

(12) **United States Patent**
Oehring et al.

(10) **Patent No.:** **US 11,009,162 B1**
(45) **Date of Patent:** **May 18, 2021**

(54) **SYSTEM AND METHOD FOR INTEGRATED FLOW SUPPLY LINE**

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,656,861 A	1/1928	Leonard
1,671,436 A	5/1928	Melott
2,004,077 A	6/1935	McCartney
2,183,364 A	12/1939	Bailey
2,220,622 A	11/1940	Aitken
		(Continued)

FOREIGN PATENT DOCUMENTS

AU	734988	9/1997
CA	2406801	11/2001
		(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion dated Jan. 2, 2020 in related PCT Application No. PCT/US19/55325.

(Continued)

Primary Examiner — Aaron L Lembo

(74) *Attorney, Agent, or Firm* — Hogan Lovells US LLP

(57) **ABSTRACT**

A hydraulic fracturing system for fracturing a subterranean formation includes an electric powered pump having an inlet and an outlet, the outlet coupled to a well associated with the subterranean formation and powered by at least one electric motor. The system also includes a fluid source, coupled to the inlet of the electric powered pump, the fluid source providing a slurry for injection into the subterranean formation. The system further includes a hose extending between the fluid source and the electric powered pump, the hose being flexible and having a first diameter. The system includes a fitting between the hose and the electric powered pump, the fitting having a first end for receiving the hose at the first diameter and a second end for coupling to the electric powered pump at a second diameter, the second diameter being larger than the first diameter.

14 Claims, 3 Drawing Sheets

(71) Applicant: **U.S. Well Services, LLC**, Houston, TX (US)

(72) Inventors: **Jared Oehring**, Houston, TX (US); **Brandon Hinderliter**, Houston, TX (US); **Lon Robinson**, Houston, TX (US); **Alexander James Christinzio**, Houston, TX (US)

(73) Assignee: **U.S. WELL SERVICES, LLC**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

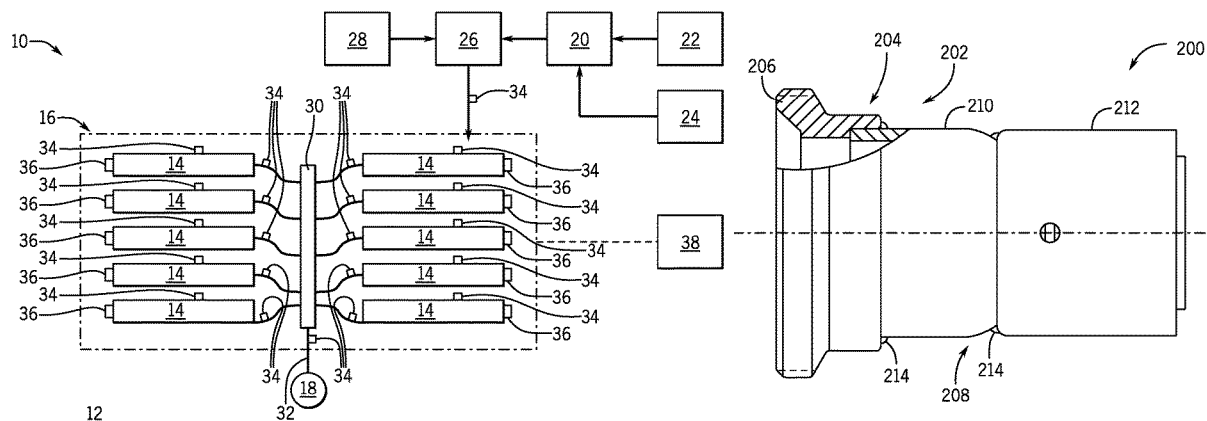
(21) Appl. No.: **16/728,359**

(22) Filed: **Dec. 27, 2019**

(51) **Int. Cl.**
F16L 33/02 (2006.01)
E21B 43/26 (2006.01)
F04B 17/03 (2006.01)
F04B 15/02 (2006.01)
F04B 1/00 (2020.01)

(52) **U.S. Cl.**
CPC **F16L 33/02** (2013.01); **E21B 43/26** (2013.01); **F04B 1/00** (2013.01); **F04B 15/02** (2013.01); **F04B 17/03** (2013.01)

(58) **Field of Classification Search**
CPC .. F16L 33/02; E21B 43/26; F04B 1/00; F04B 15/02; F04B 17/03
See application file for complete search history.



US 11,009,162 B1

Page 2

(56)	References Cited			6,529,135 B1	3/2003	Bowers et al.	
	U.S. PATENT DOCUMENTS			6,560,131 B1	5/2003	VonBrethorst	
				6,626,646 B2	9/2003	Rajewski	
				6,719,900 B2 *	4/2004	Hawkins	B01D 29/118
							210/248
2,248,051 A	7/1941	Armstrong		6,765,304 B2	7/2004	Baten et al.	
2,407,796 A	9/1946	Page		6,776,227 B2	8/2004	Beida	
2,416,848 A	3/1947	Rothery		6,802,690 B2	10/2004	Han	
2,610,741 A *	9/1952	Schmid	B01D 35/02	6,808,303 B2	10/2004	Fisher	
			210/309	6,931,310 B2	8/2005	Shimizu et al.	
2,753,940 A	7/1956	Bonner		6,936,947 B1	8/2005	Leijon	
3,055,682 A *	9/1962	Bacher	F16L 33/18	7,082,993 B2	8/2006	Ayoub	
			285/222.1	7,104,233 B2	9/2006	Ryzcek et al.	
3,061,039 A	10/1962	Peters		7,170,262 B2	1/2007	Pettigrew	
3,066,503 A	12/1962	Fleming		7,173,399 B2	2/2007	Sihler	
3,302,069 A	1/1967	Webster		7,308,933 B1	12/2007	Mayfield	
3,334,495 A	8/1967	Jensen		7,312,593 B1	12/2007	Streicher et al.	
3,722,595 A	3/1973	Kiel		7,336,514 B2	2/2008	Amarillas	
3,764,233 A	10/1973	Strickland		7,445,041 B2	11/2008	O'Brien	
3,773,140 A	11/1973	Mahajan		7,494,263 B2	2/2009	Dykstra et al.	
3,837,179 A	9/1974	Barth		7,500,642 B2	3/2009	Cunningham	
3,849,662 A	11/1974	Blaskowski		7,525,264 B2	4/2009	Dodge	
3,878,884 A	4/1975	Raleigh		7,563,076 B2	7/2009	Brunet	
3,881,551 A	5/1975	Terry		7,581,379 B2	9/2009	Yoshida	
4,037,431 A	7/1977	Sugimoto		7,675,189 B2	3/2010	Grenier	
4,100,822 A	7/1978	Rosman		7,683,499 B2	3/2010	Saucier	
4,151,575 A	4/1979	Hogue		7,717,193 B2	5/2010	Egilsson et al.	
4,226,299 A	10/1980	Hansen		7,755,310 B2	7/2010	West et al.	
4,265,266 A	5/1981	Kierbow et al.		7,807,048 B2	10/2010	Collette	
4,432,064 A	2/1984	Barker		7,835,140 B2	11/2010	Mori	
4,442,665 A	4/1984	Fick et al.		7,845,413 B2	12/2010	Shampine et al.	
4,456,092 A	6/1984	Kubozuka		7,926,562 B2	4/2011	Poitzsch	
4,506,982 A	3/1985	Smithers et al.		7,894,757 B2	7/2011	Keast	
4,512,387 A	4/1985	Rodriguez		7,977,824 B2	7/2011	Halen et al.	
4,529,887 A	7/1985	Johnson		7,984,757 B1	7/2011	Keast	
4,538,916 A	9/1985	Zimmerman		8,037,936 B2	10/2011	Neuroth	
4,676,063 A	6/1987	Goebel et al.		8,054,084 B2	11/2011	Schulz et al.	
4,759,674 A	7/1988	Schroder		8,083,504 B2	12/2011	Williams	
4,793,386 A	12/1988	Sloan		8,091,928 B2 *	1/2012	Carrier	F16L 33/02
4,845,981 A	7/1989	Pearson					285/242
4,922,463 A	5/1990	Del Zotto et al.		8,096,354 B2	1/2012	Poitzsch	
5,004,400 A	4/1991	Handke		8,096,891 B2	1/2012	Lochtefeld	
5,006,044 A	4/1991	Walker, Sr.		8,139,383 B2	3/2012	Efraimsson	
5,025,861 A	6/1991	Huber		8,146,665 B2	4/2012	Neal	
5,050,673 A	9/1991	Baldrige		8,154,419 B2	4/2012	Daussin et al.	
5,130,628 A	7/1992	Owen		8,232,892 B2	7/2012	Overholt et al.	
5,131,472 A	7/1992	Dees et al.		8,261,528 B2	9/2012	Chillar	
5,172,009 A	12/1992	Mohan		8,272,439 B2	9/2012	Strickland	
5,189,388 A	2/1993	Mosley		8,310,272 B2	11/2012	Quarto	
5,230,366 A *	7/1993	Marandi	G05D 7/01	8,354,817 B2	1/2013	Yeh et al.	
			137/613	8,474,521 B2	7/2013	Kajaria	
5,366,324 A	11/1994	Arlt		8,506,267 B2	8/2013	Gambier et al.	
5,422,550 A	6/1995	McClanahan		8,534,235 B2	9/2013	Chandler	
5,433,243 A *	7/1995	Griswold	B01D 35/157	8,573,303 B2	11/2013	Kerfoot	
			137/498	8,596,056 B2	12/2013	Woodmansee	
5,439,066 A	8/1995	Gipson		8,616,005 B1	12/2013	Cousino	
5,517,822 A	5/1996	Haws et al.		8,616,274 B2	12/2013	Belcher et al.	
5,548,093 A	8/1996	Sato		8,646,521 B2	2/2014	Bowen	
5,590,976 A	1/1997	Kilheffer et al.		8,692,408 B2	4/2014	Zhang et al.	
5,655,361 A	8/1997	Kishi		8,727,068 B2	5/2014	Bruin	
5,736,838 A	4/1998	Dove et al.		8,760,657 B2	6/2014	Pope	
5,755,096 A	5/1998	Holleyman		8,763,387 B2	7/2014	Schmidt	
5,790,972 A	8/1998	Kohlenberger		8,774,972 B2	7/2014	Rusnak	
5,865,247 A	2/1999	Paterson		8,789,601 B2	7/2014	Broussard	
5,879,137 A	3/1999	Yie		8,795,525 B2	8/2014	McGinnis et al.	
5,894,888 A	4/1999	Wiemers		8,800,652 B2	8/2014	Bartko	
5,907,970 A	6/1999	Havlovick et al.		8,807,960 B2	8/2014	Stephenson	
5,985,750 A	11/1999	Oda		8,838,341 B2	9/2014	Kumano	
6,138,764 A	10/2000	Scarsdale et al.		8,851,860 B1	10/2014	Mail	
6,142,878 A	11/2000	Barin		8,857,506 B2	10/2014	Stone, Jr.	
6,164,910 A	12/2000	Mayleben		8,899,940 B2	12/2014	Laugemors	
6,202,702 B1	3/2001	Ohira		8,905,056 B2	12/2014	Kendrick	
6,208,098 B1	3/2001	Kume		8,905,138 B2	12/2014	Lundstedt et al.	
6,254,462 B1	7/2001	Kelton		8,997,904 B2	4/2015	Cryer	
6,271,637 B1	8/2001	Kushion		9,018,881 B2	4/2015	Mao et al.	
6,273,193 B1	8/2001	Hermann		9,051,822 B2	6/2015	Ayan	
6,315,523 B1	11/2001	Mills		9,051,923 B2	6/2015	Kuo	
6,477,852 B2	11/2002	Dodo		9,061,223 B2 *	6/2015	Winborn	B01D 35/02
6,484,490 B1	11/2002	Olsen		9,062,545 B2	6/2015	Roberts et al.	
6,491,098 B1	12/2002	Dallas					

US 11,009,162 B1

Page 3

(56)

References Cited

U.S. PATENT DOCUMENTS

9,067,182	B2	6/2015	Nichols	2003/0079875	A1	5/2003	Weng	
9,103,193	B2	8/2015	Coli	2003/0138327	A1	7/2003	Jones et al.	
9,119,326	B2	8/2015	McDonnell	2004/0040746	A1	3/2004	Niedermayr et al.	
9,121,257	B2	9/2015	Coli et al.	2004/0102109	A1	5/2004	Crafty et al.	
9,140,110	B2	9/2015	Coli et al.	2004/0167738	A1	8/2004	Miller	
9,160,168	B2	10/2015	Chapel	2005/0061548	A1	3/2005	Hooper	
9,260,253	B2	2/2016	Naizer	2005/0116541	A1	6/2005	Seiver	
9,322,239	B2	4/2016	Angeles Boza et al.	2005/0274508	A1	12/2005	Folk	
9,324,049	B2	4/2016	Thomeer	2006/0052903	A1	3/2006	Bassett	
9,340,353	B2	5/2016	Oren	2006/0065319	A1*	3/2006	Csitari	F01P 3/205 137/887
9,366,114	B2	6/2016	Coli et al.	2007/0131410	A1	6/2007	Hill	
9,410,410	B2	8/2016	Broussard et al.	2007/0187163	A1	8/2007	Cone	
9,450,385	B2	9/2016	Kristensen	2007/0201305	A1	8/2007	Heilman et al.	
9,475,020	B2	10/2016	Coli et al.	2007/0226089	A1	9/2007	DeGaray et al.	
9,475,021	B2	10/2016	Coli et al.	2007/0277982	A1	12/2007	Shampine	
9,482,086	B2	11/2016	Richardson et al.	2007/0278140	A1	12/2007	Mallet et al.	
9,499,335	B2	11/2016	McIver	2008/0017369	A1	1/2008	Sarada	
9,506,333	B2	11/2016	Castillo et al.	2008/0041596	A1	2/2008	Blount	
9,513,055	B1*	12/2016	Seal	2008/0095644	A1	4/2008	Mantei et al.	
9,534,473	B2	1/2017	Morris et al.	2008/0112802	A1	5/2008	Orlando	
9,562,420	B2	2/2017	Morris et al.	2008/0137266	A1	6/2008	Jensen	
9,587,649	B2	3/2017	Oehring	2008/0208478	A1	8/2008	Ella et al.	
9,611,728	B2	4/2017	Oehring	2008/0217024	A1	9/2008	Moore	
9,650,871	B2	5/2017	Oehring et al.	2008/0264625	A1	10/2008	Ochoa	
9,650,879	B2	5/2017	Broussard et al.	2008/0264649	A1	10/2008	Crawford	
9,706,185	B2	7/2017	Ellis	2008/0277120	A1	11/2008	Hickie	
9,728,354	B2	8/2017	Skolozdra	2009/0045782	A1	2/2009	Datta	
9,738,461	B2	8/2017	DeGaray	2009/0065299	A1	3/2009	Vito	
9,739,546	B2	8/2017	Bertilsson et al.	2009/0078410	A1	3/2009	Krenek et al.	
9,745,840	B2	8/2017	Oehring et al.	2009/0093317	A1	4/2009	Kajiwarra et al.	
9,840,901	B2	12/2017	Oehring et al.	2009/0095482	A1	4/2009	Surjaatmadja	
9,863,228	B2	1/2018	Shampine et al.	2009/0145611	A1	6/2009	Pallini, Jr.	
9,893,500	B2	2/2018	Oehring	2009/0153354	A1	6/2009	Daussin et al.	
9,909,398	B2	3/2018	Pham	2009/0188181	A1	7/2009	Forbis	
9,915,128	B2	3/2018	Hunter	2009/0200035	A1	8/2009	Bjerkreim et al.	
9,932,799	B2	4/2018	Symchuk	2009/0260826	A1	10/2009	Sherwood	
9,963,961	B2	5/2018	Hardin	2009/0308602	A1	12/2009	Bruins et al.	
9,970,278	B2	5/2018	Broussard	2010/0000508	A1	1/2010	Chandler	
9,976,351	B2	5/2018	Randall	2010/0019574	A1	1/2010	Baldassarre et al.	
9,995,218	B2	6/2018	Oehring	2010/0038907	A1	2/2010	Hunt	
10,008,880	B2	6/2018	Vicknair	2010/0045109	A1	2/2010	Arnold	
10,020,711	B2	7/2018	Oehring	2010/0051272	A1	3/2010	Loree et al.	
10,036,238	B2	7/2018	Oehring	2010/0132949	A1	6/2010	DeFosse et al.	
10,107,086	B2	10/2018	Oehring	2010/0146981	A1	6/2010	Motakef	
10,119,381	B2	11/2018	Oehring	2010/0172202	A1	7/2010	Borgstadt	
10,184,465	B2	1/2019	Enis et al.	2010/0250139	A1	9/2010	Hobbs et al.	
10,196,878	B2	2/2019	Hunter	2010/0293973	A1	11/2010	Erickson	
10,221,639	B2	3/2019	Romer et al.	2010/0303655	A1	12/2010	Scekic	
10,227,854	B2	3/2019	Glass	2010/0322802	A1	12/2010	Kugelev	
10,232,332	B2	3/2019	Oehring	2011/0005757	A1	1/2011	Hebert	
10,246,984	B2	4/2019	Payne	2011/0017468	A1	1/2011	Birch et al.	
10,254,732	B2	4/2019	Oehring	2011/0052423	A1	3/2011	Gambier et al.	
10,260,327	B2	4/2019	Kajaria	2011/0061855	A1	3/2011	Case et al.	
10,280,724	B2	5/2019	Hinderliter	2011/0085924	A1	4/2011	Shampine	
10,287,873	B2	5/2019	Filas	2011/0110793	A1	5/2011	Leugemors et al.	
10,302,079	B2	5/2019	Kendrick	2011/0166046	A1	7/2011	Weaver	
10,309,205	B2	6/2019	Randall	2011/0247878	A1	10/2011	Rasheed	
10,337,308	B2	7/2019	Broussard	2011/0272158	A1	11/2011	Neal	
10,371,012	B2	8/2019	Davis	2012/0018016	A1	1/2012	Gibson	
10,378,326	B2	8/2019	Morris	2012/0049625	A1	3/2012	Hopwood	
10,393,108	B2	8/2019	Chong	2012/0085541	A1	4/2012	Love et al.	
10,407,990	B2	9/2019	Oehring	2012/0127635	A1	5/2012	Grindeland	
10,408,030	B2	9/2019	Dehring et al.	2012/0152716	A1	6/2012	Kikukawa et al.	
10,408,031	B2	9/2019	Dehring et al.	2012/0205301	A1	8/2012	McGuire et al.	
10,415,332	B2	9/2019	Morris	2012/0205400	A1	8/2012	DeGaray et al.	
10,436,026	B2	10/2019	Onadajela	2012/0222865	A1	9/2012	Larson	
10,627,003	B2	4/2020	Dale et al.	2012/0232728	A1	9/2012	Karimi et al.	
10,669,471	B2	6/2020	Schmidt et al.	2012/0247783	A1	10/2012	Berner, Jr.	
10,669,804	B2*	6/2020	Kotrla	2012/0255734	A1	10/2012	Coli et al.	
10,695,950	B2	6/2020	Igo et al.	2013/0009469	A1	1/2013	Gillett	
10,711,576	B2	7/2020	Bishop	2013/0025706	A1	1/2013	DeGaray et al.	
10,740,730	B2	8/2020	Altamirano et al.	2013/0175038	A1	7/2013	Conrad	
2002/0169523	A1	11/2002	Ross et al.	2013/0175039	A1	7/2013	Guidry	
2003/0000759	A1	1/2003	Schmitz	2013/0180722	A1	7/2013	Olarte Caro et al.	
2003/0056514	A1	3/2003	Lohn	2013/0189629	A1	7/2013	Chandler	
				2013/0199617	A1	8/2013	DeGaray et al.	
				2013/0233542	A1	9/2013	Shampine	
				2013/0255271	A1	10/2013	Yu et al.	

(56)

References Cited

U.S. PATENT DOCUMENTS

2013/0284278	A1*	10/2013	Winborn	F16L 15/00 137/15.01	2016/0341281	A1	11/2016	Brunvold et al.
2013/0284455	A1	10/2013	Kajaria et al.		2016/0348479	A1	12/2016	Oehring
2013/0299167	A1	11/2013	Fordyce et al.		2016/0349728	A1	12/2016	Oehring
2013/0306322	A1	11/2013	Sanborn		2016/0369609	A1	12/2016	Morris et al.
2013/0317750	A1	11/2013	Hunter		2017/0016433	A1	1/2017	Chong
2013/0341029	A1	12/2013	Roberts et al.		2017/0021318	A1	1/2017	McIver et al.
2013/0343858	A1	12/2013	Flusche		2017/0022788	A1	1/2017	Oehring et al.
2014/0000899	A1	1/2014	Nevison		2017/0022807	A1	1/2017	Dursun
2014/0010671	A1	1/2014	Cryer et al.		2017/0028368	A1	2/2017	Oehring et al.
2014/0054965	A1	2/2014	Jain		2017/0030177	A1	2/2017	Oehring
2014/0060658	A1	3/2014	Hains		2017/0030178	A1	2/2017	Oehring et al.
2014/0095114	A1	4/2014	Thomeer		2017/0036178	A1	2/2017	Coli et al.
2014/0096974	A1	4/2014	Coli		2017/0036872	A1	2/2017	Wallace
2014/0124162	A1	5/2014	Leavitt		2017/0037717	A1	2/2017	Oehring
2014/0138079	A1	5/2014	Broussard		2017/0037718	A1	2/2017	Coli et al.
2014/0174691	A1	6/2014	Kamps		2017/0043280	A1	2/2017	Vankouwenberg
2014/0174717	A1	6/2014	Broussard et al.		2017/0051732	A1	2/2017	Hernandez et al.
2014/0219824	A1	8/2014	Burnette		2017/0074076	A1	3/2017	Joseph et al.
2014/0238683	A1	8/2014	Korach		2017/0082033	A1	3/2017	Wu et al.
2014/0246211	A1	9/2014	Guidry et al.		2017/0096885	A1	4/2017	Oehring
2014/0251623	A1	9/2014	Lestz et al.		2017/0104389	A1	4/2017	Morris et al.
2014/0255214	A1	9/2014	Burnette		2017/0114625	A1	4/2017	Norris
2014/0277772	A1	9/2014	Lopez		2017/0130743	A1	5/2017	Anderson
2014/0290768	A1	10/2014	Randle		2017/0138171	A1	5/2017	Richards et al.
2014/0379300	A1	12/2014	Devine		2017/0145918	A1	5/2017	Oehring
2015/0027712	A1	1/2015	Vicknair		2017/0146189	A1	5/2017	Herman
2015/0053426	A1	2/2015	Smith		2017/0159570	A1	6/2017	Bickert
2015/0068724	A1	3/2015	Coli et al.		2017/0159654	A1	6/2017	Kendrick
2015/0068754	A1	3/2015	Coli et al.		2017/0175516	A1	6/2017	Eslinger
2015/0075778	A1	3/2015	Walters		2017/0212535	A1	7/2017	Shelman et al.
2015/0083426	A1	3/2015	Lesko		2017/0218727	A1	8/2017	Oehring
2015/0097504	A1	4/2015	Lamascus		2017/0218843	A1	8/2017	Oehring
2015/0114652	A1	4/2015	Lestz		2017/0222409	A1	8/2017	Oehring
2015/0136043	A1	5/2015	Shaaban		2017/0226838	A1	8/2017	Ciezobka et al.
2015/0144336	A1	5/2015	Hardin et al.		2017/0226839	A1	8/2017	Broussard
2015/0159911	A1	6/2015	Holt		2017/0226842	A1	8/2017	Omont
2015/0175013	A1	6/2015	Cryer et al.		2017/0234250	A1	8/2017	Janik
2015/0176386	A1	6/2015	Castillo et al.		2017/0241221	A1	8/2017	Seshadri
2015/0211512	A1	7/2015	Wiegman		2017/0259227	A1	9/2017	Morris et al.
2015/0211524	A1	7/2015	Broussard		2017/0292513	A1	10/2017	Haddad
2015/0217672	A1	8/2015	Shampine		2017/0302218	A1	10/2017	Janik
2015/0225113	A1	8/2015	Lungu		2017/0313499	A1	11/2017	Hughes et al.
2015/0252661	A1	9/2015	Glass		2017/0314380	A1	11/2017	Oehring
2015/0300145	A1	10/2015	Coli et al.		2017/0314979	A1	11/2017	Ye
2015/0300336	A1	10/2015	Hernandez		2017/0328179	A1	11/2017	Dykstra
2015/0314225	A1	11/2015	Coli et al.		2017/0369258	A1	12/2017	DeGaray
2015/0330172	A1	11/2015	Allmaras		2017/0370639	A1	12/2017	Barden et al.
2015/0354322	A1	12/2015	Vicknair		2018/0028992	A1	2/2018	Stegemoeller
2016/0032703	A1	2/2016	Broussard et al.		2018/0038216	A1	2/2018	Zhang
2016/0102537	A1	4/2016	Lopez		2018/0045331	A1	2/2018	Lopez
2016/0105022	A1	4/2016	Oehring		2018/0090914	A1	3/2018	Johnson et al.
2016/0160889	A1	6/2016	Hoffman et al.		2018/0156210	A1	6/2018	Oehring
2016/0177675	A1	6/2016	Morris et al.		2018/0181830	A1	6/2018	Laharuka et al.
2016/0177678	A1	6/2016	Morris		2018/0183219	A1	6/2018	Oehring
2016/0186531	A1	6/2016	Harkless et al.		2018/0216455	A1	8/2018	Andreychuk
2016/0208592	A1	7/2016	Oehring		2018/0238147	A1	8/2018	Shahri
2016/0208593	A1	7/2016	Coli et al.		2018/0245428	A1	8/2018	Richards
2016/0208594	A1	7/2016	Coli et al.		2018/0258746	A1	9/2018	Broussard
2016/0208595	A1	7/2016	Tang		2018/0259080	A1	9/2018	Dale et al.
2016/0221220	A1	8/2016	Paige		2018/0266217	A1	9/2018	Funkhauser et al.
2016/0230524	A1	8/2016	Dumoit		2018/0266412	A1	9/2018	Stokkevag
2016/0230525	A1	8/2016	Lestz et al.		2018/0274446	A1	9/2018	Oehring
2016/0258267	A1	9/2016	Payne		2018/0284817	A1	10/2018	Cook et al.
2016/0265457	A1	9/2016	Stephenson		2018/0291713	A1	10/2018	Jeanson
2016/0273328	A1	9/2016	Oehring		2018/0298731	A1	10/2018	Bishop
2016/0273456	A1	9/2016	Zhang et al.		2018/0312738	A1	11/2018	Rutsch et al.
2016/0281484	A1	9/2016	Lestz		2018/0320483	A1	11/2018	Zhang
2016/0290114	A1	10/2016	Oehring		2018/0343125	A1	11/2018	Clish
2016/0290563	A1	10/2016	Diggins		2018/0363437	A1	12/2018	Coli
2016/0312108	A1	10/2016	Lestz et al.		2019/0003329	A1	1/2019	Morris
2016/0319650	A1	11/2016	Oehring		2019/0010793	A1	1/2019	Hinderliter
2016/0326853	A1	11/2016	Fred et al.		2019/0063309	A1	2/2019	Davis
2016/0326854	A1	11/2016	Broussard		2019/0100989	A1	4/2019	Stewart
2016/0326855	A1	11/2016	Coli et al.		2019/0112910	A1	4/2019	Oehring
					2019/0119096	A1	4/2019	Haile
					2019/0120024	A1	4/2019	Oehring
					2019/0128080	A1	5/2019	Ross
					2019/0154020	A1	5/2019	Glass
					2019/0162061	A1	5/2019	Stepheson

(56)

References Cited**U.S. PATENT DOCUMENTS**

2019/0169971	A1	6/2019	Oehring
2019/0178057	A1	6/2019	Hunter
2019/0178235	A1	6/2019	Coskrey
2019/0203567	A1	7/2019	Ross
2019/0203572	A1	7/2019	Morris
2019/0211661	A1	7/2019	Reckels
2019/0226317	A1	7/2019	Payne
2019/0245348	A1	8/2019	Hinderliter
2019/0249527	A1	8/2019	Kraynek
2019/0292866	A1	9/2019	Ross
2019/0292891	A1	9/2019	Kajaria
2019/0316447	A1	10/2019	Oehring
2020/0047141	A1	2/2020	Oehring et al.
2020/0088152	A1	3/2020	Allion et al.
2020/0232454	A1	7/2020	Chretien

FOREIGN PATENT DOCUMENTS

CA	2707269	12/2010
CA	2482943	5/2011
CA	3050131	11/2011
CA	2955706	10/2012
CA	2966672	10/2012
CA	3000322	4/2013
CA	2787814	2/2014
CA	2833711	5/2014
CA	2978706	9/2016
CA	2944980	2/2017
CA	3006422	6/2017
CA	3018485	8/2017
CA	2964593	10/2017
CA	2849825	7/2018
CA	3067854	A1 1/2019
CA	2919649	2/2019
CA	2919666	7/2019
CA	2797081	9/2019
CA	2945579	10/2019
CN	101977016	2/2011
CN	104196613	A 12/2014
CN	205986303	U 2/2017
CN	108049999	A 5/2018
JP	2004264589	9/2004
WO	2016/144939	9/2016
WO	2016/160458	10/2016
WO	2018044307	A1 3/2018
WO	2018213925	A1 11/2018

OTHER PUBLICATIONS

Notice of Allowance dated Jan. 9, 2020 in related U.S. Appl. No. 16/570,331.

Non-Final Office Action dated Dec. 23, 2019 in related U.S. Appl. No. 16/597,008.

Non-Final Office Action dated Jan. 10, 2020 in related U.S. Appl. No. 16/597,014.

Non-Final Office Action dated Dec. 6, 2019 in related U.S. Appl. No. 16/564,186.

International Search Report and Written Opinion dated Nov. 26, 2019 in related PCT Application No. PCT/US19/51018.

International Search Report and Written Opinion dated Feb. 11, 2020 in related PCT Application No. PCT/US2019/055323.

Final Office Action dated Mar. 31, 2020 in related U.S. Appl. No. 15/356,436.

Non-Final Office Action dated Mar. 3, 2020 in related U.S. Appl. No. 16/152,695.

UK Power Networks—Transformers to Supply Heat to Tate Modern—from Press Releases May 16, 2013.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/293,681 dated Feb. 16, 2017.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/294,349 dated Mar. 14, 2017.

Final Office Action issued in corresponding U.S. Appl. No. 15/145,491 dated Jan. 20, 2017.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/145,443 dated Feb. 7, 2017.

Notice of Allowance issued in corresponding U.S. Appl. No. 15/217,040 dated Mar. 28, 2017.

Notice of Allowance issued in corresponding U.S. Appl. No. 14/622,532 dated Mar. 27, 2017.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/291,842 dated Jan. 6, 2017.

Final Office Action issued in corresponding U.S. Appl. No. 14/622,532 dated Dec. 7, 2016.

Non-Final Office Action issued in corresponding U.S. Appl. No. 14/622,532 dated May 17, 2016.

Final Office Action issued in corresponding U.S. Appl. No. 14/622,532 dated Dec. 21, 2015.

Non-Final Office Action issued in corresponding U.S. Appl. No. 14/622,532 dated Aug. 5, 2015.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/145,491 dated Sep. 12, 2016.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/217,040 dated Nov. 29, 2016.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/235,788 dated Dec. 14, 2016.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/145,491 dated May 15, 2017.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/486,970 dated Jun. 22, 2017.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/487,656 dated Jun. 23, 2017.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/487,694 dated Jun. 26, 2017.

Final Office Action issued in corresponding U.S. Appl. No. 15/294,349 dated Jul. 6, 2017.

Non-Final Office Action issued in corresponding U.S. Appl. No. 14/884,363 dated Sep. 5, 2017.

Final Office Action issued in corresponding U.S. Appl. No. 15/145,491 dated Sep. 6, 2017.

Non-Final Office Action issued in corresponding U.S. Appl. No. 14/881,535 dated Oct. 6, 2017.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/145,414 dated Nov. 29, 2017.

Non-Final Office Action issued in corresponding U.S. Appl. No. 15/644,487 dated Nov. 13, 2017.

Canadian Office Action dated Mar. 2, 2018 in related Canadian Patent Application No. 2,833,711.

Office Action dated Apr. 10, 2018 in related U.S. Appl. No. 15/294,349.

Office Action dated Apr. 2, 2018 in related U.S. Appl. No. 15/183,387.

Office Action dated May 29, 2018 in related U.S. Appl. No. 15/235,716.

Canadian Office Action dated Apr. 18, 2018 in related Canadian Patent Application No. 2,928,711.

Canadian Office Action dated Jun. 22, 2018 in related Canadian Patent Application No. 2,886,697.

Office Action dated Jul. 25, 2018 in related U.S. Appl. No. 15/644,487.

Office Action dated Oct. 4, 2018 in related U.S. Appl. No. 15/217,081.

International Search Report and Written Opinion dated Sep. 19, 2018 in related PCT Patent Application No. PCT/US2018/040683.

Canadian Office Action dated Sep. 28, 2018 in related Canadian Patent Application No. 2,945,281.

Office Action dated Dec. 12, 2018 in related U.S. Appl. No. 16/160,708.

International Search Report and Written Opinion dated Jan. 2, 2019 in related PCT Patent Application No. PCT/US18/54542.

International Search Report and Written Opinion dated Jan. 2, 2019 in related PCT Patent Application No. PCT/US18/54548.

International Search Report and Written Opinion dated Dec. 31, 2018 in related PCT Patent Application No. PCT/US18/55913.

International Search Report and Written Opinion dated Jan. 4, 2019 in related PCT Patent Application No. PCT/US18/57539.

Non-Final Office Action dated Feb. 12, 2019 in related U.S. Appl. No. 16/170,695.

(56)

References Cited**OTHER PUBLICATIONS**

International Search Report and Written Opinion dated Feb. 15, 2019 in related PCT Patent Application No. PCT/US18/63977.
 International Search Report and Written Opinion dated Mar. 5, 2019 in related PCT Patent Application No. PCT/US18/63970.
 Non-Final Office Action dated Feb. 25, 2019 in related U.S. Appl. No. 16/210,749.
 Non-Final Office Action dated Mar. 6, 2019 in related U.S. Appl. No. 15/183,387.
 Office Action dated Jan. 30, 2019 in related Canadian Patent Application No. 2,936,997.
 Office Action dated Mar. 1, 2019 in related Canadian Patent Application No. 2,943,275.
 International Search Report and Written Opinion dated Apr. 10, 2019 in corresponding PCT Application No. PCT/US2019/016635.
 Notice of Allowance dated Apr. 23, 2019 in corresponding U.S. Appl. No. 15/635,028.
 International Search Report and Written Opinion dated Jul. 9, 2019 in corresponding PCT Application No. PCT/US2019/027584.
 Non-Final Office Action issued in corresponding U.S. Appl. No. 16/170,695 dated Jun. 7, 2019.
 Non-Final Office Action issued in corresponding Application No. 16/268,030 dated May 10, 2019.
 Final Office Action issued in corresponding U.S. Appl. No. 16/210,749 dated Jun. 11, 2019.
 Canadian Office Action dated May 30, 2019 in corresponding CA Application No. 2,833,711.
 Canadian Office Action dated Jun. 20, 2019 in corresponding CA Application No. 2,964,597.
 International Search Report and Written Opinion dated Jul. 9, 2019 in related PCT Application No. PCT/US2019/027584.
 Office Action dated Jun. 7, 2019 in related U.S. Appl. No. 16/268,030.
 International Search Report and Written Opinion dated Sep. 11, 2019 in related PCT Application No. PCT/US2019/037493.
 Office Action dated Aug. 19, 2019 in related U.S. Appl. No. 15/356,436.
 Office Action dated Oct. 2, 2019 in related U.S. Appl. No. 16/152,732.
 Office Action dated Sep. 11, 2019 in related U.S. Appl. No. 16/268,030.
 Office Action dated Oct. 11, 2019 in related U.S. Appl. No. 16/385,070.
 Office Action dated Sep. 3, 2019 in related U.S. Appl. No. 15/994,772.
 Office Action dated Sep. 20, 2019 in related U.S. Appl. No. 16/443,273.
 Canadian Office Action dated Oct. 1, 2019 in related Canadian Patent Application No. 2,936,997.
 Office Action dated Dec. 6, 2019 in related U.S. Appl. No. 16/564,186.
 Non-Final Office dated Oct. 26, 2020 in U.S. Appl. No. 15/356,436.
 Non-Final Office dated Oct. 5, 2020 in U.S. Appl. No. 16/443,273.
 Non-Final Office Action dated Sep. 29, 2020 in U.S. Appl. No. 16/943,727.
 Non-Final Office Action dated Sep. 2, 2020 in U.S. Appl. No. 16/356,263.
 Non-Final Office Action dated Aug. 31, 2020 in U.S. Appl. No. 16/167,083.
 Albone, "Mobile Compressor Stations for Natural Gas Transmission Service," ASME 67-GT-33, Turbo Expo, Power for Land, Sea and Air, vol. 79887, p. 1-10, 1967.
 Canadian Office Action dated Sep. 22, 2020 in Canadian Application No. 2,982,974.
 International Search Report and Written Opinion dated Sep. 3, 2020 in PCT/US2020/36932.

"Process Burner" (<https://www.cebasrt.com/products/loi-gas/process-burner>) 06 Sep. 6, 2018 (Sep. 6, 2018), entire document, especially para (Burners for refinery Heaters).
 Water and Glycol Heating Systems* (<https://www.heat-inc.com/wg-series-water-glycol-systems/>) Jun. 18, 2018 (Jun. 18, 2018), entire document, especially WG Series Water Glycol Systems.
 "Heat Exchanger" (https://en.wikipedia.org/w/index.php?title=Heat_exchanger&oldid=89300146) Dec. 18, 2019 Apr. 2019 (Apr. 18, 2019), entire document, especially para (0001).
 Canadian Office Action dated Sep. 8, 2020 in Canadian Patent Application No. 2,928,707.
 Canadian Office Action dated Aug. 31, 2020 in Canadian Patent Application No. 2,944,980.
 International Search Report and Written Opinion dated Aug. 28, 2020 in PCT/US20/23821.
 Non-Final Office Action issued in U.S. Appl. No. 14/881,535 dated May 20, 2020.
 Non-Final Office Action issued in U.S. Appl. No. 15/145,443 dated May 8, 2020.
 Non-Final Office Action issued in U.S. Appl. No. 16/458,696 dated May 22, 2020.
 International Search Report and Written Opinion issued in PCT/US2020/023809 dated Jun. 2, 2020.
 Karin, "Duel Fuel Diesel Engines," (2015), Taylor & Francis, pp. 62-63, Retrieved from <https://app.knovel.com/hotlink/toc/id:kpDFDE0001/dual-fueal-diesel-engines/duel-fuel-diesel-engines> (Year 2015).
 Goodwin, "High-voltage auxilliary switchgear for power stations," Power Engineering Journal, 1989, 10 pg. (Year 1989).
 International Search Report and Written Opinion dated Jun. 2, 2020 in corresponding PCT Application No. PCT/US20/23809.
 International Search Report and Written Opinion dated Jun. 23, 2020 in corresponding PCT Application No. PCT/US20/23912.
 International Search Report and Written Opinion dated Jul. 22, 2020 in corresponding PCT Application No. PCT/US20/00017.
 Office Action dated Aug. 4, 2020 in related U.S. Appl. No. 16/385,070.
 Office Action dated Jun. 29, 2020 in related U.S. Appl. No. 16/404,283.
 Canadian Office Action dated Aug. 17, 2020 in related CA Patent Application No. 2,944,968.
 Office Action dated Jun. 22, 2020 in related U.S. Appl. No. 16/377,861.
 Canadian Office Action dated Aug. 18, 2020 in related CA Patent Application No. 2,933,444.
 International Search Report and Written Opinion dated Nov. 24, 2020 in corresponding PCT Application No. PCT/US20/44274.
 Morris et al., U.S. Appl. No. 62/526,869; Hydration-Blender Transport and Electric Power Distribution for Fracturing Operation; Jun. 28, 2018; USPTO; see entire document.
 Final Office Action dated Feb. 4, 2021 in U.S. Appl. No. 16/597,014.
 International Search Report and Written Opinion dated Feb. 4, 2021 in PCT/US20/59834.
 International Search Report and Written Opinion dated Feb. 2, 2021 in PCT/US20/58906.
 International Search Report and Written Opinion dated Feb. 3, 2021 in PCT/US20/58899.
 Non-Final Office Action dated Jan. 29, 2021 in U.S. Appl. No. 16/564,185.
 Final Office Action dated Jan. 21, 2021 in U.S. Appl. No. 16/458,696.
 Final Office Action dated Jan. 11, 2021 in U.S. Appl. No. 16/404,283.
 Non-Final Office Action dated Jan. 4, 2021 in U.S. Appl. No. 16/522,043.
 International Search Report and Written Opinion dated Dec. 14, 2020 in PCT/US2020/53980.

* cited by examiner

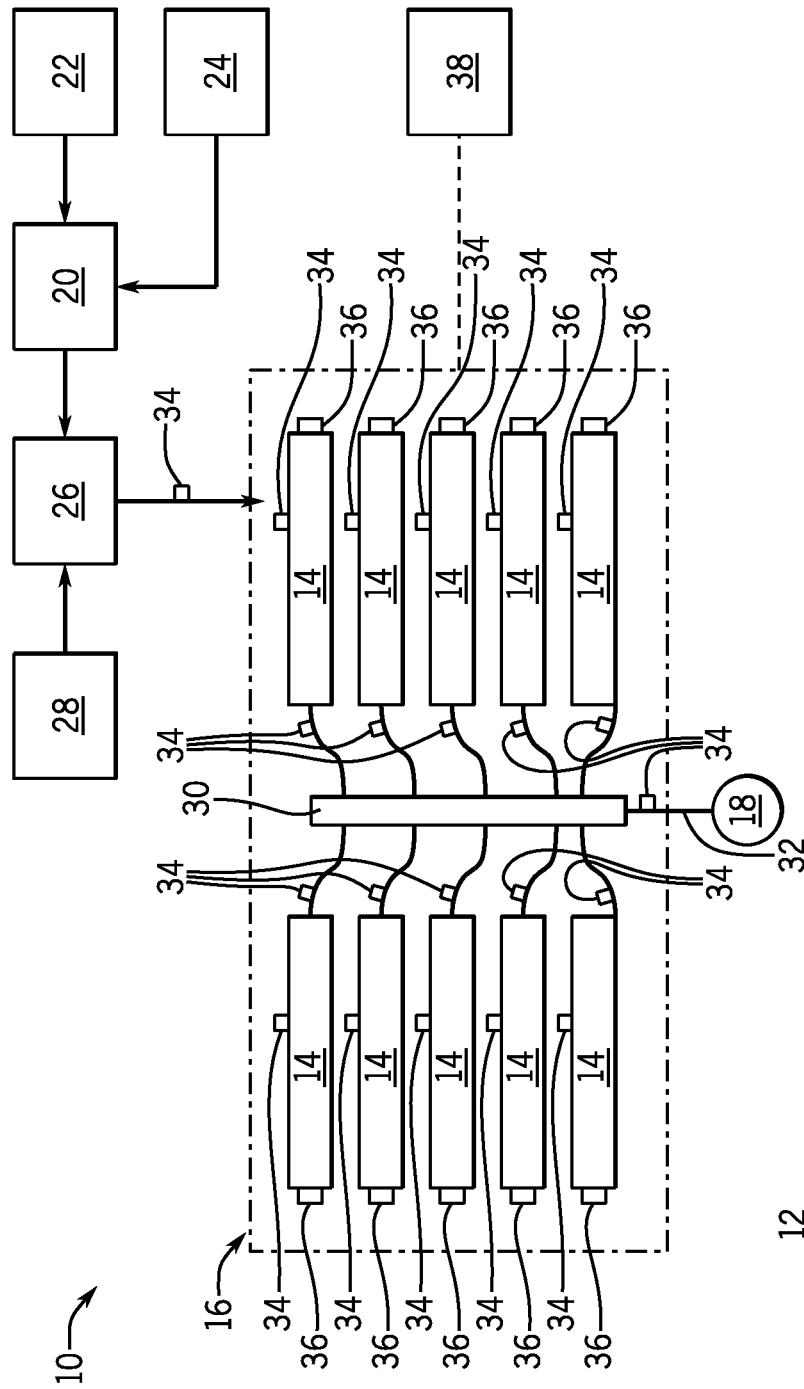


FIG. 1

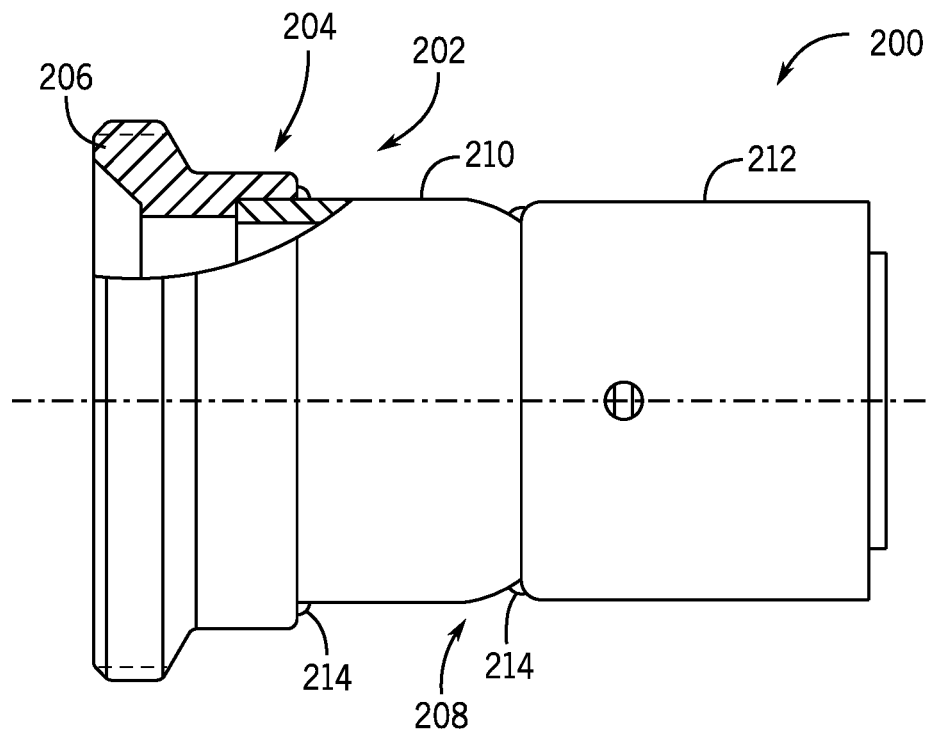


FIG. 2

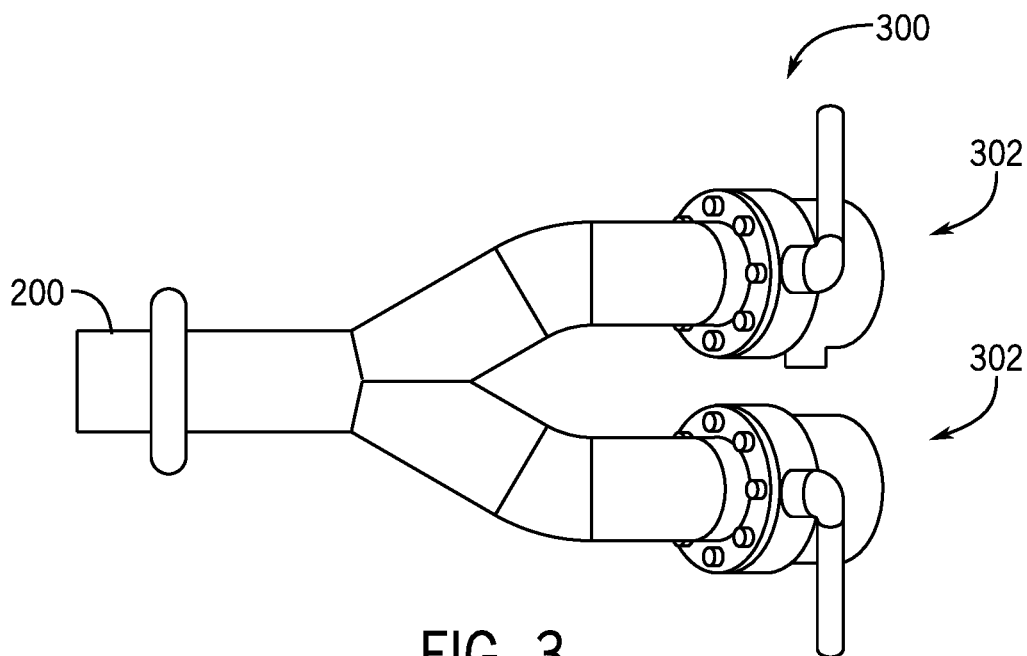


FIG. 3

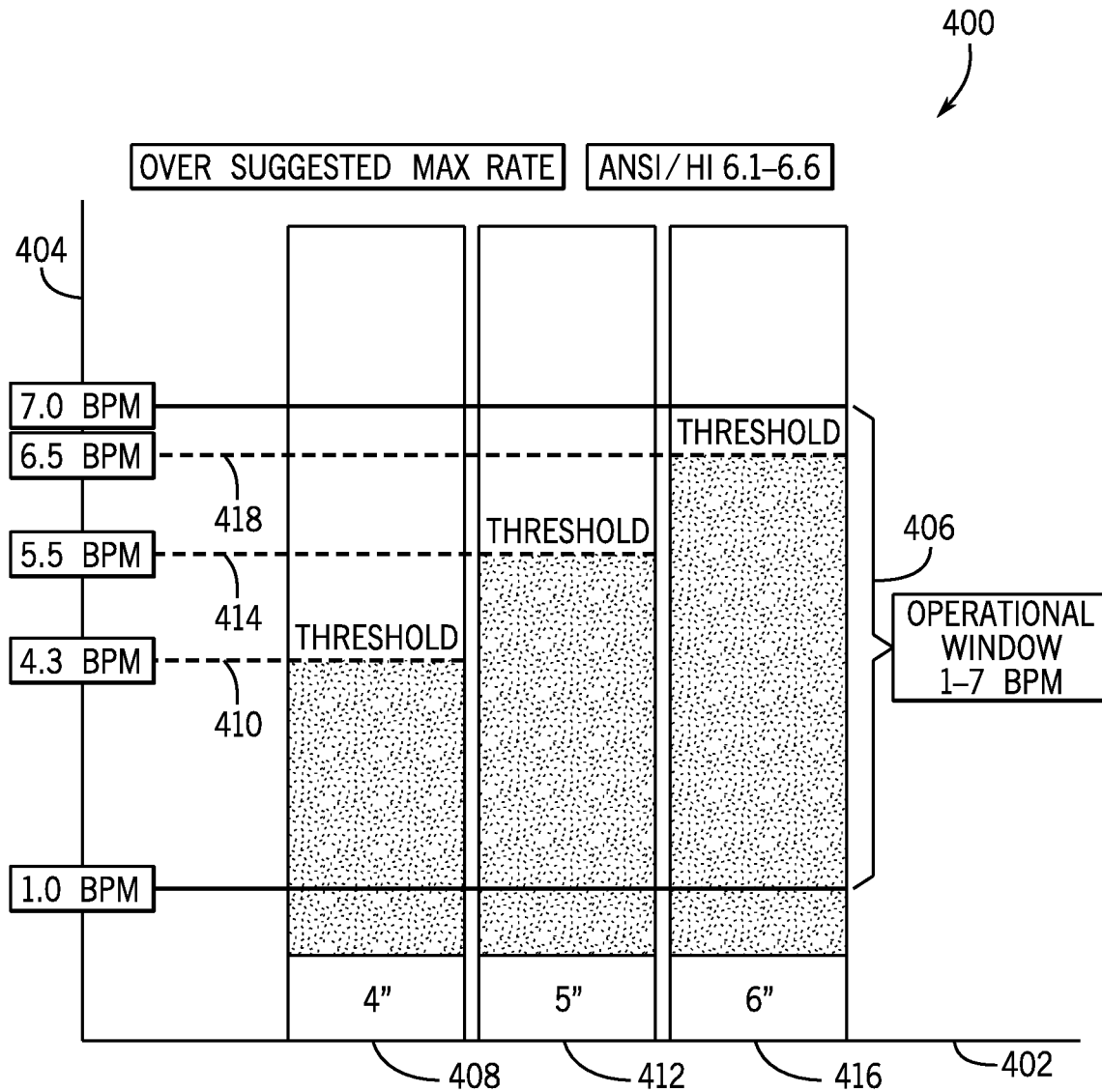


FIG. 4

1

SYSTEM AND METHOD FOR INTEGRATED FLOW SUPPLY LINE

BACKGROUND

1. Technical Field

This disclosure relates generally to hydraulic fracturing and more particularly to systems and methods for fluid supply lines utilized in hydraulic fracturing.

2. Background

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 (fracturing) 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 fracturing 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 fracturing operations.

Hydraulic fracturing operations often try to increase flow rates through fracturing pumps in order to reduce operational times and save costs. However, typical fracturing systems have established component sizes and non-standard components are challenging to incorporate and may lead to errors, as operators may be unfamiliar with the new components. One such instance is in fluid flow lines (e.g., hoses) utilized to supply fracturing fluid to the pumps. Many flow lines utilized in the industry have a 4 inch diameter. However, this flow diameter limits fluid inlet into the pumps, which may be undesirable, because pumps operating at lower flow rates and/or pressures than desired may experience premature wear and failures. Moreover, merely increasing hose sizes is not practical because of component fittings on the pump and potential problems with flow rates, as flow rates that drop below a threshold may experience drop out of particulates, leading to blockages and other problems at the well site.

SUMMARY

Applicant recognized the problems noted above herein and conceived and developed embodiments of systems and methods, according to the present disclosure, for operating electric fracturing pumps.

In an embodiment, a hydraulic fracturing system for fracturing a subterranean formation includes an electric powered, multi-plunger pump having an inlet and an outlet, the outlet coupled to a well associated with the subterranean formation and powered by at least one electric motor, the electric powered 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. The system also includes a fluid source, coupled to the inlet of the electric powered pump, the fluid source providing a slurry for injection into the subterranean formation. The system further includes a hose extending between the fluid source and the electric powered pump, the hose being flexible and having a first diameter. The system includes a

2

fitting between the hose and the electric powered pump, the fitting having a first end for receiving the hose at the first diameter and a second end for coupling to the electric powered pump at a second diameter, the second diameter being larger than the first diameter. The system also includes a distribution system, positioned between the wellbore and the electric powered pump, the distribution system collecting the slurry from electric powered pumps for injection into the subterranean formation.

In an embodiment, a hydraulic fracturing system for fracturing a subterranean formation includes an electric powered, multi-plunger pump having an inlet and an outlet, the outlet coupled to a well associated with the subterranean formation and powered by at least one electric motor, the electric powered 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. The system also includes a fluid source, coupled to the inlet of the electric powered pump, the fluid source providing a slurry for injection into the subterranean formation. The system includes a hose extending between the fluid source and the electric powered pump, the hose including a first end, for coupling to the fluid source, having a first diameter, a second end, for coupling to the inlet of the electric powered pump, having a second diameter, and a body between the first end and the second end having a third diameter, the third diameter being less than both the first diameter and the second diameter. The system further includes a pair of fittings, a first fitting forming the first end and a second fitting forming the second end, each fitting of the pair of fittings having a shank end for receiving at least a portion of the body and a union for engaging the respective fluid source and electric powered pump.

In an embodiment, a method for selecting a hose diameter for a flow line utilized in fracturing operations includes determining a first end connection size is a first diameter. The method also includes determining a second end connection size is a second diameter. The method further includes determining a first flow rate, associated with a first hose diameter, is below a threshold. The method includes determining a second flow rate, associated with a second hose diameter, exceeds the threshold. The method also includes forming the flow line using the second hose diameter.

BRIEF DESCRIPTION OF DRAWINGS

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

FIG. 1 is a schematic plan view of an embodiment of a fracturing operation, in accordance with embodiments of the present disclosure;

FIG. 2 is a side view of an embodiment of a fitting, in accordance with embodiments of the present disclosure;

FIG. 3 is a schematic perspective view of an embodiment of a flow line, in accordance with embodiments of the present disclosure; and

FIG. 4 is a graphical representation of suction pipe flow rates, in accordance with embodiments of the present disclosure.

While the disclosure will be described in connection with the preferred embodiments, it will be understood that it is not intended to limit the disclosure to that embodiment. On the contrary, it is intended to cover all alternatives, modifi-

cations, and equivalents, as may be included within the spirit and scope of the disclosure as defined by the appended claims.

DETAILED DESCRIPTION

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. In an embodiment, usage of the term "about" includes $\pm 5\%$ of the cited magnitude. In an embodiment, usage of the term "substantially" includes $\pm 5\%$ of the cited magnitude.

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.

When introducing elements of various embodiments of the present disclosure, the articles "a", "an", "the", and "said" are intended to mean that there are one or more of the elements. The terms "comprising", "including", and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements. Any examples of operating parameters and/or environmental conditions are not exclusive of other parameters/conditions of the disclosed embodiments. Additionally, it should be understood that references to "one embodiment", "an embodiment", "certain embodiments", or "other embodiments" of the present disclosure are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features. Furthermore, reference to terms such as "above", "below", "upper", "lower", "side", "front", "back", or other terms regarding orientation or direction are made with reference to the illustrated embodiments and are not intended to be limiting or exclude other orientations or directions. Additionally, recitations of steps of a method should be understood as being capable of being performed in any order unless specifically stated otherwise. Furthermore, the steps may be performed in series or in parallel unless specifically stated otherwise. Particular dimensions may be referred to herein along with their accompanying abbreviations, including but not limited to: inches (in, "), meters (m), centimeters (cm), pounds per square inch (PSI), pascals (Pa), feet per second (ft/s), barrels per minute (BPM), and the like.

Embodiments of the present disclosure include specialty-sized hoses developed in order to allow greater flow/supply to frac pumps (e.g., positive displacement, multi plunger pumps). This increased flow capability reduces cavitation events and prolongs equipment life. Specially selecting a 5" (0.127 m) diameter hose allows for fluid velocity to be maintained above a threshold at which sand particles would begin to fall out and eventually cause a blockage (sand off) the hose itself. In order to utilize this diameter/size hose in a large-scale function, a connection point was developed to enable use of standard 6" (0.1524 m) components, such as

but not limited to hammer unions, butterfly valves, and other 6" steel pipe components. Embodiments include a hybrid of 5" hose and 6" end connectors. This then results in an improvement to existing methods of supplying fluid to a positive displacement pump.

Embodiments of the present disclosure present an improvement over existing systems by removing the standard 4" (0.1016 m) supply hoses while maintaining standard 6" connection types by utilizing a particularly designed ferrule. The standard 4" supply hose provides an insufficient volume of fracturing fluid to a pump utilizing in hydraulic fracturing operation. These problems may be compounded when 4" connections are also used. Using a 5" diameter hose supplies more volume, reduces pressure drop, and reduces cavitation and other poor conditions pumps can experience when not supplied adequately.

FIG. 1 is a plan schematic view of an embodiment of a hydraulic fracturing system 10 positioned at a well site 12. In the illustrated embodiment, pump units 14, which make up a pumping system 16, are used to pressurize a slurry solution for injection into a wellhead 18. An optional hydration unit 20 receives fluid from a fluid source 22 via a line, such as a tubular, and also receives additives from an additive source 24. In an embodiment, the fluid is water and the additives are mixed together and transferred to a blender unit 26 where proppant from a proppant source 28 may be added to form the slurry solution (e.g., fracturing slurry) which is transferred to the pumping system 16. The pump units 14 may receive the slurry solution at a first pressure (e.g., 80 psi to 160 psi) and boost the pressure to around 15,000 psi for injection into the wellhead 18. In certain embodiments, the pump units 14 are powered by electric motors.

After being discharged from the pump system 16, a distribution system 30, such as a missile, receives the slurry solution for injection into the wellhead 18. The distribution system 30 consolidates the slurry solution from each of the pump units 14 and includes discharge piping 32 coupled to the wellhead 18. In this manner, pressurized solution for hydraulic fracturing may be injected into the wellhead 18.

In the illustrated embodiment, one or more sensors 34, 36 are arranged throughout the hydraulic fracturing system 10 to measure various properties related to fluid flow, vibration, and the like.

It should be appreciated that while various embodiments of the present disclosure may describe electric motors powering the pump units 14, in embodiments, electrical generation can be supplied by various different options, as well as hybrid options. Hybrid options may include two or more of the following electric generation options: Gas turbine generators with fuel supplied by field gas, CNG, and/or LNG, diesel turbine generators, diesel engine generators, natural gas engine generators, batteries, electrical grids, and the like. Moreover, these electric sources may include a single source type unit or multiple units. For example, there may be one gas turbine generator, two gas turbines generators, two gas turbine generators coupled with one diesel engine generator, and various other configurations.

In various embodiments, equipment at the well site may utilize 3-phase, 60 Hz, 690V electrical power. However, it should be appreciated that in other embodiments different power specifications may be utilized, such as 4160V or at different frequencies, such as 50 Hz. Accordingly, discussions herein with a particular type of power specification should not be interpreted as limited only the particularly discussed specification unless otherwise explicitly stated. Furthermore, systems described herein are designed for use

5

in outdoor, oilfield conditions with fluctuations in temperature and weather, such as intense sunlight, wind, rain, snow, dust, and the like. In embodiments, the components are designed in accordance with various industry standards, such as NEMA, ANSI, and NFPA.

FIG. 2 is a side view of an embodiment of a fitting 200 (e.g., ferrule) that may be utilized with embodiments of the present disclosure to incorporate 5" hoses into systems using 4" hoses and 6" fittings. In the illustrated embodiment, the fitting 200 includes a cutaway region 202 illustrating a coupling location 204 between a union 206 and a stem assembly 208. In the illustrated embodiment, the union 206 is configured to couple to a 6" coupling, for example on a pump. However, as illustrated, the stem assembly 208 includes a reducer 210 and a shank end 212 to receive a 5" hose (not pictured). For example, an end of the hose may be inserted into the shank end 212 and crimped, thereby joining the hose to the fitting 200. As a result, 5" hoses may be utilized in embodiments that include 6" fittings without significantly overhauling and/or modifying existing equipment. As discussed herein, 5" hoses provide numerous advantages including reduced pressure drop, greater capacity, and flow velocities greater than a threshold level corresponding to particulate drop out.

In the illustrated embodiment, various rigid couplings 214 are included along the fitting 200, for example, as welds utilizing to secure one or more components together. For example, there is a rigid coupling 214 between the union 206 and the reducer 210, as well as a rigid coupling 214 between the reducer 210 and the shank end 214. Accordingly, the components forming the fitting 200 may be particularly selected, based on one or more properties, for use with fracturing operations. For example, different fittings 200 may include different components. By way of example only, the union 206 may be replaced with a flanged end connection or the like.

Embodiments of the present disclosure that utilize the fitting 200 provide improved operations at a well site at least because greater volumes of fluid may be provided to fracturing pumps while maintaining flow rates above a threshold amount where particulates begin to drop out of the flow. For example, a 5" hose may meet rate demands while maintaining flow velocities at sufficient levels to reduce the likelihood of drop out. In contrast, a 4" hose may not meet rate demands and a 6" hose may not maintain flow velocities above the threshold for drop out. Moreover, the fitting 200 provides easy integration into existing systems without overhauling expensive equipment. For example, it may be costly to overhaul inlet piping on a fracturing pump, so much so, that it may be cost prohibitive to do so. Additionally, existing field equipment may be configured with certain specifications and include sunk costs, leading producers and operators to be reluctant to change. However, utilizing the fitting 200 enables existing equipment to remain in operation while providing improved operations.

FIG. 3 is a schematic perspective view of an embodiment of a portion of a flow line 300 including the fitting 200. In the illustrated embodiment, the flow line 300 includes connections 302 for coupling to mating 6" connections. However, due to the inclusion of the fitting 200, a 5" flow line may be incorporated into the design. The fitting 200, as noted above includes a transition from the 5" line to a 6" connection, thereby enabling use with the illustrated flow line 300. Advantageously, the flow line 300 may continue to be used in wellbore operations without modifications, which may reduce costs to operators with respect to obtaining new equipment for jobs.

6

As noted above, embodiments of the present disclosure provide advantages over existing systems that either utilize flow lines having diameters that are too small to provide sufficient capacity or are too large to maintain fluid velocities above threshold levels. Embodiments of the present disclosure overcome these problems by providing more volume, reducing drop in pressure, and reducing a likelihood of cavitation and other unhealthy pump conditions, such as starving. By way of example, frac slurry often consists of sand media also known as proppant, at low fluid velocities this proppant can begin to fall out of suspension. Some industry data notes that sand fall out begins at 2.21 ft/sec, which equates to 3.2 BPM in a 5" hose. Sand fall out is substantial at 1.72 ft/sec, which equates to 2.2 BPM in a 5" hoses. As a result, systems may be deployed to ensure that flow rates are maintained above these levels (which may be set as the thresholds) during operation.

Furthermore, embodiments of the present disclosure improve existing systems by reducing damage accumulation rates due to the improved flow characteristics associated with the 5" hose when compared to the 4" hose of existing systems. For example, a damage accumulate rate associated with the 5" hose may be less than the 4" hose and may increase at a lower rate as flow rate increases. Damage accumulation may be a factor, at least in part, on flow velocities, where a small diameter pipe will have greater velocities than a larger diameter pipe.

FIG. 4 is a graphical representation 400 illustrating pump flow rates and respective suction piping sizes. The x-axis 402 corresponds to suction pipe diameter (in inches) and the y-axis 404 corresponds to flow rate (in BPM). An operational window 406 is provided indicative of typical ranges where fracturing operations may occur. In this embodiment, the operational window 406 extends from approximately 1 BPM to approximately 7 BPM.

Each respective suction pipe diameter includes a threshold flow rate, which may be obtained through experimental procedures and/or reference materials. For example, a 4" suction pipe illustrated at 408 has a threshold 410 of approximately 4.3 BPM, a 5" suction pipe illustrated at 412 has a threshold 414 of approximately 5.5 BPM, and a 6" suction pipe illustrated at 416 has a threshold 418 of approximately 6.5 BPM. The operational window 406 includes a portion that exceeds each of the illustrated thresholds 410, 414, 418.

Operations using the 4" suction pipe 408 include an operating range that is approximately 40% larger than the threshold 410. As a result, there is a high likelihood that operations will exceed the threshold due to demands to supply additional fluid for fracturing operations. Similarly, operations using the 5" suction pipe 412 and the 6" suction pipe 416 also exceed threshold 414, 418 by approximately 22% and 7%, respectively. The instant application has identified that while the 6" suction pipe 416 enables the largest flow rate, that problems associated with fluid velocities and drop out make the 6" suction pipe 416 undesirable. Accordingly, embodiments may incorporate the 5" suction pipe 412, which provides significant improvements over the 4" suction pipe 408 while also reducing the likelihood of drop out. The 5" suction pipe 412 also has less pressure drop, when compared to the 4" suction pipe 408, providing an additional improvement over existing configurations.

The present disclosure 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 disclosure has been given for purposes of disclosure, numerous

7

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 disclosure disclosed herein and the scope of the appended claims. 5

The invention claimed is:

1. A hydraulic fracturing system for fracturing a subterranean formation, comprising:

an electric powered, multi-plunger hydraulic fracturing pump having an inlet and an outlet, the outlet coupled to a well associated with the subterranean formation and powered by at least one electric motor;

a fluid source, coupled to the inlet of the electric powered pump, the fluid source providing a slurry for injection into the subterranean formation; 15

a hose extending between the fluid source and the electric powered pump, the hose being flexible and having a first diameter;

a fitting between the hose and the electric powered pump, the fitting having a first end for receiving the hose at the first diameter and a second end for coupling to the electric powered pump at a second diameter, the second diameter being larger than the first diameter; and 20

a distribution system, positioned between the wellbore and the electric powered pump, the distribution system collecting the slurry from electric powered pumps for injection into the subterranean formation. 25

2. The system of claim 1, wherein the first diameter is approximately 5 inches and the second diameter is approximately 6 inches. 30

3. The system of claim 1, wherein the fitting further comprises:

a union at the second end, the union configured to couple to a mating fitting; 35

a shank end at the first end, the shank end receiving at least a portion of the hose, the shank end being crimped over at least the portion of the hose; and

a reducer between the union and the shank end, at least a portion of the reducer extending into a groove formed in the union, the union extending farther laterally than the reducer. 40

4. The system of claim 3, wherein the fitting is formed as an integral piece with at least one rigid coupling between at least one of the union, the shank end, and the reducer. 45

5. The system of claim 1, wherein the first diameter is particularly selected based at least in part on a threshold, the threshold corresponding to a drop out rate for the slurry.

6. The system of claim 1, wherein the first diameter is particularly selected based at least in part on a pressure drop rate, a damage accumulation rate, or a suggested flow rate. 50

7. The system of claim 1, wherein the first diameter is associated with a second threshold, corresponding to a maximum suggested flow rate, an operating window for the electric powered pump exceeding the maximum suggested flow rate. 55

8. The system of claim 1, further comprising:

a plurality of electric powered, multi-plunger pumps, each pump receiving fluid from the fluid source;

8

a plurality of hoses having the first diameter; and
a plurality of fittings between respective hoses of the plurality of the hoses and respective pumps of the plurality of pumps, each of the pumps having a connection having the second diameter.

9. A hydraulic fracturing system for fracturing a subterranean formation, comprising:

an electric powered, multi-plunger hydraulic fracturing pump having an inlet and an outlet, the outlet coupled to a well associated with the subterranean formation and powered by at least one electric motor;

a fluid source, coupled to the inlet of the electric powered pump, the fluid source providing a slurry for injection into the subterranean formation;

a hose extending between the fluid source and the electric powered pump, the hose being flexible and having a first diameter;

a fitting between the hose and the electric powered pump, the fitting comprising:

a union arranged at a first end, the union having a second diameter, larger than the first diameter, and being configured to couple to the pump;

a shank end configured to receive at least a portion of the hose, the shank end being securable to at least the portion of the hose, the shank end including an opening to receive the shank end; and

a reducer positioned between the union and the shank end, the reducer being welded to the respective union and shank end at each end, the reducer having an increasing diameter along its axial length, the reducer extending at least partially into the union; and

a distribution system, positioned between the wellbore and the electric powered pump, the distribution system collecting the slurry from electric powered pumps for injection into the subterranean formation.

10. The system of claim 9, wherein the first diameter is approximately 5 inches and the second diameter is approximately 6 inches.

11. The system of claim 9, wherein the first diameter is particularly selected based at least in part on a threshold, the threshold corresponding to a drop out rate for the slurry.

12. The system of claim 9, wherein the first diameter is particularly selected based at least in part on a pressure drop rate, a damage accumulation rate, or a suggested flow rate.

13. The system of claim 9, wherein the first diameter is associated with a second threshold, corresponding to a maximum suggested flow rate, an operating window for the electric powered pump exceeding the maximum suggested flow rate.

14. The system of claim 9, further comprising:

a plurality of electric powered, multi-plunger pumps, each pump receiving fluid from the fluid source;

a plurality of hoses having the first diameter; and

a plurality of fittings between respective hoses of the plurality of the hoses and respective pumps of the plurality of pumps, each of the pumps having a connection having the second diameter.

* * * * *