	4432064		1984-02-14	Barker	
	2	5006044		1991-04-09	Walker, Sr.	

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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
	1	20170292513		2017-10-12	Haddad	
	2	20140095114		2014-04-03	Thomeer	
	3	20150217672		2015-08-06	Shampine	
	4	20170328179		2017-11-16	Dykstra	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	
	Examiner Name	
	Attorney Docket Number	047158.100035

	5	20040040746		2004-03-04	Niedermayr	
	6	20140379300		2014-12-25	Devine et al.	
	7	20060052903		2006-03-09	Bassett	
	8	20170037717		2017-02-09	Oehring	
	9	20110247878		2011-10-13	Rasheed	
	10	20160230524		2016-08-11	Dumoit	
	11	20170114625		2017-04-27	Norris	
	12	20170022807		2017-01-26	Dursun	
	13	20160208595		2016-07-21	Tang	
	14	20150075778		2015-03-19	Walters	

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	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	
	Examiner Name	
	Attorney Docket Number	047158.100035

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	2016/144939	WO		2016-09-15	Schlumberger Technologies Corporation		☒
	2	2016/160458	WO		2016-10-06	Schlumberger Technology Corporation		☒

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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	Office Action mailed December 12, 2018 in related U.S. Patent Application No. 16/160,708	☒
	2	International Search Report and Written Opinion mailed January 2, 2019 in related PCT Patent Application No. PCT/US18/54542	☒
	3	International Search Report and Written Opinion mailed January 2, 2019 in related PCT Patent Application No. PCT/US18/54548	☒
	4	International Search Report and Written Opinion mailed December 31, 2018 in related PCT Patent Application No. PCT/US18/55913	☒
	5	International Search Report and Written Opinion mailed January 4, 2019 in related PCT Patent Application No. PCT/US18/57539	☒

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16210807
	Filing Date	2018-12-05
	First Named Inventor	Jared Oehring
	Art Unit	
	Examiner Name	
	Attorney Docket Number	047158.100035

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	16210807
Filing Date	2018-12-05
First Named Inventor	Jared Oehring
Art Unit	
Examiner Name	
Attorney Docket Number	047158.100035

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	/Taylor P. Evans/	Date (YYYY-MM-DD)	2019-01-22
Name/Print	Taylor P. Evans	Registration Number	60506

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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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 record s.

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:	34926433
Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Taylor P. Evans/Stephanie McDonough
Filer Authorized By:	Taylor P. Evans
Attorney Docket Number:	047158.100035
Receipt Date:	22-JAN-2019
Filing Date:	
Time Stamp:	17:43:48
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	100035_IDS.pdf	1035280 549ba62d56269ddd4e17017116adec1462 0e96d2	no	6

Warnings:

Information:					
2	Other Reference-Patent/App/Search documents	100031.pdf	214752 faa678d394f7cde3d00109e900e2ee8a3df7a63f	no	7
Warnings:					
Information:					
3	Foreign Reference	WO2016144939A1.pdf	2806113 872bb70d656a1509be358ed84d26d96df024df95	no	51
Warnings:					
Information:					
4	Foreign Reference	WO2016160458A1.pdf	2943101 c19c0fff680828435 78b747bb7ab73e084460695	no	57
Warnings:					
Information:					
5	Other Reference-Patent/App/Search documents	047158-500029_ISR.pdf	802847 09a6ee9f7678ee3365f1ee4a86703a29c1c6ee60	no	13
Warnings:					
Information:					
6	Other Reference-Patent/App/Search documents	047158-500030_ISR.pdf	665357 36b902d632a1627341950fd2f01f5d30c9ebd86d	no	13
Warnings:					
Information:					
7	Other Reference-Patent/App/Search documents	047158-500031_ISR.pdf	952437 a028f3c3a8360e2f1ae30b8c076ed95c2155e085	no	14
Warnings:					
Information:					
8	Other Reference-Patent/App/Search documents	047158-500032_ISR.pdf	832886 f41c7088830eacd43d5727861d637e53eca5a9fb	no	15
Warnings:					

The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing

Information:	
Total Files Size (in bytes):	10252773

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

Electronic Patent Application Fee Transmittal

Application Number:	16210807
Filing Date:	
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Filer:	Taylor P. Evans/Stephanie McDonough
Attorney Docket Number:	047158.100035

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
LATE FILING FEE FOR OATH OR DECLARATION	1051	1	160	160
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

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

Electronic Acknowledgement Receipt

EFS ID:	34868591
Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Taylor P. Evans/Stephanie McDonough
Filer Authorized By:	Taylor P. Evans
Attorney Docket Number:	047158.100035
Receipt Date:	16-JAN-2019
Filing Date:	
Time Stamp:	11:37:34
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$160
RAM confirmation Number	011619INTEFSW00012091501349
Deposit Account	501349
Authorized User	Stephanie McDonough

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Fee Worksheet (SB06)	fee-info.pdf	30346 3f0f8319fce9d1abeba301e8bbdfcfe6c11c92ad	no	2

Warnings:	
Information:	
Total Files Size (in bytes):	30346

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

New Applications Under 35 U.S.C. 111

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

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

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New International Application Filed with the USPTO as a Receiving Office

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Doc Code: PA.
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
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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: 132858

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):

U.S. Well 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	Jared Oshring		
Title	Vice President of Technology		

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 1 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.

Electronic Acknowledgement Receipt

EFS ID:	34868368
Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Taylor P. Evans/Stephanie McDonough
Filer Authorized By:	Taylor P. Evans
Attorney Docket Number:	047158.100035
Receipt Date:	16-JAN-2019
Filing Date:	
Time Stamp:	11:26:25
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	Alex_Declaration.PDF	1382821 0982dca88b688649235b2828770d6f42ac823a51	no	2

Warnings:

Information:					
2	Oath or Declaration filed	Brandon_Declaration.pdf	81161 330ffdf32d456e376604eb46036f359f5bd62148	no	2
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
3	Oath or Declaration filed	JOehring_Declaration.pdf	84858 01bc14ed77821a44589a8aa22f1589b0cc6f8f27	no	1
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
4	Oath or Declaration filed	Lon_Declaration.pdf	1171491 794d7b1641070e07f1680cc29b0c6c17a4a0704f	no	2
Warnings:					
Information:					
5	Power of Attorney	Signed_Applicant_POA.pdf	104663 a348fa5e3baf32ac615c2242176ba5ccb879e88e	no	1
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
			Total Files Size (in bytes):	2824994	

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/AIA/01 (06-12)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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

Title of Invention	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

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 _____ filed on _____.

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: Alexander James Christinzio Date (Optional): 12/5/18

Signature: Alexander James Christinzio

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. 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.

Privacy Act Statement

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

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

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
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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.
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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.

PTO/AIA/01 (08-12)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

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 _____ filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

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LEGAL NAME OF INVENTOR

Inventor: Brandon N. Hinderliter Date (Optional): 12/5/18

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. 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.**

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

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

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

Title of Invention	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

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 16/210,807

filed on December 5, 2018

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: Jared Oehring Date (Optional) :

Signature:

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor

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LEGAL NAME OF INVENTOR

Inventor: Lon Robinson Date (Optional): 5-Dec-2018

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
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(Not for submission under 37 CFR 1.99)

Application Number	16210807
Filing Date	2018-12-05
First Named Inventor	Jared Oehring
Art Unit	
Examiner Name	
Attorney Docket Number	047158.100035

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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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	Art Unit	
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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
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	2	20110085924		2011-04-14	Shampine	
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	Attorney Docket Number	047158.100035

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	Attorney Docket Number	047158.100035

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	First Named Inventor	Jared Oehring
	Art Unit	
	Examiner Name	
	Attorney Docket Number	047158.100035

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	Art Unit	
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	Attorney Docket Number	047158.100035

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	1	2004264589	JP		2004-09-24	Toshiba KK [TOKE]		☒
	2	101977016	CN		2011-02-16	Univ Tianjin Technology		☒
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	1	UK Power Networks - Transformers to Supply Heat to Tate Modern - from Press Releases May 16, 2013.	☒
	2	Non-Final Office Action issued in corresponding Application No. 15/293,681 dated February 16, 2017.	☒
	3	Non-Final Office Action issued in corresponding Application No. 15/294,349 dated March 14, 2017.	☒
	4	Final Office Action issued in corresponding Application No. 15/145,491 dated January 20, 2017.	☒
	5	Non-Final Office Action issued in corresponding Application No. 15/145,443 dated February 7, 2017.	☒
	6	Notice of Allowance issued in corresponding Application No. 15/217,040 dated March 28, 2017.	☒
	7	Notice of Allowance issued in corresponding Application No. 14/622,532 dated March 27, 2017.	☒
	8	Non-Final Office Action issued in corresponding Application No. 15/291,842 dated January 6, 2017.	☒
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	10	Non-Final Office Action issued in corresponding Application No. 14/622,532 dated May 17, 2016.	☒

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	Art Unit	
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	Attorney Docket Number	047158.100035

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	22	Final Office Action issued in corresponding Application No. 15/145,491 dated September 6, 2017	☒
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	24	Non-Final Office Action issued in corresponding Application No. 15/145,414 dated November 29, 2017	☒
	25	Non-Final Office Action issued in corresponding Application No. 15/644,487 dated November 13, 2017	☒
	26	Canadian Office Action dated March 2, 2018 in related Canadian Patent Application No. 2,833,711	☒
	27	Office Action dated April 10, 2018 in related U.S. Patent Application No. 15/294,349	☒
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	29	Office Action dated May 29, 2018 in related U.S. Patent Application No. 15/235,716	☒
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	31	Canadian Office Action dated June 22, 2018 in related Canadian Patent Application No. 2,886,697	☒
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	Examiner Name	
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	33	Office Action dated October 4, 2018 in related U.S. Patent Application No. 15/217,081	☒
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	35	Canadian Office Action dated September 28, 2018 in related Canadian Patent Application No. 2,945,281	☒

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	Art Unit	
	Examiner Name	
	Attorney Docket Number	047158.100035

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).

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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	/Taylor P. Evans/	Date (YYYY-MM-DD)	2018-12-07
Name/Print	Taylor P. Evans	Registration Number	60506

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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Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Taylor P. Evans/Stephanie McDonough
Filer Authorized By:	Taylor P. Evans
Attorney Docket Number:	047158.100035
Receipt Date:	07-DEC-2018
Filing Date:	
Time Stamp:	11:31:13
Application Type:	Utility under 35 USC 111(a)

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Warnings:					
Information:					
28	Other Reference-Patent/App/Search documents	NPL-24.pdf	451221 e687ad5f4706b9e03066369dc1420137400f88de	no	8
Warnings:					
Information:					
29	Other Reference-Patent/App/Search documents	NPL-25.pdf	377985 237e2c85af09d19cf7cb543c47313c5a45ddb5ad	no	7
Warnings:					
Information:					

30	Other Reference-Patent/App/Search documents	NPL-26.pdf	1183912 7e1a6ae1483129df3319e86782490d171adcddd6	no	4
Warnings:					
Information:					
31	Other Reference-Patent/App/Search documents	NPL-27.pdf	513370 613846c97d5a97f394676e8db875d38ebbc6a14c	no	14
Warnings:					
Information:					
32	Other Reference-Patent/App/Search documents	NPL-28.pdf	259116 a14d6a19e09f39b424e07487c378c1ff22b9eaab	no	8
Warnings:					
Information:					
33	Other Reference-Patent/App/Search documents	NPL-29.pdf	246974 90f86007da0c8c3e09c6f313efbbd8165e8b46c7	no	7
Warnings:					
Information:					
34	Other Reference-Patent/App/Search documents	NPL-30.PDF	1720052 4521f83d51ace785df9c8c36491647 4f6a0636a2	no	6
Warnings:					
Information:					
35	Other Reference-Patent/App/Search documents	NPL-31.pdf	1075045 57b28c6bfb3d0fa629280b4b1901d26504cc2573	no	4
Warnings:					
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36	Other Reference-Patent/App/Search documents	NPL-32.pdf	219467 aaf00dcfa34bf6fe5e9894a1b1ced293f1b2bbc6	no	7
Warnings:					
Information:					

37	Other Reference-Patent/App/Search documents	NPL-33.pdf	304155 03f600617bb97ec2d345ef87af05ffe83a1f4e55	no	9
Warnings:					
Information:					
38	Other Reference-Patent/App/Search documents	NPL-34.pdf	414424 e98d69001209ae5ac3a6b2472c1e0c3447c49857	no	9
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
39	Other Reference-Patent/App/Search documents	NPL-35.pdf	176576 9d704329cec304ab4ecf65ec3669ed96e4e65e2d	no	3
Warnings:					
Information:					
			Total Files Size (in bytes):	22366573	

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Jared Oehring	Nonprovisional Application Number (if known):	
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. The applicable box is checked below:

I. ☑ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, **or** the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Kristin L. Lamb/	Date 2018-12-05
Name (Print/Typed) Kristin L. Lamb	Practitioner Registration Number 71571

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

☑ *Total of 1 forms are submitted.

Privacy Act Statement

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

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

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	047158.100035
	Application Number	
Title of Invention	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jared		Oehring	

Residence Information (Select One) ● US Residency Non US Residency Active US Military Service

City	State/Province	Country of Residence
Houston	TX	US

Mailing Address of Inventor:

Address 1	c/o U.S. Well Services, Inc.
Address 2	770 South Post Oak Lane, Suite 410
City	Houston
State/Province	TX
Postal Code	77056
Country	US

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Lon		Robinson	

Residence Information (Select One) ◉ US Residency Non US Residency Active US Military Service

City	State/Province	Country of Residence
Houston	TX	US

Mailing Address of Inventor:

Address 1	c/o U.S. Well Services, Inc.
Address 2	770 South Post Oak Lane, Suite 410
City	Houston
State/Province	TX
Postal Code	77056
Country	US

Inventor 3 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Brandon	N.	Hinderliter	

Residence Information (Select One) ◉ US Residency Non US Residency Active US Military Service

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	047158.100035
	Application Number	
Title of Invention	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS	

City	Houston	State/Province	TX	Country of Residence	US

Mailing Address of Inventor:

Address 1	c/o U.S. Well Services, Inc.
Address 2	770 South Post Oak Lane, Suite 410

City	Houston	State/Province	TX
Postal Code	77056	Country	US

Inventor 4 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Alexander	James	Christinzio	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Houston	State/Province	TX	Country of Residence	US

Mailing Address of Inventor:

Address 1	c/o U.S. Well Services, Inc.
Address 2	770 South Post Oak Lane, Suite 410

City	Houston	State/Province	TX
Postal Code	77056	Country	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	132858		
Email Address	hlusdocketing@hoganlovells.com	Add Email	Remove Email

Application Information:

Title of the Invention	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS		
Attorney Docket Number	047158.100035	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	3	Suggested Figure for Publication (if any)	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	047158.100035
	Application Number	
Title of Invention	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS	

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

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	132858		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Claims benefit of provisional	62594912	2017-12-05

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	047158.100035
	Application Number	
Title of Invention	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS	

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

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.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	047158.100035
	Application Number	
Title of Invention	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS	

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	047158.100035
	Application Number	
Title of Invention	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS	

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 — Remove

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	U.S. Well Services, Inc.		
Mailing Address Information For Applicant:			
Address 1	770 South Post Oak Lane		
Address 2	Suite 410		
City	Houston	**State/Province**	TX
Country	US	Postal Code	77056
Phone Number		Fax Number	
Email Address			

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

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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	047158.100035
	Application Number	
Title of Invention	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS	

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.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☒

Organization Name	U.S. Well Services, Inc.

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	770 South Post Oak Lane		
Address 2	Suite 410		
City	Houston	**State/Province**	TX
Country i	US	Postal Code	77056
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

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	/Kristin L. Lamb/			Date (YYYY-MM-DD)	2018-12-05
First Name	Kristin L.	Last Name	Lamb	Registration Number	71571

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	047158.100035
	Application Number	
Title of Invention	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS	

This collection of information is required by 37 CFR 1.76. 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 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet 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.

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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.

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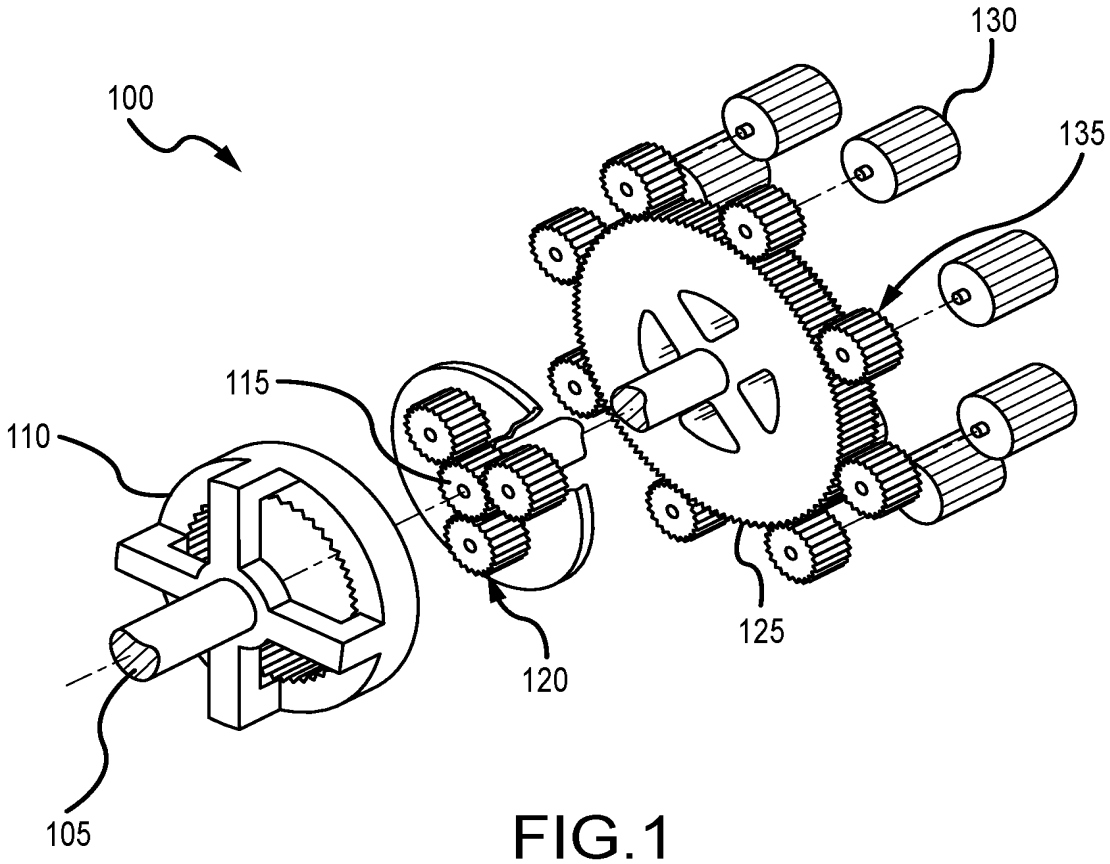


FIG.1

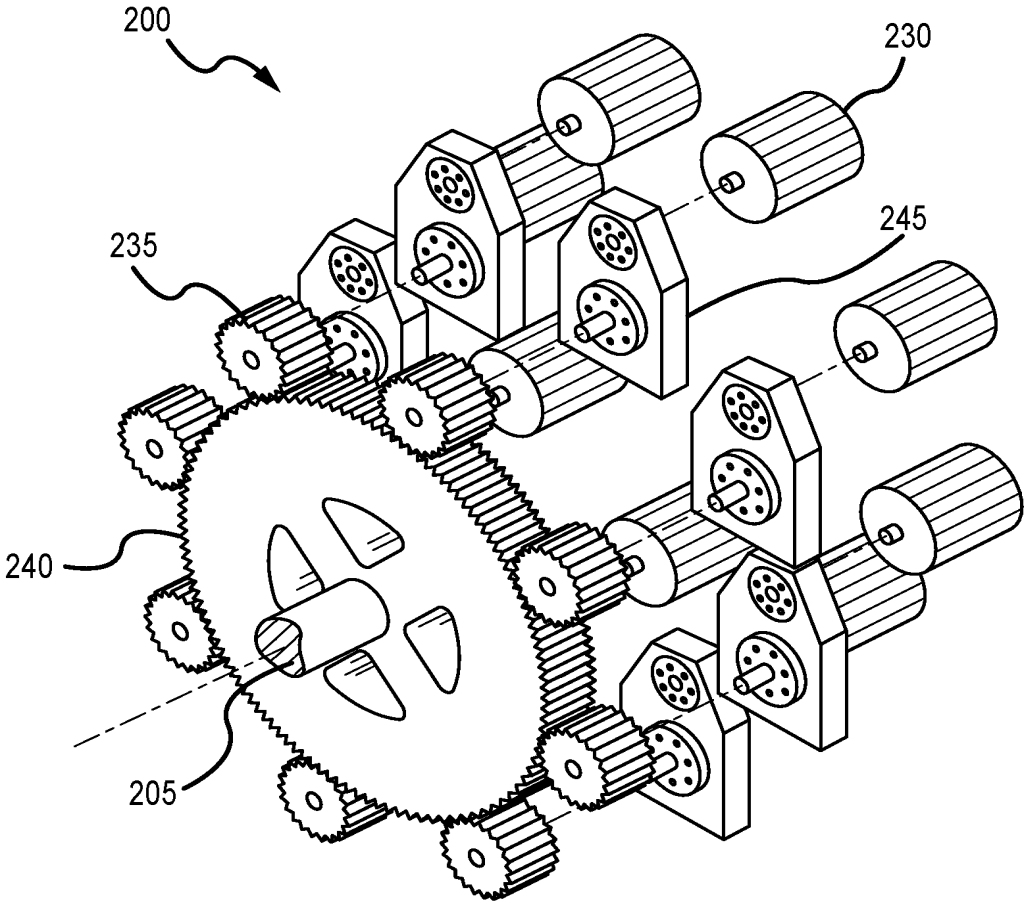


FIG.2

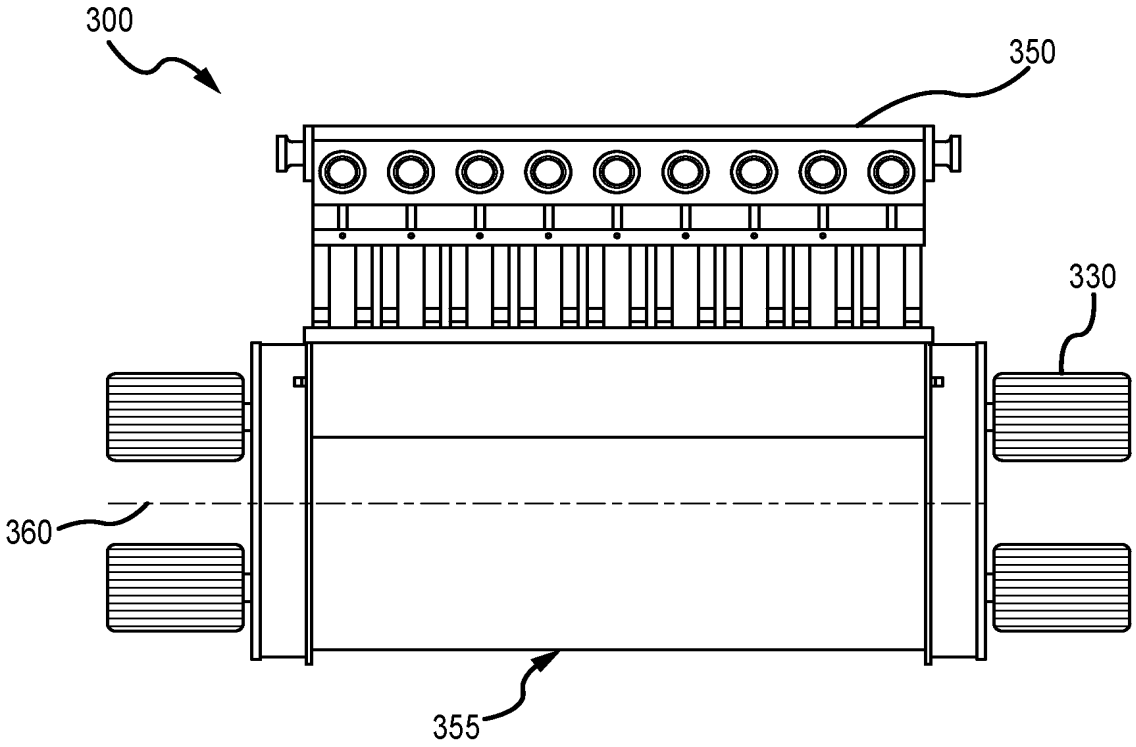


FIG.3

PATENT APPLICATION

ATTORNEY DOCKET NO.: 047158.100035

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MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of U.S. Provisional Patent Application No. 62/594,912, filed December 5, 2017, the full disclosure of which is hereby incorporated by reference herein for all purposes.

BACKGROUND

[0002] 1. Technical Field

[0003] This disclosure relates generally to drive systems for reciprocating plunger-style pumps used in hydraulic fracturing operations, and more particularly to multi-plunger hydraulic fracturing pumps and associated drive systems.

[0004] 2. Background

[0005] With advancements in technology over the past few decades, the ability to reach unconventional sources of hydrocarbons has tremendously increased. Horizontal drilling and hydraulic fracturing are two such ways that new developments in technology have led to hydrocarbon production from previously unreachable shale formations. Hydraulic fracturing (fracking) operations typically require powering numerous components in order to recover oil and gas resources from the ground. For example, hydraulic fracturing usually includes pumps that inject fracking fluid down the wellbore, blenders that mix proppant into the fluid, cranes, wireline units, and many other components that all must perform different functions to carry out fracking operations.

[0006] Hydraulic fracturing operations commonly use diesel-powered pumps to transmit fluid media down the well bore, the transmissions for the diesel-powered pumps often having seven

speeds or more. When one or more pumps go offline during operation, for example due to system failure or for scheduled maintenance, the speed of the remaining operating pumps is increased accordingly. However, many of the top gears in these diesel transmissions provide speeds that are above the critical speed for the associated plunger pumps. Thus, compensating for the downed pump or pumps by up-shifting operation of the remaining pumps to these higher gears, above the critical speed for the pumps, can result in damage to the pumps. There is a need for hydraulic fracturing pumps that are capable of operation at or below the critical speed, without sacrificing pump rate, efficiency, and efficacy.

SUMMARY

[0007] One of the most common transmissions utilized in hydraulic fracturing pump applications is a nine-speed transmission, often driven by a diesel-powered engine. When this transmission is in fifth gear and the engine is running at 1700 rotations per minute (rpm), for example, the critical speed of 120 rpm on an associated 8-inch stroke pump is reached. Therefore, running the pump with the transmission operating in any of gears six through nine, above the critical speed reached at gear five, could cause pump cavitation and damage accumulation to the fluid end of the pump.

[0008] It has historically been believed that pump cavitation is caused by air entering the pump. Through testing and data-gathering, however, Applicants have observed that pump cavitation and damage are caused by the formation of vacuum bubbles as a result of fluid being accelerated too fast through the pump. A heightened speed of operation creates low pressure within the pumps, creating vacuum bubbles. As the pump plungers retract, the vacuum bubbles implode, causing damage (cavitation) to the pump and engine systems. Although the risks of operating the pumps at too great of speeds may be known, concerns about lowered pump rates and lost

efficiency resulting from maintaining slower transmission speeds commonly lead to disregard of the risks as an unavoidable consequence of maintaining pump efficiency.

[0009] In seeking to avoid such pump damage, Applicants have observed that, by operating transmissions such that pumps are maintained at or below critical pump speeds, such formation of vacuum bubbles and resulting pump cavitation and damage may be avoided. Further still, Applicants have observed that use of electric- or hydraulic-powered pumps may allow for better control of pump speeds at or below the critical speed due to the smaller increments between gear speeds as compared to those of pumps driven by diesel-powered engines.

[0010] Operation below critical pump speeds has previously been avoided as being considered inefficient and ineffective for pump usage in fracking, as slower pump speeds are historically believed to be directly tied to pump rates. Applicant has observed, however, that the introduction of multiple electric- or hydraulic-powered motors driving planetary gear trains can provide effective and efficient pumping power, thereby maintaining a consistent pump rate for fluid transfer, while also sustaining a pumping speed at or below the critical speed for the plungers. For example, Applicant discovered that varying pump bore sizes and stroke lengths, as well as number of plungers, allowed for operation at slower pump speeds while maintaining or increasing fluid pump rates. Applicant also discovered, through testing and analysis, that certain bore size, stroke length, and plunger number combinations provided maximum pump rate efficiency at a usable and economically effective overall pump size.

[0011] The present disclosure is directed to hydraulic fracturing system for fracturing a subterranean formation, according to various embodiments. In an embodiment, the hydraulic fracturing system can include a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, and the multi-plunger pump can be configured

to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation. In an embodiment, the system can further include a plurality of motors positioned to power the multi-plunger pump, and a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors. In an embodiment, a gear ratio of the planetary gear train and a speed at which the plurality of motors operates can be selected so as to limit a maximum pump speed associated with the multi-plunger pump.

[0012] In an embodiment, the system can include a plurality of speed reduction gearboxes positioned between the plurality of input pinion gears and the plurality of motors so as to achieve a desired pump rate.

[0013] In an embodiment, the plurality of motors can include one of a plurality of electric motors or a plurality of hydraulic motors.

[0014] In an embodiment, the maximum pump speed can correlate to a critical plunger speed associated with each of the plurality of hydraulic pumps.

[0015] In an embodiment, the maximum pump speed can be 5% or less over a critical plunger speed associated with each of the plurality of hydraulic pumps.

[0016] In an embodiment, the plurality of hydraulic pumps includes an odd number of plungers greater than or equal to five plungers.

[0017] In an embodiment, a stroke length of each of the plungers associated with the plurality of hydraulic pumps can be selected to inversely relate to a pump speed associated with the plurality of hydraulic pumps so as to achieve a predetermined flow rate.

[0018] In an embodiment, the system can include a variable frequency drive (VFD) connected to the plurality of motors to control the speed of the plurality of motors. The VFD can be positioned

to accelerate or decelerate pump rotational speeds associated with each of the plurality of hydraulic pumps, according to an embodiment.

[0019] In an embodiment, the VFD can include a plurality of VFDs, and the plurality of VFDs can be configured to share a load required to power the plurality of hydraulic pumps.

[0020] In an embodiment, the plurality of VFDs can be configured to automatically shut off in the event of an overpressure event with respect to the plurality of hydraulic pumps.

[0021] The present disclosure is also related to a hydraulic fracturing system for fracturing a subterranean formation, according to an embodiment. In an embodiment, the system can include a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, and the multi-plunger pump can be configured to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation. In an embodiment, a plurality of motors can be positioned to power the multi-plunger pump. The system can further include a variable frequency drive connected to the plurality of motors to control the speeds of the plurality of electric motors, according to an embodiment. In an embodiment, the system can include a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors. In an embodiment, a gear ratio of the planetary gear train and a speed at which the plurality of motors operates can be selected so as to limit a maximum pump speed associated with the multi-plunger pump.

[0022] The present disclosure is also directed to a method for pumping fluid into a wellbore associated with a subterranean formation. In an embodiment, the method can include fluidly connecting a multi-plunger hydraulic fracturing pump to a well associated with the subterranean formation such that the multi-plunger pump pumps fluid into the wellbore at a high pressure so

that fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation. In an embodiment, the method can include powering the multi-plunger pump with a plurality of motors. In an embodiment, the method can further include providing a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors so as to translate power from the plurality of motors into a desired pump rate of the multi-plunger pump.

[0023] Other aspects and features of the present disclosure will become apparent to those of ordinary skill in the art after reading the detailed description herein and the accompanying figures.

BRIEF DESCRIPTION OF DRAWINGS

[0024] Some of the features and benefits of the present invention having been stated, others will become apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

[0025] FIG. 1 is an exploded schematic example of a planetary gear train having multiple input pinions for direct connection to an electric motor, according to an embodiment.

[0026] FIG. 2 is an exploded schematic example of a planetary gear train having a speed reduction gearbox mounting for connection to an electric motor, according to an embodiment.

[0027] FIG. 3 is a schematic example of a multi-plunger pump having nine plungers and four electric motors mounted for driving the multi-plunger pump, according to an embodiment.

[0028] While the invention will be described in connection with the preferred embodiments, it will be understood that the included description is not intended to limit the invention to the described preferred embodiments. On the contrary, the description is intended to cover all

alternatives, modifications, and equivalents, as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF INVENTION

[0029] The method and system of the present disclosure will now be described more fully hereinafter with reference to the accompanying drawings in which embodiments are shown. The method and system of the present disclosure may be in many different forms and should not be construed as limited to the illustrated embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey its scope to those skilled in the art. Like numbers refer to like elements throughout.

[0030] It is to be further understood that the scope of the present disclosure is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. In the drawings and specification, there have been disclosed illustrative embodiments and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation.

[0031] Described herein is an example of a method and system for providing reciprocating, plunger-style pumps as part of a multi-plunger system for use in hydraulic fracturing operations. Also described are various drive systems for use with the described reciprocating, plunger-style pumps. In various embodiments, the pumps and drive systems may be utilized by conventionally powered (i.e., diesel engine-driven) hydraulic fracturing pumping systems, or in other embodiments by hydraulically powered or electrically powered hydraulic fracturing pumping systems.

[0032] Multi-plunger hydraulic fracturing pumps, though known in the art, are typically limited to either triplex (three plungers) or quintuplex (five plungers) arrangements. Common hydraulic fracturing pumps often utilize 8-inch, 10-inch, and 11-inch stroke triplex and quintuplex hydraulic fracturing pumps. Hydraulic fracturing pumps are commonly driven by an engine (usually a 2500 horsepower (HP) diesel engine) and a multiple speed transmission, usually having seven speeds or more. However, many of the top gears, depending on the manufacturer and gear ratios, provide speeds that are above the critical speed of a plunger pump. Table 1, below, details calculations of such plunger critical speeds.

Plunger Critical Speed Calculations

Plunger Critical Speed = 32 in/sec (based on 120 rpm crankshaft speed on 8" stroke pump)
Plunger Maximum Speed = 90 in/sec (based on 150 rpm crankshaft speed on 8" stroke pump)

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
2.75" Bore	8	0.01469	0.02449	0.03408	0.04967	120.00	150.00	3.76	7.98	5.29	7.64	2.20	3.67	6.61	9.55
	9	0.01653	0.02755	0.04959	0.07163	106.67	133.33								
	10	0.01837	0.03061	0.05510	0.07959	96.00	120.00								
	11	0.02020	0.03367	0.06061	0.08754	87.27	109.09								
	12	0.02204	0.03673	0.06612	0.09550	80.00	100.00								
	13	0.02388	0.03979	0.07163	0.10346	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
3.0" Bore	8	0.01749	0.02914	0.05246	0.07577	120.00	150.00	2.10	3.50	6.29	9.09	2.62	4.37	7.87	11.37
	9	0.01967	0.03279	0.05901	0.08524	106.67	133.33								
	10	0.02186	0.03643	0.06557	0.09471	96.00	120.00								
	11	0.02404	0.04007	0.07213	0.10419	87.27	109.09								
	12	0.02623	0.04371	0.07868	0.11366	80.00	100.00								
	13	0.02841	0.04736	0.08524	0.12313	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
3.25" Bore	8	0.02052	0.03420	0.06158	0.08893	120.00	150.00	2.46	4.10	7.39	10.67	3.08	5.13	9.23	13.34
	9	0.02309	0.03848	0.06926	0.10004	106.67	133.33								
	10	0.02565	0.04275	0.07696	0.11116	96.00	120.00								
	11	0.02822	0.04703	0.08465	0.12227	87.27	109.09								
	12	0.03078	0.05130	0.09235	0.13339	80.00	100.00								
	13	0.03335	0.05558	0.10004	0.14450	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
3.5" Bore	8	0.02380	0.03967	0.07140	0.10313	120.00	150.00	2.86	4.76	8.57	12.38	3.57	5.95	10.71	15.47
	9	0.02677	0.04462	0.08032	0.11602	106.67	133.33								
	10	0.02975	0.04958	0.08925	0.12897	96.00	120.00								
	11	0.03272	0.05454	0.09817	0.14183	87.27	109.09								
	12	0.03570	0.05950	0.10710	0.15470	80.00	100.00								
	13	0.03867	0.06446	0.11602	0.16758	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
4.0" Bore	8	0.03109	0.05181	0.09326	0.13470	120.00	150.00	3.73	6.22	11.19	16.16	4.66	7.77	13.99	20.21
	9	0.03497	0.05829	0.10491	0.15154	106.67	133.33								
	10	0.03886	0.06476	0.11657	0.16838	96.00	120.00								
	11	0.04274	0.07124	0.12823	0.18522	87.27	109.09								
	12	0.04663	0.07771	0.13989	0.20206	80.00	100.00								
	13	0.05051	0.08419	0.15154	0.21889	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
4.5" Bore	8	0.03934	0.06557	0.11803	0.17048	120.00	150.00	4.72	7.87	14.16	20.46	5.90	9.84	17.70	25.57
	9	0.04426	0.07377	0.13278	0.19180	106.67	133.33								
	10	0.04918	0.08196	0.14754	0.21311	96.00	120.00								
	11	0.05410	0.09016	0.16229	0.23442	87.27	109.09								
	12	0.05901	0.09836	0.17704	0.25573	80.00	100.00								
	13	0.06393	0.10655	0.19180	0.27704	73.85	92.31								

	Pump	Volume per rev, (BBL)				Crankshaft rpm		Discharge Rates, (BPM) at Critical Speed				Discharge Rates, (BPM) at Maximum Speed			
	Stroke (in.)	Triplex	Quint	9 Plunger	13 Plunger	Critical	Maximum	Triplex	Quint	9 Plunger	13 Plunger	Triplex	Quint	9 Plunger	13 Plunger
5.0" Bore	8	0.04857	0.08095	0.14571	0.21048	120.00	150.00	5.83	9.71	17.49	25.26	7.29	12.14	21.86	31.57
	9	0.05464	0.09107	0.16393	0.23678	106.67	133.33								
	10	0.06071	0.10119	0.18214	0.26309	96.00	120.00								
	11	0.06679	0.11131	0.20036	0.28940	87.27	109.09								
	12	0.07286	0.12143	0.21857	0.31571	80.00	100.00								
	13	0.07893	0.13155	0.23680	0.34202	73.85	92.31								

Table 1 – Plunger Critical Speed Calculations

[0033] For example, one of the most common transmissions utilized in hydraulic fracturing pump applications is the Caterpillar model TH55-E90, which is a 9-speed transmission. As shown in Table 2 below, when this transmission is in 5th gear and the engine is operating at 1700 rpm, the critical speed of 120 rpm on an 8-inch stroke pump is reached. Therefore, running the pump with the transmission in any of gears 6 through 9 could cause pump cavitation and damage accumulation to the fluid end.

Transmission	
CAT TH55-E90 Series	
1st Gear	4.67
2nd Gear	3.45
3rd Gear	2.63
4th Gear	2.01
5th Gear	1.55
6th Gear	1.54
7th Gear	1.20
8th Gear	1.00
9th Gear	0.86

Frac Pump	
Fluid End Bore	Quint Disp. BBL/rev
4.0"	0.053157
4.5"	0.066548
5.0"	0.080935

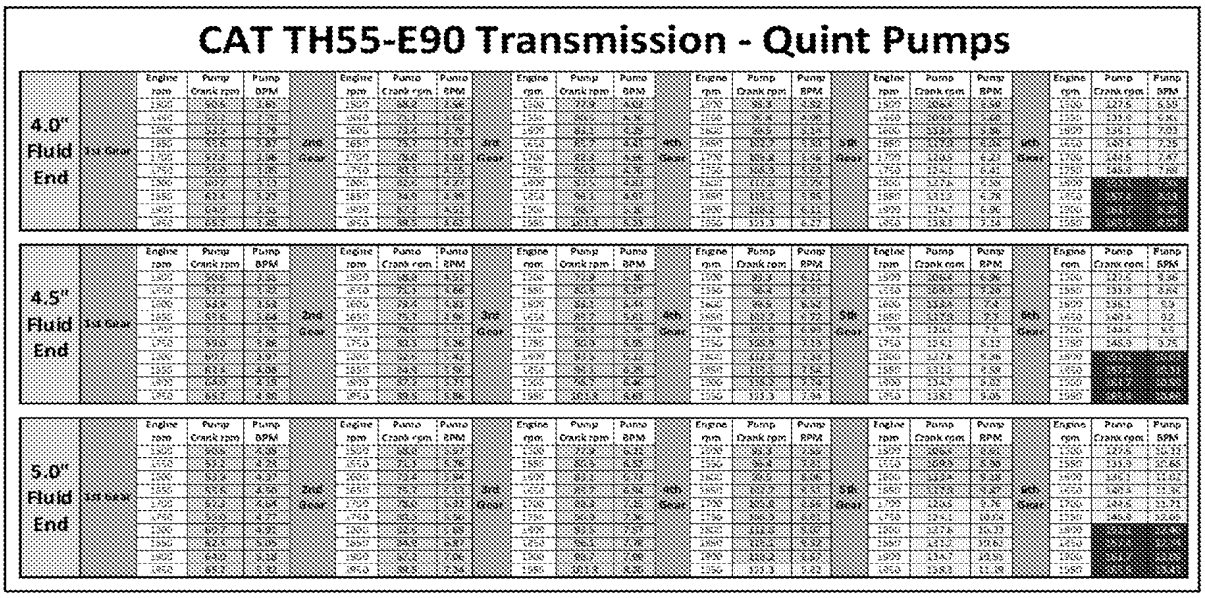


Table 2 – Critical Plunger Speed reached in 4th and 5th gears

[0034] Similarly, the common hydraulic fracturing application transmissions known in the art may exhibit the same issues in higher gears, as shown below in Tables 3-7. For example, as shown in Tables 3 and 4, the critical plunger speed is reached in the 3rd gear, such that use of gears 4-7 may cause cavitation and damage accumulation. Similarly, as shown in Tables 5 and 6, the critical plunger speed is reached in the 4th gear, such that use of gears 5-7 may cause cavitation and damage accumulation. In Table 7, the critical plunger speed is reached in the 4th gear, such that use of gears 5-9 may result in cavitation and damage accumulation.

Transmission	
Allison 9800 Ratios	
1st Gear	3.75
2nd Gear	2.69
3rd Gear	2.20
4th Gear	1.77
5th Gear	1.38
6th Gear	1.27
7th Gear	1.00

Frac Pump	
Fluid End Bore	Triplex BBL/rev
4.0"	0.051107
4.5"	0.039935
5.0"	0.031855

Allison 9800 Transmission, Triplex Pumps

	TRIPLEX 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 4.0"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	85.0	3.86	2nd Gear	1500	97.9	2.98	3rd Gear	1500	107.8	3.35	4th Gear	1500	133.4	4.14
		1550	88.2	4.00		1550	101.2	3.08		1550	111.4	3.46		1550	137.8	4.28
		1600	91.2	4.14		1600	104.6	3.18		1600	115.0	3.56		1600	142.3	4.42
		1650	94.1	4.27		1650	107.9	3.28		1650	118.7	3.67		1650	146.7	4.56
		1700	97.0	4.40		1700	111.2	3.38		1700	122.3	3.78		1700	[illegible]	[illegible]
		1750	99.8	4.53		1750	114.4	3.48		1750	125.9	3.89		1750	[illegible]	[illegible]
		1800	102.7	4.66		1800	117.7	3.58		1800	129.5	4.00		1800	[illegible]	[illegible]
		1850	105.5	4.79		1850	120.9	3.68		1850	133.1	4.11		1850	[illegible]	[illegible]
		1900	108.4	4.92		1900	124.2	3.78		1900	136.7	4.22		1900	[illegible]	[illegible]
		1950	111.3	5.05		1950	127.5	3.88		1950	140.3	4.33		1950	[illegible]	[illegible]

	TRIPLEX 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 4.5"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	85.0	3.08	2nd Gear	1500	97.9	2.38	3rd Gear	1500	107.8	2.67	4th Gear	1500	133.4	3.25
		1550	88.2	3.18		1550	101.2	2.46		1550	111.4	2.76		1550	137.8	3.42
		1600	91.2	3.29		1600	104.6	2.54		1600	115.0	2.84		1600	142.3	3.50
		1650	94.1	3.40		1650	107.9	2.62		1650	118.7	2.93		1650	146.7	3.62
		1700	97.0	3.51		1700	111.2	2.70		1700	122.3	3.02		1700	[illegible]	[illegible]
		1750	99.8	3.62		1750	114.4	2.78		1750	125.9	3.11		1750	[illegible]	[illegible]
		1800	102.7	3.72		1800	117.7	2.86		1800	129.5	3.20		1800	[illegible]	[illegible]
		1850	105.5	3.83		1850	120.9	2.94		1850	133.1	3.29		1850	[illegible]	[illegible]
		1900	108.4	3.93		1900	124.2	3.02		1900	136.7	3.38		1900	[illegible]	[illegible]
		1950	111.3	4.04		1950	127.5	3.10		1950	140.3	3.47		1950	[illegible]	[illegible]

	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	TRIPLEX 5.0"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	85.0	2.46	2nd Gear	1500	97.9	1.91	3rd Gear	1500	107.8	2.13	4th Gear	1500	133.4	2.59
		1550	88.2	2.55		1550	101.2	1.97		1550	111.4	2.21		1550	137.8	2.68
		1600	91.2	2.64		1600	104.6	2.03		1600	115.0	2.27		1600	142.3	2.76
		1650	94.1	2.73		1650	107.9	2.09		1650	118.7	2.34		1650	146.7	2.85
		1700	97.0	2.82		1700	111.2	2.16		1700	122.3	2.41		1700	[illegible]	[illegible]
		1750	99.8	2.90		1750	114.4	2.22		1750	125.9	2.48		1750	[illegible]	[illegible]
		1800	102.7	2.98		1800	117.7	2.29		1800	129.5	2.56		1800	[illegible]	[illegible]
		1850	105.5	3.06		1850	120.9	2.35		1850	133.1	2.63		1850	[illegible]	[illegible]
		1900	108.4	3.14		1900	124.2	2.41		1900	136.7	2.70		1900	[illegible]	[illegible]
		1950	111.3	3.23		1950	127.5	2.48		1950	140.3	2.77		1950	[illegible]	[illegible]

Table 3 - Critical Plunger Speed reached in 3rd gear

Transmission	
Allison 9800 Ratios	
1st Gear	3.75
2nd Gear	2.69
3rd Gear	2.20
4th Gear	1.77
5th Gear	1.38
6th Gear	1.27
7th Gear	1.00

Frac Pump	
Fluid End Bore	Quint BBL/rev
4.0"	0.050107
4.5"	0.039935
5.0"	0.031855

Allison 9800 Transmission, Quint Pumps

	QUINT 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.0"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	85.0	5.16	2nd Gear	1500	97.9	3.98	3rd Gear	1500	107.8	4.47	4th Gear	1500	133.4	5.52
		1550	88.2	5.36		1550	101.2	4.11		1550	111.4	4.62		1550	137.8	5.71
		1600	91.2	5.47		1600	104.6	4.24		1600	115.0	4.78		1600	142.3	5.89
		1650	94.1	5.68		1650	107.9	4.39		1650	118.7	4.93		1650	146.7	6.08
		1700	97.0	5.89		1700	111.2	4.51		1700	122.3	5.08		1700	[illegible]	[illegible]
		1750	99.8	6.05		1750	114.4	4.64		1750	125.9	5.22		1750	[illegible]	[illegible]
		1800	102.7	6.22		1800	117.7	4.77		1800	129.5	5.37		1800	[illegible]	[illegible]
		1850	105.5	6.39		1850	120.9	4.90		1850	133.1	5.51		1850	[illegible]	[illegible]
		1900	108.4	6.56		1900	124.2	5.03		1900	136.7	5.66		1900	[illegible]	[illegible]
		1950	111.3	6.73		1950	127.5	5.17		1950	140.3	5.81		1950	[illegible]	[illegible]

	QUINT 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.5"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 4.5"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	85.0	4.10	2nd Gear	1500	97.9	3.16	3rd Gear	1500	107.8	3.55	4th Gear	1500	133.4	4.39
		1550	88.2	4.26		1550	101.2	3.27		1550	111.4	3.67		1550	137.8	4.54
		1600	91.2	4.35		1600	104.6	3.37		1600	115.0	3.79		1600	142.3	4.68
		1650	94.1	4.51		1650	107.9	3.49		1650	118.7	3.92		1650	146.7	4.83
		1700	97.0	4.67		1700	111.2	3.58		1700	122.3	4.03		1700	[illegible]	[illegible]
		1750	99.8	4.80		1750	114.4	3.69		1750	125.9	4.14		1750	[illegible]	[illegible]
		1800	102.7	4.94		1800	117.7	3.79		1800	129.5	4.26		1800	[illegible]	[illegible]
		1850	105.5	5.07		1850	120.9	3.89		1850	133.1	4.37		1850	[illegible]	[illegible]
		1900	108.4	5.21		1900	124.2	4.00		1900	136.7	4.49		1900	[illegible]	[illegible]
		1950	111.3	5.34		1950	127.5	4.10		1950	140.3	4.61		1950	[illegible]	[illegible]

	QUINT 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 5.0"	Engine rpm	Pump Crank rpm	Pump BPM	QUINT 5.0"	Engine rpm	Pump Crank rpm	Pump BPM
Allison 9800 Transmission	1st Gear	1500	85.0	3.26	2nd Gear	1500	97.9	2.51	3rd Gear	1500	107.8	2.82	4th Gear	1500	133.4	3.49
		1550	88.2	3.37		1550	101.2	2.60		1550	111.4	2.92		1550	137.8	3.61
		1600	91.2	3.48		1600	104.6	2.68		1600	115.0	3.01		1600	142.3	3.73
		1650	94.1	3.61		1650	107.9	2.77		1650	118.7	3.11		1650	146.7	3.84
		1700	97.0	3.72		1700	111.2	2.86		1700	122.3	3.20		1700	[illegible]	[illegible]
		1750	99.8	3.84		1750	114.4	2.94		1750	125.9	3.30		1750	[illegible]	[illegible]
		1800	102.7	3.95		1800	117.7	3.03		1800	129.5	3.39		1800	[illegible]	[illegible]
		1850	105.5	4.06		1850	120.9	3.11		1850	133.1	3.49		1850	[illegible]	[illegible]
		1900	108.4	4.17		1900	124.2	3.20		1900	136.7	3.59		1900	[illegible]	[illegible]
		1950	111.3	4.28		1950	127.5	3.28		1950	140.3	3.68		1950	[illegible]	[illegible]

Table 4 – Critical Plunger Speed reached in 3rd gear

Transmission	
CAT TH55-E70 Ratios	
1st Gear	5.25
2nd Gear	4.56
3rd Gear	3.38
4th Gear	2.45
5th Gear	1.85
6th Gear	1.36
7th Gear	1.00

Fast Pump	
Fluid End Bore	Triplex SRL/rev
4.0"	0.0567
4.5"	0.07183
5.0"	0.08865

CAT TH55-E70 Transmission, Triplex Pumps

CAT TH55-E70 Transmission	1st Gear 5.25			2nd Gear 4.56			3rd Gear 3.38			4th Gear 2.45			5th Gear 1.85		
	Engine rpm	Pump Crank rpm	Pump SPM	Engine rpm	Pump Crank rpm	Pump SPM	Engine rpm	Pump Crank rpm	Pump SPM	Engine rpm	Pump Crank rpm	Pump SPM	Engine rpm	Pump Crank rpm	Pump SPM
	1400	266.7	533.3	1400	307.2	614.5	1400	414.2	828.4	1400	571.4	1142.9	1400	756.8	1513.5
	1450	276.2	552.4	1450	318.1	636.3	1450	428.9	857.8	1450	591.8	1183.7	1450	783.8	1567.6
	1500	285.7	571.4	1500	329.1	658.2	1500	443.7	887.3	1500	612.2	1224.5	1500	810.8	1621.6
	1550	295.2	590.5	1550	340.1	680.1	1550	458.5	916.8	1550	632.7	1265.3	1550	837.8	1675.7
	1600	304.8	609.5	1600	351.0	701.9	1600	473.2	946.4	1600	653.1	1306.1	1600	864.8	1729.7
	1650	314.3	628.6	1650	362.0	723.8	1650	488.0	975.9	1650	673.5	1347.0	1650	891.8	1783.8
	1700	323.8	647.6	1700	373.0	745.7	1700	502.8	1005.5	1700	693.9	1387.8	1700	918.9	1837.8
	1750	333.3	666.7	1750	383.9	767.6	1750	517.5	1035.0	1750	714.3	1428.6	1750	945.9	1891.9
	1800	342.9	685.7	1800	394.9	789.4	1800	532.3	1064.5	1800	734.7	1469.4	1800	972.9	1945.9
	1850	352.4	704.8	1850	405.9	811.3	1850	547.0	1094.1	1850	755.1	1510.2	1850	999.9	1999.9
	1900	361.9	723.8	1900	416.8	833.2	1900	561.8	1123.6	1900	775.5	1551.0	1900	1026.9	2054.0
	1950	371.4	742.9	1950	427.8	855.1	1950	576.6	1153.1	1950	795.9	1591.8	1950	1053.9	2108.0

Table 5 – Critical Plunger Speed reached in 4th gear

Transmission	
CAT TH55-E70 Ratios	
1st Gear	4.25
2nd Gear	3.69
3rd Gear	2.73
4th Gear	1.98
5th Gear	1.50
6th Gear	1.10
7th Gear	1.00

Fast Pump	
Fluid End Bore	Quint BBL/rev
4.0"	0.0521
4.5"	0.06594
5.0"	0.08141

CAT TH55-E70 Transmission, Quint Pumps

CAT TH55-E70 Transmission	1st Gear 4.25			2nd Gear 3.69			3rd Gear 2.73			4th Gear 1.98			5th Gear 1.50		
	Engine rpm	Pump Crank rpm	Pump SPM	Engine rpm	Pump Crank rpm	Pump SPM	Engine rpm	Pump Crank rpm	Pump SPM	Engine rpm	Pump Crank rpm	Pump SPM	Engine rpm	Pump Crank rpm	Pump SPM
	1400	329.4	658.8	1400	379.5	759.0	1400	512.1	1024.2	1400	706.1	1412.1	1400	935.2	1870.4
	1450	341.2	682.4	1450	392.9	785.9	1450	530.1	1060.2	1450	731.1	1462.2	1450	968.6	1937.2
	1500	352.9	705.9	1500	406.4	812.8	1500	548.2	1096.3	1500	756.1	1512.2	1500	1002.0	2004.0
	1550	364.7	729.4	1550	419.9	839.8	1550	566.3	1132.4	1550	781.1	1562.2	1550	1035.4	2070.8
	1600	376.5	752.9	1600	433.4	866.8	1600	584.4	1168.5	1600	806.1	1612.2	1600	1068.8	2137.6
	1650	388.2	776.5	1650	446.9	893.8	1650	602.5	1204.6	1650	831.1	1662.2	1650	1102.2	2204.4
	1700	400.0	800.0	1700	460.4	920.8	1700	620.6	1240.7	1700	856.1	1712.2	1700	1135.6	2271.2
	1750	411.8	823.5	1750	473.9	947.8	1750	638.7	1276.8	1750	881.1	1762.2	1750	1169.0	2338.0
	1800	423.5	847.1	1800	487.4	974.8	1800	656.8	1312.9	1800	906.1	1812.2	1800	1202.4	2404.8
	1850	435.3	870.6	1850	500.9	1001.8	1850	674.9	1349.0	1850	931.1	1862.2	1850	1235.8	2471.6
	1900	447.1	894.1	1900	514.4	1028.8	1900	693.0	1385.1	1900	956.1	1912.2	1900	1269.2	2538.4
	1950	458.8	917.6	1950	527.9	1055.8	1950	711.1	1421.2	1950	981.1	1962.2	1950	1302.6	2605.2

Table 6 – Critical Plunger Speed reached in 4th gear

Transmission	
TA90-8501 Ratios	
1st Gear	4.47
2nd Gear	3.57
3rd Gear	2.85
4th Gear	2.43
5th Gear	1.92
6th Gear	1.54
7th Gear	1.25
8th Gear	1.00
9th Gear	0.80

Frac Pump	
Fluid End Bore	Quint BBL/rev
4.0"	0.05167
4.5"	0.06538
5.0"	0.08795

Twin Disc TA90-8501 Transmission - Quint Pumps

4.0" Fluid End

1st Gear				2nd Gear				3rd Gear				4th Gear				5th Gear			
Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM	
1500	72.8	2.73		1500	85.1	3.42		1500	82.6	4.38		1500	98.0	5.85		1500	123.0	8.35	
1550	75.2	2.82		1550	88.1	3.55		1550	85.6	4.52		1550	101.2	6.05		1550	127.1	8.57	
1600	77.7	2.91		1600	90.9	3.65		1600	88.4	4.67		1600	104.5	6.24		1600	131.2	8.78	
1650	80.1	3.00		1650	93.8	3.76		1650	91.1	4.81		1650	107.8	6.43		1650	135.3	8.99	
1700	82.6	3.09		1700	96.8	3.87		1700	93.9	4.95		1700	111.0	6.62		1700	139.4	9.20	
1750	85.0	3.18		1750	99.5	3.98		1750	96.7	5.09		1750	114.3	6.81		1750	143.5	9.41	
1800	87.4	3.28		1800	102.4	4.09		1800	99.4	5.24		1800	117.6	7.00		1800	147.6	9.62	
1850	89.9	3.37		1850	105.3	4.21		1850	102.2	5.38		1850	120.8	7.20		1850	151.7	9.83	
1900	92.3	3.46		1900	108.1	4.33		1900	104.9	5.52		1900	124.1	7.39		1900	155.8	10.04	
1950	94.7	3.55		1950	111.0	4.44		1950	107.7	5.66		1950	127.4	7.58		1950	159.9	10.25	

4.5" Fluid End

1st Gear				2nd Gear				3rd Gear				4th Gear				5th Gear			
Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM	
1500	72.8	3.86		1500	85.1	4.52		1500	82.6	5.42		1500	98.0	6.42		1500	123.0	8.08	
1550	75.2	3.97		1550	88.1	4.68		1550	85.6	5.61		1550	101.2	6.63		1550	127.1	8.32	
1600	77.7	4.09		1600	90.9	4.82		1600	88.4	5.79		1600	104.5	6.86		1600	131.2	8.6	
1650	80.1	4.60		1650	93.8	4.76		1650	91.1	5.97		1650	107.8	7.06		1650	135.3	8.9	
1700	82.6	4.63		1700	96.8	4.91		1700	93.9	6.15		1700	111.0	7.27		1700	139.4	9.1	
1750	85.0	4.77		1750	99.5	5.05		1750	96.7	6.33		1750	114.3	7.48		1750	143.5	9.39	
1800	87.4	4.91		1800	102.4	5.20		1800	99.4	6.51		1800	117.6	7.70		1800	147.6	9.66	
1850	89.9	5.04		1850	105.3	5.34		1850	102.2	6.69		1850	120.8	7.91		1850	151.7	9.93	
1900	92.3	5.18		1900	108.1	5.49		1900	104.9	6.87		1900	124.1	8.13		1900	155.8	10.20	
1950	94.7	5.32		1950	111.0	5.64		1950	107.7	7.05		1950	127.4	8.34		1950	159.9	10.47	

5.0" Fluid End

1st Gear				2nd Gear				3rd Gear				4th Gear				5th Gear			
Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM		Engine rpm	Pump Crank rpm	Pump BPM	
1500	72.8	4.28		1500	85.1	5.03		1500	82.6	6.01		1500	98.0	7.15		1500	123.0	9.05	
1550	75.2	4.42		1550	88.1	5.19		1550	85.6	6.20		1550	101.2	8.30		1550	127.1	10.39	
1600	77.7	4.56		1600	90.9	5.33		1600	88.4	6.38		1600	104.5	8.46		1600	131.2	10.62	
1650	80.1	4.70		1650	93.8	5.86		1650	91.1	7.38		1650	107.8	8.73		1650	135.3	10.95	
1700	82.6	4.85		1700	96.8	6.07		1700	93.9	7.60		1700	111.0	8.99		1700	139.4	11.28	
1750	85.0	4.99		1750	99.5	6.25		1750	96.7	7.82		1750	114.3	9.26		1750	143.5	11.61	
1800	87.4	5.13		1800	102.4	6.42		1800	99.4	8.05		1800	117.6	9.52		1800	147.6	11.93	
1850	89.9	5.27		1850	105.3	6.60		1850	102.2	8.27		1850	120.8	9.78		1850	151.7	12.26	
1900	92.3	5.42		1900	108.1	6.78		1900	104.9	8.49		1900	124.1	10.05		1900	155.8	12.59	
1950	94.7	5.56		1950	111.0	6.96		1950	107.7	8.72		1950	127.4	10.31		1950	159.9	12.92	

Table 7 – Critical Plunger Speed reached in 4th gear

[0035] Use of the multi-plunger hydraulic fracturing pumps according to the present disclosure may eliminate the need for a diesel engine and transmission. As shown above, diesel engines and transmissions often include multiple gears that accelerate the plunger speed above critical operating speeds. This elimination of the typical engine and transmission from hydraulic fracturing pump units may enable the pumps to be driven by multiple electric motors, according to some embodiments, or multiple hydraulic motors according to other embodiments. These electric or hydraulic motors may have fewer gears such that operation in gears that increase the plunger speeds above their critical speeds can be avoided. By using multiple motors, whether

hydraulic or electric, to drive a single pump, pump rates can be increased without exceeding critical plunger speeds.

[0036] Use of electric or hydraulic motors, rather than diesel motors, may also make maintenance, repair, and replacement of the electric motors safer and faster than single or double electric motor-driven pumps. This configuration may prevent the fracturing pumps from being run at speeds higher than the critical plunger speed, which may help to minimize pump cavitation and damage accumulation, thus greatly extending the usable life of the pump fluid ends. For example, as discussed in more detail below, the system could be designed to allow only a slight overspeed of the pumps beyond the identified critical pump speed as a safety margin in the event that one of the fleet's pumps were taken offline for repairs or maintenance, and an additional rate of the remaining online pumps were required to complete the stage being pumped.

[0037] In the multiple electric motor-driven embodiment of the present disclosure, the electric motors may directly drive the pump, and the gear ratios of the planetary drive along with the electric motor-rated speeds may be chosen to limit the maximum pump speed, so as to not exceed the plunger critical speed. However, the gear ratios and electric motor-rated speeds may also be chosen to allow only a slight percentage of overspeed (higher than critical plunger speed) as a safe margin to enable a fleet of operating pumps to achieve a desired pump rate, for example when one pump is taken off line, as is often the case in hydraulic fracturing. For example, the gear ratios and electric motor-rated speeds may be chosen to operate 5% or less above the critical plunger speed according to some examples; 10% or less above the critical plunger speed according to some examples; or any other acceptable range as will be readily understood by one having ordinary skill in the art. Repairs or maintenance are generally performed as quickly as possible so that the offline pump is available by the next sequential fracturing stage. This same

logic could be applied to the hydraulic motor driven system or the system that utilizes speed reduction gearboxes driving a single ring gear.

[0038] By the present disclosure, multi-plunger hydraulic fracturing pumps utilizing higher multiples of plungers, such as 7, 9, 11, 13, etc. (septenplex, novenplex, undenplex, tredenplex, etc.), are described. In some embodiments, more than 13 plungers may be utilized, as will be readily understood by one having ordinary skill in the art. In some embodiments, odd numbers of plungers may be chosen so that the pump flow ripple magnitude is minimized. For example, in multi-plunger hydraulic fracturing pumps having higher numbers of plungers, the plunger ripple frequency may be increased, thereby reducing the amount of time between ripples, which may provide a smoother pressure performance for the pumps.

[0039] In some embodiments, longer stroke lengths of the plunger pumps may be utilized to reduce plunger speed. For example, a 10-inch stroke pump of a given plunger size may be run at a slower speed than an 8-inch stroke pump of the same plunger size, in order to accomplish the same flow rate. Slowing the plunger down may also decrease the possibility of pump cavitation. For example, when triplex and quintuplex pumps, as are known in the art, are operated at higher rates, conditions for cavitation to occur are measurably higher. According to an embodiment, a critical pump speed may be 120 rpm of the pump crankshaft. With this pump speed, on the currently used 8-inch stroke pumps, the rotational speed translates to an average linear speed of the plungers at a velocity of 32 inches per second. At higher speeds, with every stroke of the plungers, fluid is accelerated into and out of the pump fluid end, creating a likelihood of low pressure regions within the fluid end that approach or dip below vapor pressure values for the fluid, thereby causing cavitation, and ultimately damage accumulation, to occur. The use of longer stroke plungers accordingly contributes critically to longer fluid end life.

[0040] Various drive systems for powering multi-plunger hydraulic fracturing pumps are contemplated. According to an embodiment, multiple electric motors may be utilized to power the multi-plunger hydraulic fracturing pump. The number of motors utilized may be selected based on the output hydraulic horsepower for which the pump is designed, in some examples. In other examples, the number of motors could be determined on an "n plus 1" basis, in which "n" number of motors would be adequate to provide enough input power according to the output hydraulic horsepower for which the pump is designed, and one ("1") additional motor would be included to allow for a single motor failure or maintenance situation. In such a situation, the failed motor (or motor purposefully removed for maintenance) could be disconnected from the electrical circuit and allowed to freewheel, while the remaining operational motors would still provide adequate power for the pump, according to an embodiment.

[0041] In the example illustrated in FIG. 1, an exploded schematic view shows an embodiment of a planetary gear train 100 in which the multiple input pinion gears 135 are directly connected to the electric motors 130. According to the illustrated embodiment, both ends of the pump crankshaft 105 may be powered with an identical planetary gear train 120 and electric motors 130 to enable the motors 130 to be sized small enough to simplify motor removal and installation as compared to a larger single electric motor, or a double electric motor drive system.

[0042] In the illustrated embodiment of FIG. 1, eight electric motors 130 may correspond to and drive eight input pinion gears 135 associated with a single main planetary gear 125. The main planetary gear 125 may in turn drive the sun gear 115 positioned central to three planetary gears 120. The final drive gear 110 may have internal gear teeth positioned to catch the external gear teeth of the three planetary gears 120, which may cause rotation of the pump crankshaft 105. In this way, a plurality of electric motors 130 may provide power to a pump crankshaft 105, which

may in turn drive a multi-plunger pump, for example as illustrated in FIG. 3 and discussed in greater detail below.

[0043] In another embodiment, multiple hydraulic motors may be utilized to power a multi-plunger hydraulic fracturing pump, in which a planetary gear train system 100 similar to that illustrated in FIG. 1 could also be utilized. In an example, a planetary gear train system may be utilized on one or both ends of the pump crankshaft to allow for smaller hydraulic motors to be utilized.

[0044] According to an alternate embodiment, for example as illustrated in FIG. 2, a plurality of electric motors or hydraulic motors 230 each may be mounted to a plurality of speed reduction gearboxes 245. FIG. 2 illustrates an exploded schematic example of a planetary gear train 200 having a plurality of speed reduction gearbox 245 mountings for connection to a plurality of electric motors 230, according to an embodiment. The speed reduction gearboxes 245 may, in turn, power a single ring gear 240 to turn the pump crankshaft 205 at the proper rpm needed to drive the multi-plunger pumps at the desired pump rate. In some examples, this configuration may not require use of a multi-planetary gear train system as described above and illustrated in FIG. 1, for example. For example, as illustrated in the embodiment of FIG. 2, the plurality of electric motors 230 may drive the main planetary gear in the form of a ring gear 240 through speed reduction gearboxes 245, and the ring gear 240 may directly turn the pump crankshaft 205. In such an example additional planetary gears 120, as illustrated in the embodiment of FIG. 1, for example, may not be included.

[0045] In an embodiment utilizing multiple electric motors, the fleet of fracturing pumps may be powered by multiple electric motors, and overall electric power may be generated by one or

more diesel or gas turbines. When the pumps are being brought online to pump fluids into the well, the power may be switched via appropriate switchgear to the electric motors.

[0046] In some embodiments, the speed of the motors may be controlled by one or more variable frequency drives (VFD), which may accelerate or decelerate the pump rotational speeds using an S curve. The pump operator may select the various pump speeds via a human-machine interface (HMI) according to some embodiments, for example from inside a data van, or from a "suitcase," which is a portable, standalone HMI. The HMI or suitcase may allow on/off control of the pumps as well as speed control of the pumps, to allow the pumps to run at speeds from zero crankshaft rpm up to the maximum speed, which would correlate with the plunger critical speed.

[0047] According to an embodiment, one of the VFDs may be designated as the master VFD, and the remaining VFDs may be designed to share the load required to power the pump under all load conditions. In the case of an overpressure event, the hydraulic fracturing controls may automatically turn the VFD off using the on/off signal for rapid shutdown, instead of using the rpm command, which uses an S curve to control the acceleration and/or deceleration. A manual emergency shutdown may also be included, which uses an HMI (such as a push button or other HMI, which may be electronic and/or manual) to shut off the VFD using the on/off function. This manual emergency shutdown feature may be configured to shut down all VFDs simultaneously, thereby shutting down the entire site. The emergency shutdown may also be configured to stop the VFD on the blender discharge pumps, and may or may not be tied into the electrical microgrid to open breakers, thereby stopping the flow and/or generation of electricity and/or gas compression.

[0048] The HMI may be designed to allow only a slight percentage of overspeed (higher than critical plunger speed) as a safe margin to enable a fleet of operating pumps to achieve a desired pump rate when one pump is taken offline, for example, as is often the case in hydraulic fracturing. Repairs or maintenance are generally performed as quickly as possible so that the offline pump is available by the next sequential fracturing stage. This same logic could be applied to the hydraulic motor driven system or the system that utilizes speed reduction gearboxes driving a single ring gear.

[0049] FIG. 3 illustrates a schematic example of a multi-plunger pump 300 with four electric motors mounted to the pump for driving the multi-plunger pump, according to an embodiment. In the illustrated embodiment, the multi-plunger pump 300 may include nine plungers positioned at the multi-plunger fluid end 350 of the multi-plunger pump 300. In other embodiments, various other numbers of plungers may be included, as will be readily understood by one having ordinary skill in the art.

[0050] A crankshaft centerline 360 may bisect the multi-plunger pump 300 between the multi-plunger fluid end 350 and the pump power end 355. Two electric motors 330 may be positioned on opposing sides of the multi-plunger pump 300, across the crankshaft centerline 360. The four total electric motors 330 may drive the crankshaft associated with the nine plungers, as described above with respect to FIGS. 1 and 2. For example, in some embodiments the four electric motors 330 may drive the crankshaft via one or more planetary gear trains. In some embodiments, a plurality of speed reduction gearboxes may be positioned between the electric motors 330 and the one or more planetary gear trains so as to control the rotational speed of the one or more planetary gear trains and, ultimately, the pump rate of the plungers.

[0051] The present invention described herein, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned, as well as others inherent therein. While a presently preferred embodiment of the invention has been given for purposes of disclosure, numerous changes exist in the details of procedures for accomplishing the desired results. These and other similar modifications will readily suggest themselves to those skilled in the art, and are intended to be encompassed within the spirit of the present invention disclosed herein and the scope of the appended claims.

CLAIMS

What is claimed is:

1. A hydraulic fracturing system for fracturing a subterranean formation comprising:

a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, the multi-plunger pump configured to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation;

a plurality of motors positioned to power the multi-plunger pump; and

a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors,

wherein a gear ratio of the planetary gear train and a speed at which the plurality of motors operates are selected so as to limit a maximum pump speed associated with the multi-plunger pump.

2. The system of claim 1, the system further comprising a plurality of speed reduction gearboxes positioned between the plurality of input pinion gears and the plurality of motors so as to achieve a desired pump rate.

3. The system of claim 1, wherein the plurality of motors comprises one of a plurality of electric motors or a plurality of hydraulic motors.

4. The system of claim 1, wherein the maximum pump speed correlates to a critical plunger speed associated with each of the plurality of hydraulic pumps.

5. The system of claim 1, wherein the maximum pump speed is 5% or less over a critical plunger speed associated with each of the plurality of hydraulic pumps.

6. The system of claim 1, wherein the plurality of hydraulic pumps comprises an odd number of plungers greater than or equal to five plungers.

7. The system of claim 6, wherein a stroke length of each of the plungers associated with the plurality of hydraulic pumps is selected to inversely relate to a pump speed associated with the plurality of hydraulic pumps so as to achieve a predetermined flow rate.

8. The system of claim 1, further comprising:

a variable frequency drive (VFD) connected to the plurality of motors to control the speed of the plurality of motors, wherein the VFD is positioned to accelerate or decelerate pump rotational speeds associated with each of the plurality of hydraulic pumps.

9. The system of claim 8, wherein the VFD comprises a plurality of VFDs and wherein the plurality of VFDs are configured to share a load required to power the plurality of hydraulic pumps.

10. The system of claim 9, wherein the plurality of VFDs are configured to automatically shut off in the event of an overpressure event with respect to the plurality of hydraulic pumps.

11. A hydraulic fracturing system for fracturing a subterranean formation comprising:

a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, the multi-plunger pump configured to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation;

a plurality of motors positioned to power the multi-plunger pump;

a variable frequency drive connected to the plurality of motors to control the speeds of the plurality of electric motors; and

a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors,

wherein a gear ratio of the planetary gear train and a speed at which the plurality of motors operates are selected so as to limit a maximum pump speed associated with the multi-plunger pump.

12. The system of claim 11, the system further comprising a plurality of speed reduction gearboxes positioned between the plurality of input pinion gears and the plurality of motors so as to achieve a desired pump rate.

13. The system of claim 11, wherein the plurality of motors comprises one of a plurality of electric motors or a plurality of hydraulic motors.

14. The system of claim 11, wherein the maximum pump speed correlates to a critical plunger speed associated with each of the plurality of hydraulic pumps.

15. A method for pumping fluid into a wellbore associated with a subterranean formation, the method comprising:

fluidly connecting a multi-plunger hydraulic fracturing pump to a well associated with the subterranean formation such that the multi-plunger pump pumps fluid into the wellbore at a high pressure so that fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation;

powering the multi-plunger pump with a plurality of motors;

providing a planetary gear train having a plurality of input pinion gears in rotational contact with each of the plurality of motors so as to translate power from the plurality of motors into a desired pump rate of the multi-plunger pump.

16. The method of claim 15, further comprising:

positioning a plurality of speed reduction gearboxes between the plurality of input pinion gears and the plurality of motors so as to achieve the desired pump rate.

17. The method of claim 15, wherein the plurality of motors comprises one of a plurality of electric motors or a plurality of hydraulic motors.

18. The method of claim 15, wherein the maximum pump speed correlates to a critical plunger speed associated with each of the plurality of hydraulic pumps.

19. The method of claim 15, further comprising:

connecting a variable frequency drive (VFD) to the plurality of motors so as to control the speed of the plurality of motors, wherein the VFD is positioned to accelerate or decelerate pump rotational speeds associated with each of the plurality of hydraulic pumps.

20. The method of claim 19, the method further comprising:

detecting an overpressure event with respect to the plurality of hydraulic pumps; and

automatically shutting off the plurality of VFDs.

ABSTRACT

A hydraulic fracturing system for fracturing a subterranean formation is described according to various embodiments. In an embodiment, the system can include a multi-plunger hydraulic fracturing pump fluidly connected to a well associated with the subterranean formation, the multi-plunger pump configured to pump fluid into a wellbore associated with the well at a high pressure so that the fluid passes from the wellbore into the subterranean formation and fractures the subterranean formation. In an embodiment, a plurality of motors can be positioned to power the multi-plunger pump, and a planetary gear train can have a plurality of pinion gears in rotational contact with each of the plurality of motors. In an embodiment, a gear ratio of the planetary gear train and a speed at which the plurality of motors operates can be selected so as to limit a maximum pump speed associated with the multi-plunger pump.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Filer:	Kristin L. Lamb/Stephanie McDonough
Attorney Docket Number:	047158.100035

Filed as Large Entity

Filing Fees for Track I Prioritized Examination - Nonprovisional Application under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	300	300
UTILITY SEARCH FEE	1111	1	660	660
UTILITY EXAMINATION FEE	1311	1	760	760
REQUEST FOR PRIORITIZED EXAMINATION	1817	1	4000	4000
Pages:				
Claims:				
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140

Petition:	
Patent-Appeals-and-Interference:	
Post-Allowance-and-Post-Issuance:	
Extension-of-Time:	
Miscellaneous:	
Total in USD ($)	**5860**

Electronic Acknowledgement Receipt

EFS ID:	34496277
Application Number:	16210807
International Application Number:	
Confirmation Number:	2654
Title of Invention:	MULTI-PLUNGER PUMPS AND ASSOCIATED DRIVE SYSTEMS
First Named Inventor/Applicant Name:	Jared Oehring
Customer Number:	132858
Filer:	Kristin L. Lamb/Stephanie McDonough
Filer Authorized By:	Kristin L. Lamb
Attorney Docket Number:	047158.100035
Receipt Date:	05-DEC-2018
Filing Date:	
Time Stamp:	16:59:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$5860
RAM confirmation Number	120618INTEFSW00015810501349
Deposit Account	501349
Authorized User	Stephanie McDonough

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal of New Application	047158-100035_Utility.pdf	287727 9153cd62e835bf666d33a138949e858618849a93	no	2
Warnings:					
Information:					
2	TrackOne Request	047158-100035_Track-One-Request.pdf	124683 3aefdf89229c111495e4f02084637925999a9212	no	2
Warnings:					
Information:					
3	Application Data Sheet	047158-100035_ADS.pdf	1272965 f70d7ffa66853a329d3ebeae81f918dc421ae5fa	no	9
Warnings:					
Information:					
4	Drawings-only black and white line drawings	047158-100035_Figures.pdf	87904 6dd7bc6772206f8cded5204d4ed5648a683e2251	no	3
Warnings:					
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5		047158-100035_Specification.pdf	2706017 55f50ce8559e0d6cbaec14bd1c7cb6e36cf727de	yes	27

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	21
Claims	22	26
Abstract	27	27

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6	Fee Worksheet (SB06)	fee-info.pdf	40385 18e4f018b4ea6821be46e456d81770bd813768a8	no	2
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			Total Files Size (in bytes):	4519681	

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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.

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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.

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PTO/AIA/15 (10-17)
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	047158.100035
First Named Inventor	Jared Oehring
Title	MULTI-PLUNGER PUMPS..
Priority Mail Express® Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. [✓] **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. [ ] **Applicant asserts small entity status.** See 37 CFR 1.27
3. [ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. [✓] **Specification** [*Total Pages* 27] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. [✓] **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 3]
6. **Inventor's Oath or Declaration** [*Total Pages*] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. [ ] Newly executed (original or copy)
   b. [ ] A copy from a prior application (37 CFR 1.63(d))
7. [✓] **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   [ ] Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   a. [ ] Computer Readable Form (CRF)
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      i. [ ] CD-ROM or CD-R (2 copies); or
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10. [ ] **Assignment Papers** (cover sheet & document(s))
    Name of Assignee
11. [ ] **37 CFR 3.73(c) Statement** (*when there is an assignee*) [ ] **Power of Attorney**
12. [ ] **English Translation Document** (*if applicable*)
13. [ ] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    [ ] Copies of citations attached
14. [ ] **Preliminary Amendment**
15. [ ] **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. [ ] **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. [ ] **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. [✓] **Other:** Track One Request

*Note: (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

[✓] The address associated with Customer Number: 132858 **OR** [ ] Correspondence address below

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City		State		Zip Code	
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Signature	/Kristin L. Lamb/	Date	2018-12-05
Name (Print/Type)	Kristin L. Lamb	Registration No. (Attorney/Agent)	71571

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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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.
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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.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.