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Hinderliter et al.

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(54) **INTEGRATED MOBILE POWER UNIT FOR HYDRAULIC FRACTURING**

(56) **References Cited**

U.S. PATENT DOCUMENTS

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1,656,861 A 1/1928 Leonard
1,671,436 A 5/1928 Melott
(Continued)

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FOREIGN PATENT DOCUMENTS

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CA 2406801 11/2001
CA 2707269 12/2010
(Continued)

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OTHER PUBLICATIONS

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(57) **ABSTRACT**

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A hydraulic fracturing system is disclosed as including a singular mobile platform of at least one mobile power unit (MPU) and at least one first switch gear that is configured to handle electric power from the MPU. The MPU is configured to generate voltage that matches the capabilities of an electrical bus from the at least one switch gear such that a combined electrical current generated as a result of the generated voltage and required load is provided to the electrical bus to the components of the hydraulic fracturing system. Further, the hydraulic fracturing system may include electrical fracturing equipment with at least one second switch gear to support the at least one first switch gear in handling electric power from the MPU. A datavan may be included in the system to control load shedding, load sharing, and power distribution for the electrical fracturing equipment comprising the at least one second switch gear.

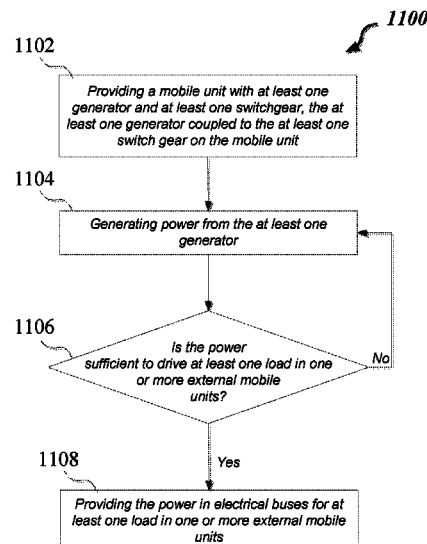
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CPC **H02J 3/46** (2013.01); **E21B 41/0085** (2013.01); **F01D 15/10** (2013.01); **G05B 15/02** (2013.01); **E21B 43/16** (2013.01); **E21B 43/26** (2013.01)

(58) **Field of Classification Search**
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(Continued)

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(56)

References Cited

U.S. PATENT DOCUMENTS

8,763,387 B2	7/2014	Schmidt	10,337,308 B2	7/2019	Broussard	
8,774,972 B2	7/2014	Rusnak	10,371,012 B2	8/2019	Davis	
8,789,601 B2	7/2014	Broussard	10,378,326 B2	8/2019	Morris	
8,795,525 B2	8/2014	McGinnis et al.	10,393,108 B2	8/2019	Chong	
8,800,652 B2	8/2014	Bartko	10,407,990 B2	9/2019	Oehring	
8,807,960 B2	8/2014	Stephenson	10,408,030 B2	9/2019	Oehring et al.	
8,838,341 B2	9/2014	Kumano	10,408,031 B2	9/2019	Oehring et al.	
8,851,860 B1	10/2014	Mail	10,415,332 B2	9/2019	Morris et al.	
8,857,506 B2	10/2014	Stone, Jr.	10,436,026 B2	10/2019	Ounadjela	
8,899,940 B2	12/2014	Leugemors	10,627,003 B2	4/2020	Dale et al.	
8,905,056 B2	12/2014	Kendrick	10,648,311 B2	5/2020	Oehring et al.	
8,905,138 B2	12/2014	Lundstedt et al.	10,669,471 B2	6/2020	Schmidt et al.	
8,997,904 B2	4/2015	Cryer	10,669,804 B2	6/2020	Kotrla	
9,018,881 B2	4/2015	Mao et al.	10,695,950 B2	6/2020	Igo et al.	
9,051,822 B2	6/2015	Ayan	10,711,576 B2	7/2020	Bishop	
9,051,923 B2	6/2015	Kuo	10,740,730 B2	8/2020	Altamirano et al.	
9,061,223 B2	6/2015	Winborn	10,794,165 B2	10/2020	Fischer et al.	
9,062,545 B2	6/2015	Roberts et al.	2001/0000996 A1	5/2001	Grimland et al.	
9,067,182 B2	6/2015	Nichols	2002/0169523 A1 *	11/2002	Ross	H02J 3/387 700/286
9,103,193 B2	8/2015	Goli	2003/0056514 A1	3/2003	Lohn	
9,119,326 B2	8/2015	McDonnell	2003/0079875 A1	5/2003	Weng	
9,121,257 B2	9/2015	Coli et al.	2003/0138327 A1	7/2003	Jones et al.	
9,140,110 B2	9/2015	Coli et al.	2004/0040746 A1	3/2004	Niedermayr et al.	
9,160,168 B2	10/2015	Chapel	2004/0102109 A1 *	5/2004	Cratty	B63H 21/17 440/113
9,260,253 B2	2/2016	Naizer	2004/0167738 A1	8/2004	Miller	
9,322,239 B2	4/2016	Angeles Boza et al.	2005/0061548 A1	3/2005	Hooper	
9,324,049 B2	4/2016	Thomeer	2005/0116541 A1	6/2005	Seiver	
9,340,353 B2	5/2016	Oren	2005/0201197 A1	9/2005	Duell et al.	
9,366,114 B2	6/2016	Coli et al.	2005/0274508 A1	12/2005	Folk	
9,410,410 B2	8/2016	Broussard et al.	2006/0052903 A1	3/2006	Bassett	
9,450,385 B2	9/2016	Kristensen	2006/0065319 A1	3/2006	Csitari	
9,475,020 B2	10/2016	Coli et al.	2006/0109141 A1	5/2006	Huang	
9,475,021 B2	10/2016	Coli et al.	2007/0131410 A1	6/2007	Hill	
9,482,086 B2	11/2016	Richardson et al.	2007/0187163 A1	8/2007	Cone	
9,499,335 B2	11/2016	McIver	2007/0201305 A1	8/2007	Heilman et al.	
9,506,333 B2	11/2016	Castillo et al.	2007/0226089 A1	9/2007	DeGaray et al.	
9,513,055 B1	12/2016	Seal	2007/0277982 A1	12/2007	Shampine	
9,534,473 B2	1/2017	Morris et al.	2007/0278140 A1	12/2007	Mallet et al.	
9,562,420 B2	2/2017	Morris et al.	2008/0017369 A1	1/2008	Sarada	
9,587,649 B2	3/2017	Oehring	2008/0041596 A1	2/2008	Blount	
9,611,728 B2	4/2017	Oehring	2008/0095644 A1	4/2008	Mantei et al.	
9,650,871 B2	5/2017	Oehring et al.	2008/0112802 A1	5/2008	Orlando	
9,650,879 B2	5/2017	Broussard et al.	2008/0137266 A1	6/2008	Jensen	
9,706,185 B2	7/2017	Ellis	2008/0164023 A1	7/2008	Dykstra et al.	
9,728,354 B2	8/2017	Skolozdra	2008/0208478 A1	8/2008	Ella et al.	
9,738,461 B2	8/2017	DeGaray	2008/0217024 A1	9/2008	Moore	
9,739,546 B2	8/2017	Bertilsson et al.	2008/0257449 A1	10/2008	Weinstein et al.	
9,745,840 B2	8/2017	Oehring et al.	2008/0264625 A1	10/2008	Ochoa	
9,840,901 B2	12/2017	Oehring et al.	2008/0264649 A1	10/2008	Crawford	
9,863,228 B2	1/2018	Shampine et al.	2008/0277120 A1	11/2008	Hickie	
9,893,500 B2	2/2018	Oehring	2009/0045782 A1	2/2009	Datta	
9,909,398 B2	3/2018	Pham	2009/0065299 A1	3/2009	Vito	
9,915,128 B2	3/2018	Hunter	2009/0072645 A1	3/2009	Quere	
9,932,799 B2	4/2018	Symchuk	2009/0078410 A1	3/2009	Krenek et al.	
9,963,961 B2	5/2018	Hardin	2009/0093317 A1	4/2009	Kajiwarra et al.	
9,970,278 B2	5/2018	Broussard	2009/0095482 A1	4/2009	Surjaatmadja	
9,976,351 B2	5/2018	Randall	2009/0145611 A1	6/2009	Pallini, Jr.	
9,995,218 B2	6/2018	Oehring	2009/0153354 A1	6/2009	Daussin et al.	
10,008,880 B2	6/2018	Vicknair	2009/0188181 A1	7/2009	Forbis	
10,020,711 B2	7/2018	Oehring	2009/0200035 A1	8/2009	Bjerkreim et al.	
10,036,238 B2	7/2018	Oehring	2009/0260826 A1	10/2009	Sherwood	
10,107,086 B2	10/2018	Oehring	2009/0308602 A1	12/2009	Bruins et al.	
10,119,381 B2	11/2018	Oehring	2010/0000508 A1	1/2010	Chandler	
10,184,465 B2	1/2019	Enis et al.	2010/0019574 A1 *	1/2010	Baldassarre	H02J 3/14 307/23
10,196,878 B2	2/2019	Hunter	2010/0038907 A1	2/2010	Hunt	
10,221,639 B2	3/2019	Romer et al.	2010/0045109 A1	2/2010	Arnold	
10,227,854 B2	3/2019	Glass	2010/0051272 A1	3/2010	Loree et al.	
10,232,332 B2	3/2019	Oehring	2010/0132949 A1	6/2010	DeFosse et al.	
10,246,984 B2	4/2019	Payne	2010/0146981 A1	6/2010	Motakef	
10,254,732 B2	4/2019	Oehring	2010/0172202 A1	7/2010	Borgstadt	
10,260,327 B2	4/2019	Kajaria	2010/0250139 A1	9/2010	Hobbs et al.	
10,280,724 B2	5/2019	Hinderliter	2010/0293973 A1	11/2010	Erickson	
10,287,873 B2	5/2019	Filas	2010/0303655 A1	12/2010	Scekic	
10,302,079 B2	5/2019	Kendrick	2010/0322802 A1	12/2010	Kugelev	
10,309,205 B2	6/2019	Randall	2011/0005757 A1	1/2011	Hebert	
			2011/0017468 A1	1/2011	Birch et al.	

US 11,211,801 B2

Page 4

(56)	References Cited			2015/0225113	A1	8/2015	Lungu	
	U.S. PATENT DOCUMENTS			2015/0233530	A1	8/2015	Sandidge	
				2015/0252661	A1*	9/2015	Glass	E21B 43/267 166/308.1
2011/0052423	A1	3/2011	Gambier	2015/0300145	A1	10/2015	Coli et al.	
2011/0061855	A1	3/2011	Case et al.	2015/0300336	A1	10/2015	Hernandez et al.	
2011/0081268	A1	4/2011	Ochoa et al.	2015/0314225	A1	11/2015	Coli et al.	
2011/0085924	A1	4/2011	Shampine	2015/0330172	A1	11/2015	Allmaras	
2011/0110793	A1	5/2011	Leugemors et al.	2015/0354322	A1	12/2015	Vicknair	
2011/0166046	A1	7/2011	Weaver	2016/0006311	A1	1/2016	Li	
2011/0247878	A1	10/2011	Rasheed	2016/0032703	A1	2/2016	Broussard et al.	
2011/0272158	A1	11/2011	Neal	2016/0102537	A1	4/2016	Lopez	
2012/0018016	A1	1/2012	Gibson	2016/0105022	A1*	4/2016	Oehring	E21B 43/26 700/293
2012/0049625	A1	3/2012	Hopwood	2016/0208592	A1	4/2016	Oehring	
2012/0063936	A1	3/2012	Baxter et al.	2016/0160889	A1	6/2016	Hoffman et al.	
2012/0085541	A1	4/2012	Love et al.	2016/0177675	A1	6/2016	Morris et al.	
2012/0127635	A1	5/2012	Grindeland	2016/0177678	A1	6/2016	Morris	
2012/0150455	A1	6/2012	Franklin et al.	2016/0186531	A1	6/2016	Harkless et al.	
2012/0152716	A1	6/2012	Kikukawa et al.	2016/0208593	A1	7/2016	Coli et al.	
2012/0205301	A1	8/2012	McGuire et al.	2016/0208594	A1	7/2016	Coli et al.	
2012/0205400	A1	8/2012	DeGaray et al.	2016/0208595	A1	7/2016	Tang	
2012/0222865	A1	9/2012	Larson	2016/0221220	A1	8/2016	Paige	
2012/0232728	A1*	9/2012	Karimi	2016/0230524	A1	8/2016	Dumoit	
			H02J 3/38 701/22	2016/0230525	A1	8/2016	Lestz et al.	
2012/0247783	A1	10/2012	Berner, Jr.	2016/0258267	A1	9/2016	Payne	
2012/0255734	A1	10/2012	Coli et al.	2016/0265457	A1	9/2016	Stephenson	
2013/0009469	A1*	1/2013	Gillett	2016/0273328	A1	9/2016	Oehring	
			H02J 3/30 307/25	2016/0273456	A1	9/2016	Zhang et al.	
2013/0025706	A1	1/2013	DeGaray et al.	2016/0281484	A1	9/2016	Lestz	
2013/0175038	A1	7/2013	Conrad	2016/0290114	A1	10/2016	Oehring	
2013/0175039	A1	7/2013	Guidry	2016/0290563	A1	10/2016	Diggins	
2013/0180722	A1	7/2013	Olarte Caro	2016/0312108	A1	10/2016	Lestz et al.	
2013/0189629	A1	7/2013	Chandler	2016/0319650	A1	11/2016	Oehring	
2013/0199617	A1	8/2013	DeGaray et al.	2016/0326853	A1	11/2016	Fred et al.	
2013/0233542	A1	9/2013	Shampine	2016/0326854	A1	11/2016	Broussard	
2013/0255271	A1	10/2013	Yu et al.	2016/0326855	A1	11/2016	Coli et al.	
2013/0284278	A1	10/2013	Winborn	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	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	
			H02J 3/46 307/65	2017/0030178	A1	2/2017	Oehring et al.	
2014/0060658	A1	3/2014	Hains	2017/0036178	A1	2/2017	Coli et al.	
2014/0095114	A1	4/2014	Thomeer	2017/0036872	A1	2/2017	Wallace	
2014/0096974	A1*	4/2014	Coli	2017/0037717	A1	2/2017	Oehring	
			E21B 43/26 166/358	2017/0037718	A1	2/2017	Coli et al.	
2014/0124162	A1	5/2014	Leavitt	2017/0043280	A1	2/2017	Vankouwenberg	
2014/0138079	A1	5/2014	Broussard	2017/0051732	A1	2/2017	Hernandez et al.	
2014/0174717	A1	6/2014	Broussard et al.	2017/0074076	A1	3/2017	Joseph et al.	
2014/0219824	A1	8/2014	Burnette	2017/0082033	A1	3/2017	Wu et al.	
2014/0238683	A1	8/2014	Korach	2017/0096885	A1	4/2017	Oehring	
2014/0246211	A1	9/2014	Guidry et al.	2017/0096889	A1	4/2017	Blanckaert et al.	
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	2017/0204852	A1	7/2017	Barnett	
2015/0083426	A1	3/2015	Lesko	2017/0212535	A1	7/2017	Shelman et al.	
2015/0097504	A1	4/2015	Lamascus	2017/0218727	A1	8/2017	Oehring	
2015/0114652	A1	4/2015	Lestz	2017/0218843	A1	8/2017	Oehring	
2015/0136043	A1	5/2015	Shaaban	2017/0222409	A1	8/2017	Oehring	
2015/0144336	A1	5/2015	Hardin et al.	2017/0226838	A1	8/2017	Ciezobka	
2015/0147194	A1	5/2015	Foote	2017/0226839	A1	8/2017	Broussard	
2015/0159911	A1	6/2015	Holt	2017/0226842	A1	8/2017	Omont et al.	
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					

(56)

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

2017/0313499	A1	11/2017	Hughes et al.	
2017/0314380	A1	11/2017	Oehring	
2017/0314979	A1	11/2017	Ye et al.	
2017/0328179	A1	11/2017	Dykstra	
2017/0369258	A1	12/2017	DeGaray	
2017/0370639	A1	12/2017	Barden et al.	
2018/0028992	A1	2/2018	Stegemoeller	
2018/0038216	A1	2/2018	Zhang	
2018/0045331	A1	2/2018	Lopez	
2018/0090914	A1	3/2018	Johnson et al.	
2018/0156210	A1	6/2018	Oehring	
2018/0181830	A1	6/2018	Luharuka et al.	
2018/0183219	A1	6/2018	Oehring	
2018/0216455	A1	8/2018	Andreychuk	
2018/0238147	A1	8/2018	Shahri	
2018/0245428	A1	8/2018	Richards	
2018/0258746	A1*	9/2018	Broussard	E21B 43/26
2018/0259080	A1	9/2018	Dale et al.	
2018/0266217	A1	9/2018	Funkhauser et al.	
2018/0266412	A1	9/2018	Stokkevag	
2018/0274446	A1	9/2018	Oehring	
2018/0284817	A1	10/2018	Cook et al.	
2018/0291713	A1	10/2018	Jeanson	
2018/0298731	A1	10/2018	Bishop	
2018/0312738	A1	11/2018	Rutsch et al.	
2018/0313677	A1	11/2018	Warren et al.	
2018/0320483	A1	11/2018	Zhang	
2018/0343125	A1	11/2018	Clish	
2018/0363437	A1	12/2018	Coli	
2018/0363640	A1	12/2018	Kajita et al.	
2019/0003329	A1	1/2019	Morris	
2019/0010793	A1	1/2019	Hinderliter	
2019/0040727	A1	2/2019	Oehring et al.	
2019/0063309	A1*	2/2019	Davis	F02B 63/047
2019/0100989	A1	4/2019	Stewart	
2019/0112910	A1	4/2019	Oehring	
2019/0119096	A1	4/2019	Haile	
2019/0120024	A1	4/2019	Oehring	
2019/0128080	A1	5/2019	Ross	
2019/0128104	A1	5/2019	Graham et al.	
2019/0145251	A1	5/2019	Johnson	
2019/0154020	A1	5/2019	Glass	
2019/0162061	A1	5/2019	Stephenson	
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	
2019/0257462	A1	8/2019	Rogers	
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	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	104117308	A	10/2014
CN	104196613	A	12/2014
CN	205986303	U	2/2017
CN	108049999	A	5/2018
CN	112196508	A	1/2021
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

Non-Final Office Action issued in corresponding U.S. Appl. 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.

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.

(56)

References Cited**OTHER PUBLICATIONS**

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.
 Candian 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.
 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.
 Office Action dated Jun. 11, 2019 in corresponding U.S. Appl. No. 16/210,749.
 Office Action dated May 10, 2019 in corresponding U.S. Appl. No. 16/268,030.
 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.
 Office Action dated Jun. 7, 2019 in corresponding 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.
 Canadian Office Action dated Oct. 1, 2019 in related Canadian Patent Application No. 2,936,997.

International Search Report and Written Opinion dated Jan. 2, 2020 in related PCT Application No. PCT/US19/55325.
 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.
 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.
 Office Action dated Jun. 29, 2020 in related U.S. Appl. No. 16/728,359.
 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.
 Canadian Office Action dated Aug. 17, 2020 in related CA Patent Application No. 2,944,968.
 Non-Final Office Action dated Mar. 31, 2020 issued in U.S. Appl. No. 15/356,436.
 Final Office Action dated Mar. 3, 2020 issued in U.S. Appl. No. 16/152,695.
 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).
 Morris et al., U.S. Appl. No. 62/526,869; Hydration-Blender Transport and Electric Power Distribution for Fracturing Operation; filed 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.
 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.

(56)

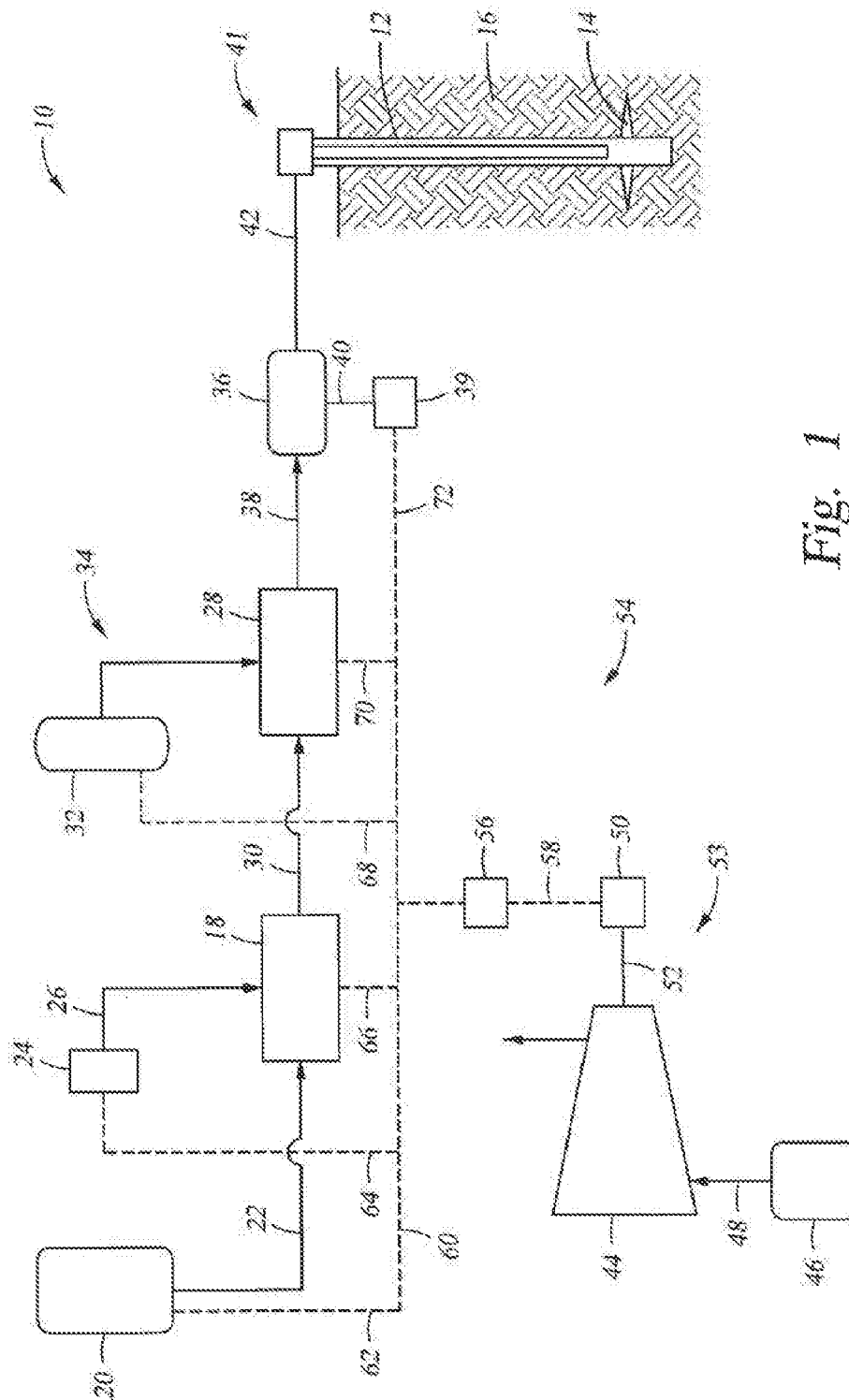
References Cited

OTHER PUBLICATIONS

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/sloii-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.

International Search Report and Written Opinion mailed in PCT/US20/67526 dated May 6, 2021.
 International Search Report and Written Opinion mailed in PCT/US20/67608 dated Mar. 30, 2021.
 International Search Report and Written Opinion mailed in PCT/US20/67528 dated Mar. 19, 2021.
 International Search Report and Written Opinion mailed in PCT/US20/67146 dated Mar. 29, 2021.
 International Search Report and Written Opinion mailed in PCT/US20/67523 dated Mar. 22, 2021.
 International Search Report and Written Opinion mailed in PCT/US2020/066543 dated Mar. 11, 2021.
 Non-Final Office Action issued in U.S. Appl. No. 16/871,928 dated Aug. 25, 2021.
 Non-Final Office Action issued in U.S. Appl. No. 16/943,727 dated Aug. 3, 2021.
 Non-Final Office Action issued in U.S. Appl. No. 14/881,525 dated Jul. 21, 2021.
 Non-Final Office Action issued in U.S. Appl. No. 16/404,283 dated Jul. 21, 2021.
 Notice of Allowance and Notice of Allowability issued in U.S. Appl. No. 15/829,419 dated Jul. 26, 2021.
 Woodbury et al., "Electrical Design Considerations for Drilling Rigs," IEEE Transactions on Industry Applications, vol. 1A-12, No. 4, Jul./Aug. 1976, pp. 421-431.

* cited by examiner



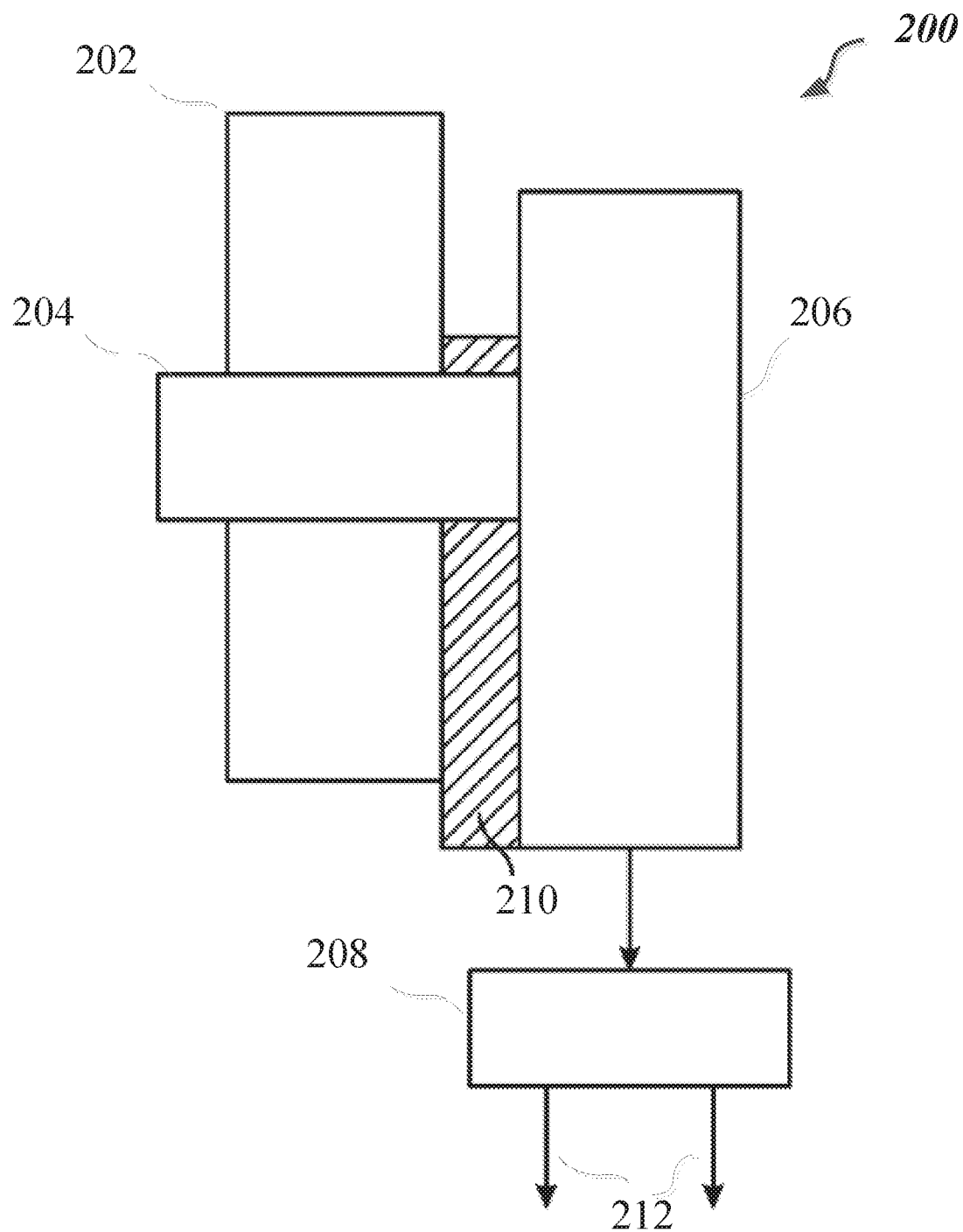


Fig. 2

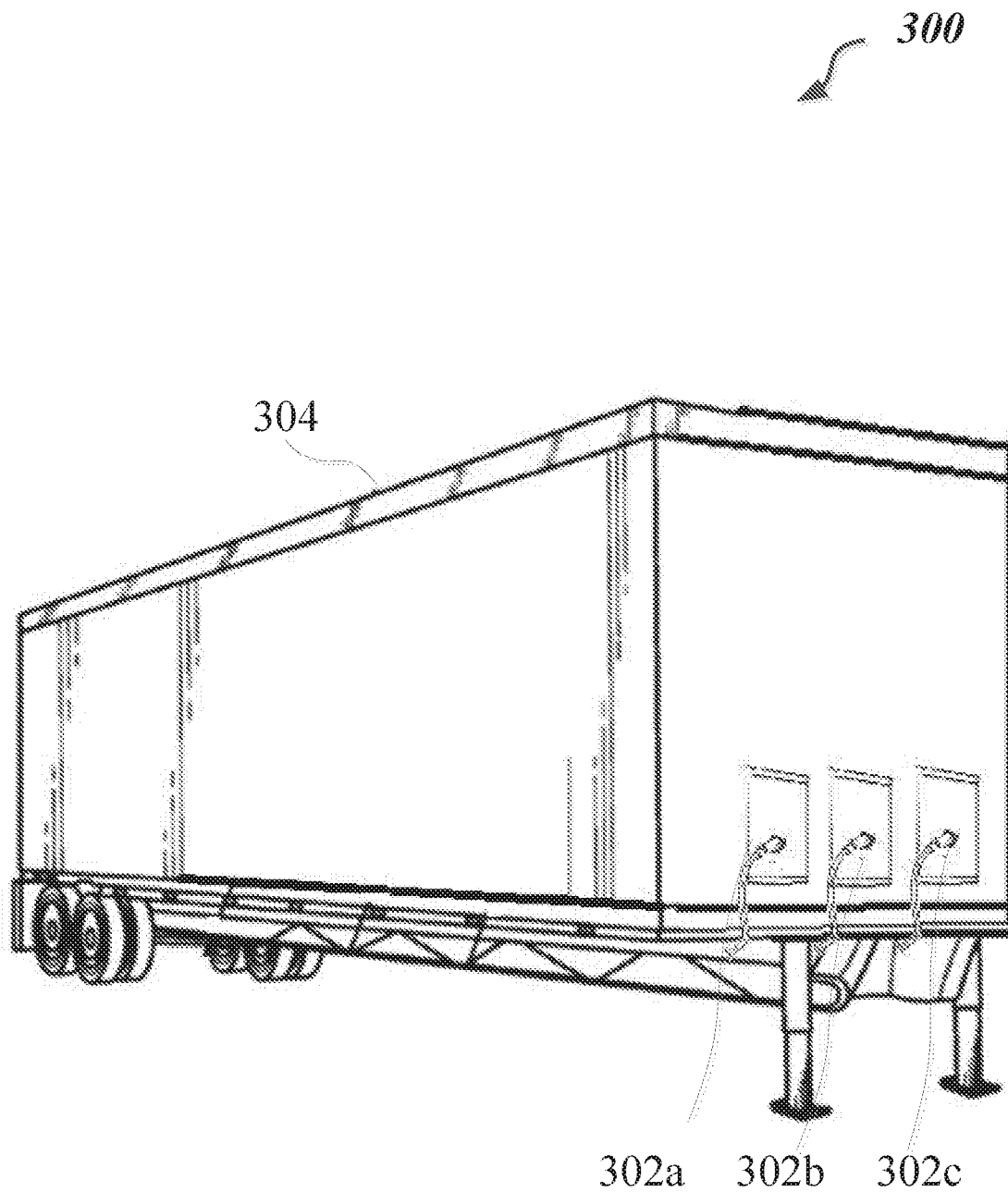


Fig. 3

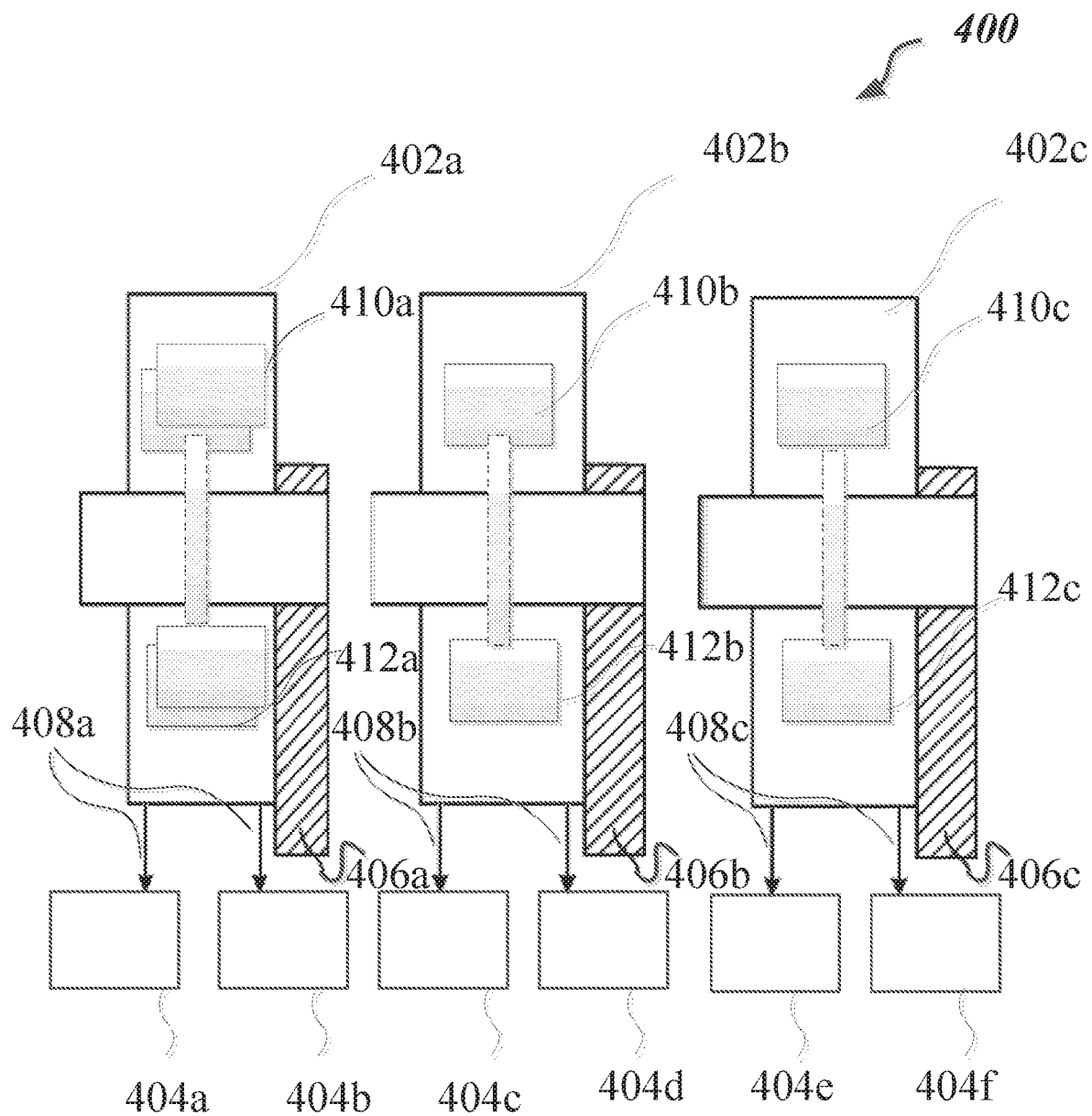


Fig. 4

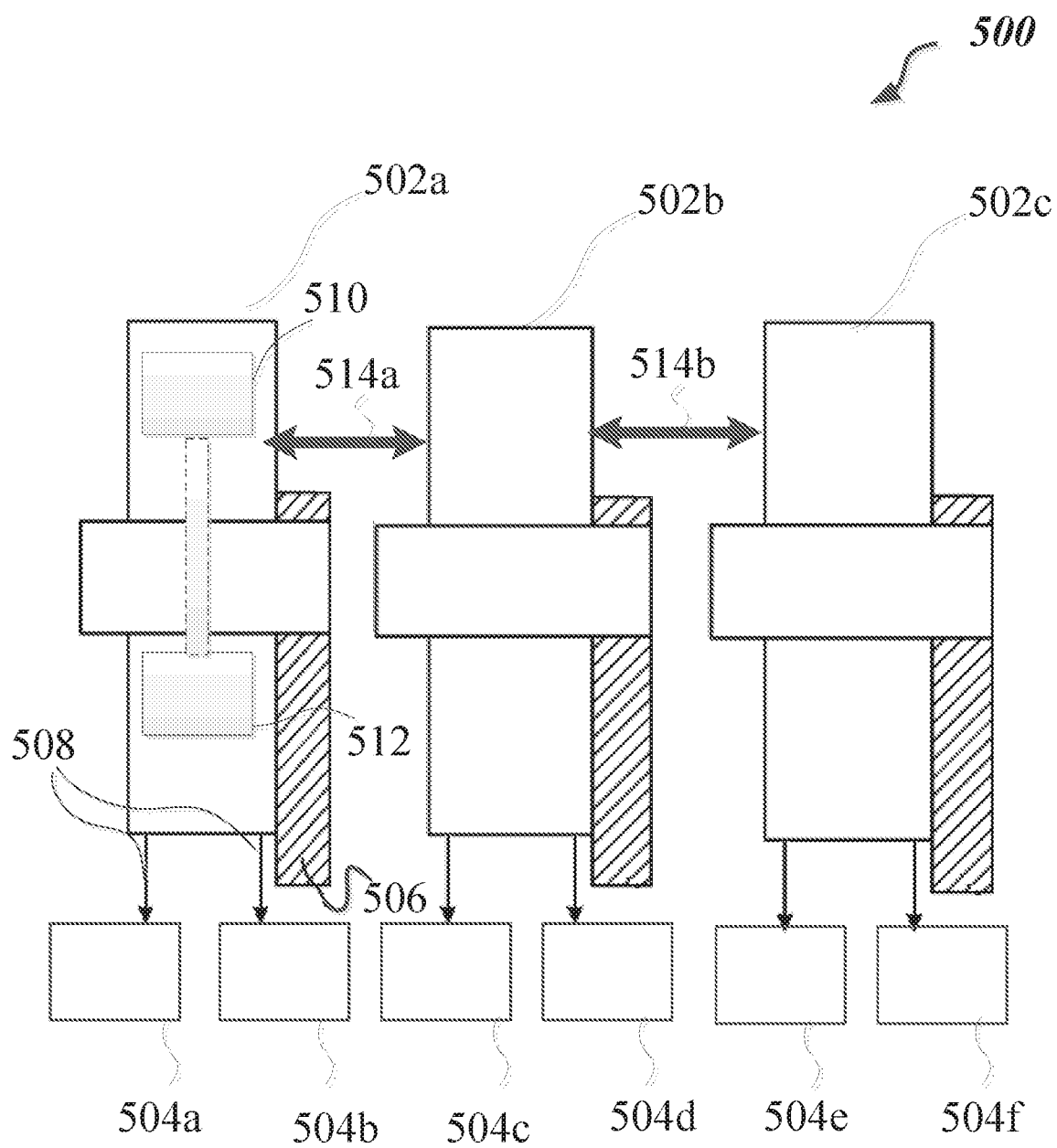


Fig. 5

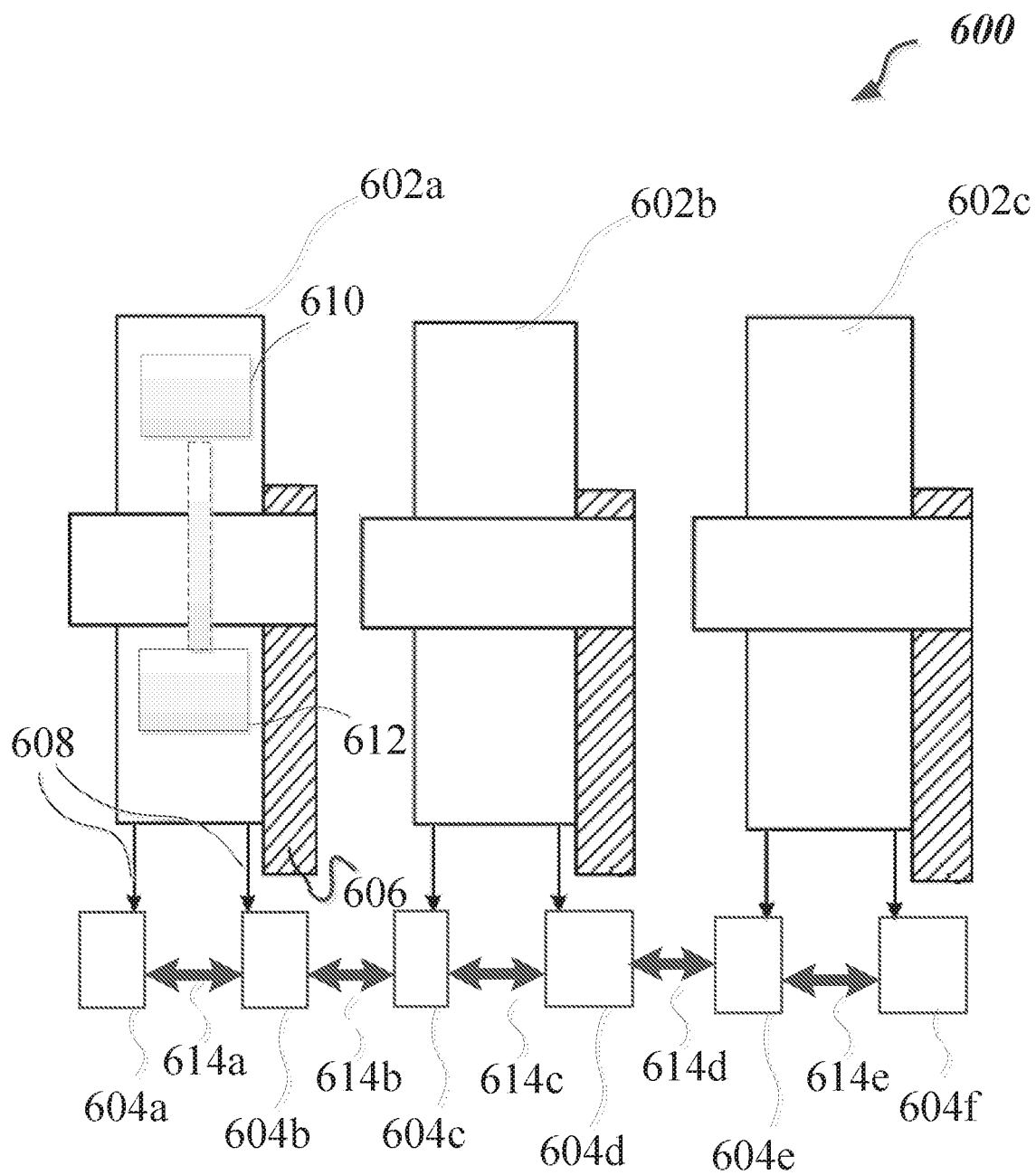
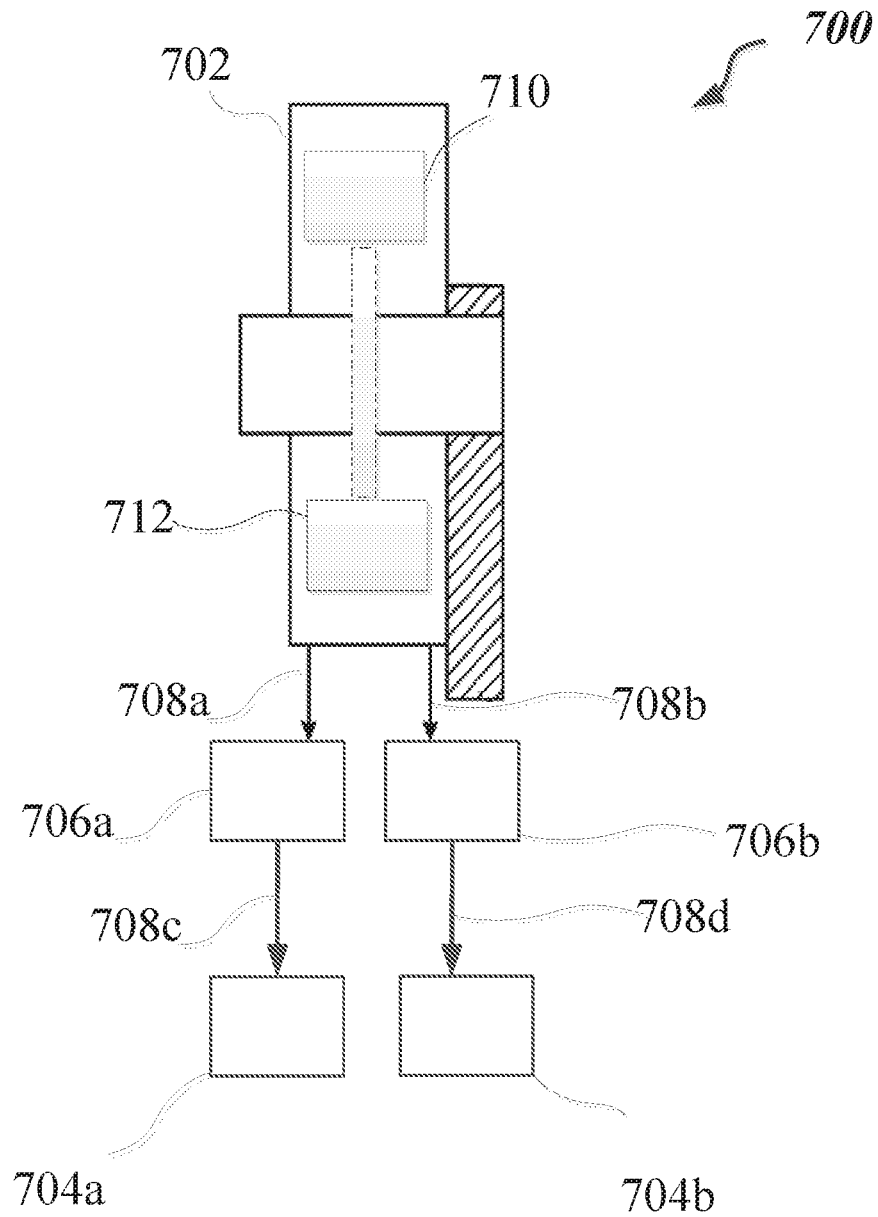


Fig. 6

*Fig. 7*

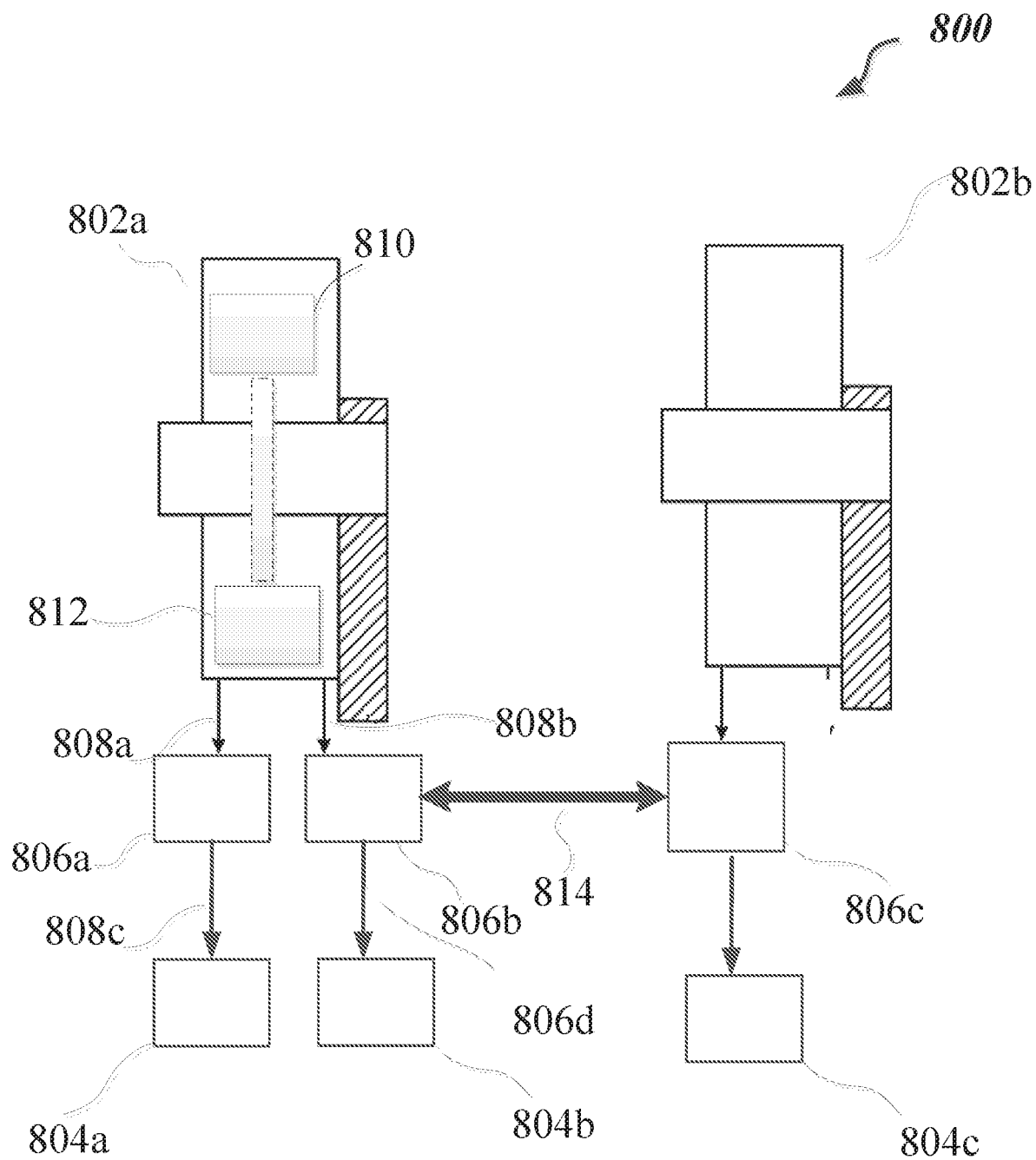


Fig. 8

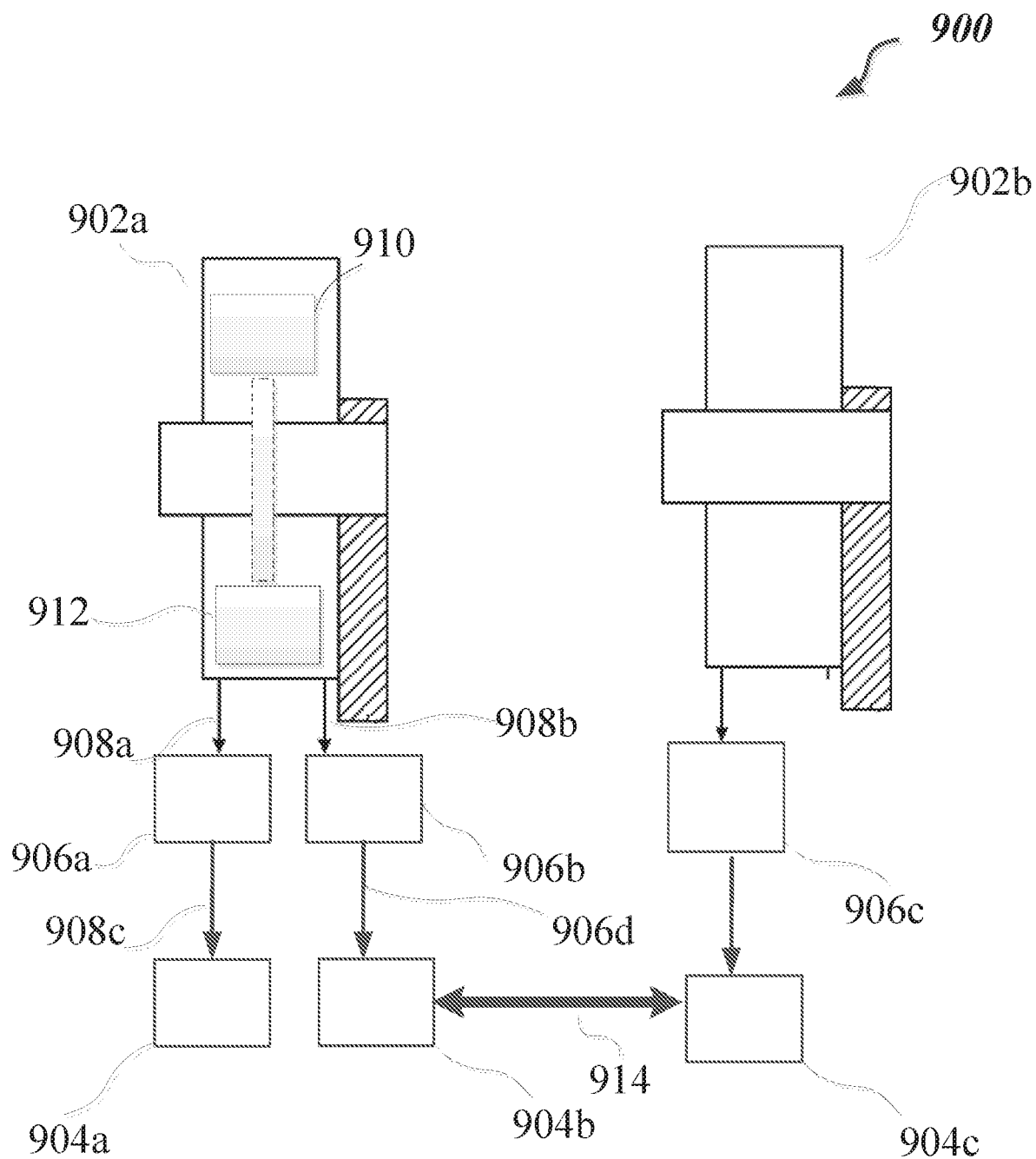


Fig. 9

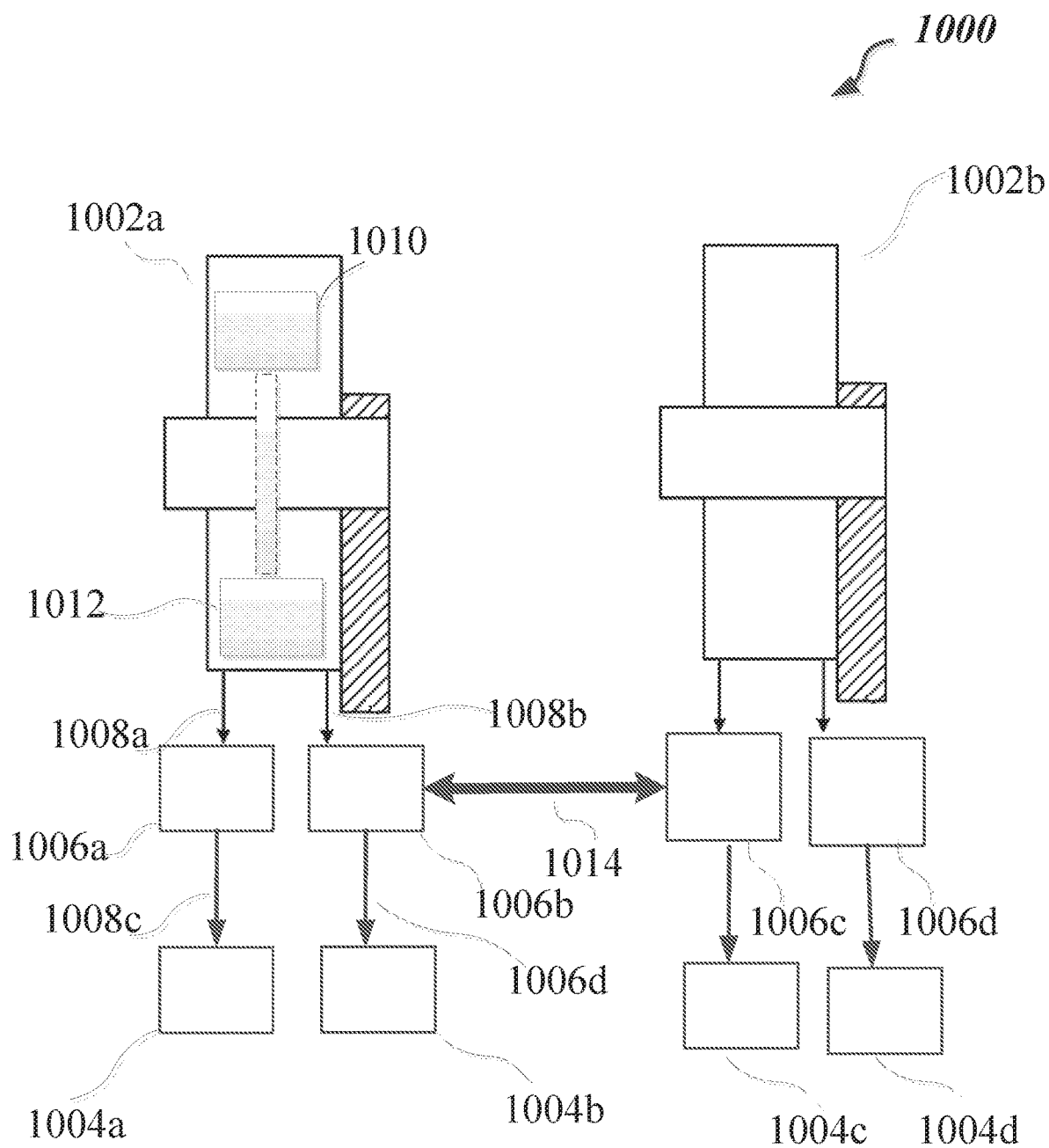
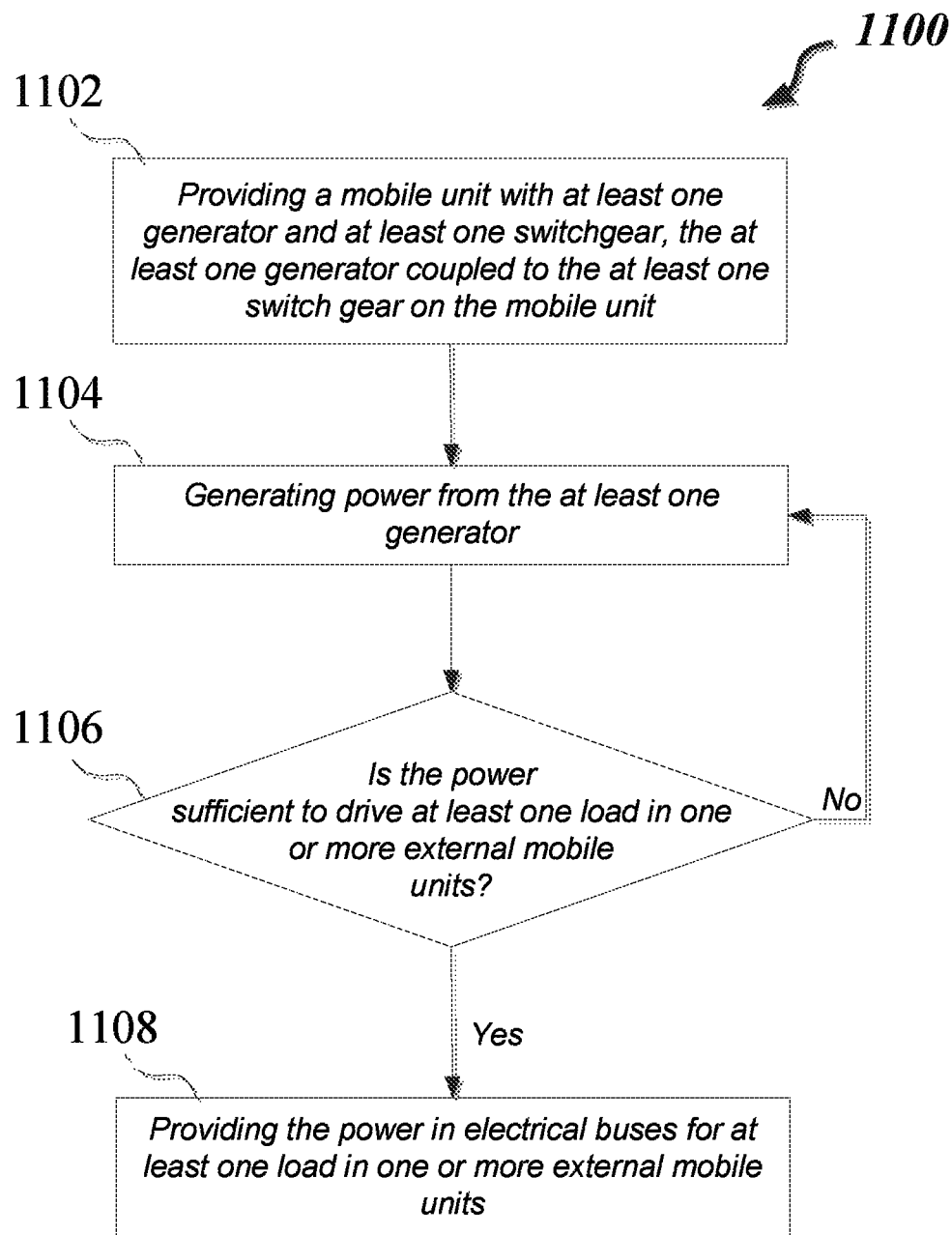


Fig. 10

**Fig. 11**

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**INTEGRATED MOBILE POWER UNIT FOR
HYDRAULIC FRACTURING****RELATED APPLICATION**

The present disclosure is related to and claims priority from U.S. Provisional Application 62/685,797, titled INTEGRATED MOBILE POWER UNIT FOR HYDRAULIC FRACTURING, filed on Jun. 15, 2018, the entirety of the disclosure of which is incorporated by reference herein.

BACKGROUND**1. Field of Invention**

The present disclosure generally relates to hydraulic fracturing. In particular, the present disclosure relates to mobile grid assembly for powering an electric hydraulic fracturing pump in limited space environments.

2. Related Technology

Fracturing, such as hydraulic fracturing, stimulates production from hydrocarbon producing wells. Such a process may utilize mobile systems for injection of fluid into wellbores at pressure to provide subterranean fissures in the area around the wellbores. Such a process relies on fracturing fluid slurry that has been pressurized using high pressure pumps. As this is a mobile process, the high pressure pumps are mounted on mobile surfaces—e.g., truck-beds, trailers, etc. Moreover, the high pressure pumps are powered by mobile power sources, such as diesel engines. However, the components, such as the high pressure pumps and associated power sources have large volume and mass. As such, the mobile surfaces may be heavy duty trailers, trucks, or skids that are used for transporting these components to remote sites where wellbores are being fractured. The components support hydraulic fracturing pumps that draw low pressure fluid slurry (at approximately 100 psi). The discharge of the same fluid slurry, however, is at high pressures of up to 15,000 psi or more. In addition, alternate mobile power sources, such as turbine generators, are available to perform the power functions of the diesel engines. At the remote site, the power sources are electrically connected to power the fracturing components. For example, motors for pressurizing fracturing and hydraulic fluids are connected to the power sources using power buses. Electrical connections may be complex, unsafe, unreliable, and may include numerous configurations requiring space and time to resolve.

SUMMARY

Herein disclosed are examples of a hydraulic fracturing system that includes a singular mobile platform of at least one mobile power unit (MPU) and at least one first switch gear that is configured to handle electric power from the MPU. The at least one MPU is configured to generate voltage that matches the requirements of load and an electrical bus of the at least one first switch gear, such that a combined electrical current generated as a result of the generated voltage is provided through the electrical bus to the components of the hydraulic fracturing system. Further, the hydraulic fracturing system may include electrical fracturing equipment with at least one second switch gear to support the at least one first switch gear in handling electric power from the at least one MPU. Automated control

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software may be included in the system to control load shedding, load sharing, and power distribution for the electrical fracturing equipment comprising the at least one second switch gear. In addition, the switchgear may be separate units or incorporated into the MPUs. Fracturing equipment, including the electrical load, may include specific voltage and current requirements. The electrical bus is, therefore, sized to match the MPU's capabilities based on the load requirements. Electrical buses may be rated in terms of maximum capability before failure, such as a voltage class of 5000V, 15000V, or 25000V, and having a current rating such as 1200 A, 2000 A, or 3000 A.

BRIEF DESCRIPTION OF THE DRAWINGS

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:

FIG. 1 is a schematic of an example hydraulic fracturing system in accordance with embodiments of the present disclosure.

FIG. 2 is an elevation schematic of example portions of an MPU, including at least a turbine, generator, and EER in one or more trailers.

FIG. 3 is an end perspective view of an example of a mobile platform that includes one or more mobile power units (MPUs) that is integrated to or with switch gear components, according to embodiments in the present disclosure.

FIG. 4 is an elevation schematic of portions of the hydraulic fracturing system in accordance with one example configuration of the embodiments herein.

FIG. 5 is an elevation schematic of portions of a hydraulic fracturing system in accordance with another example configuration of the embodiments herein.

FIG. 6 is an elevation schematic of portions of a hydraulic fracturing system in accordance with yet another example configuration of the embodiments herein.

FIG. 7 is an elevation schematic of portions of a hydraulic fracturing system in accordance with further example configurations available using the embodiments herein.

FIG. 8 is an elevation schematic of portions of a hydraulic fracturing system according to other example configurations of the embodiments herein.

FIG. 9 is an elevation schematic of portions of a hydraulic fracturing system according to other example configurations of the embodiments herein.

FIG. 10 is an elevation schematic of portions of a hydraulic fracturing system according to other example configurations of the embodiments herein.

FIG. 11 is a flowchart of a hydraulic fracturing method using the example configurations of the embodiments herein.

While the invention will be described in connection with the preferred embodiments, it will be understood that it is not intended to limit the invention to that embodiment. Instead, the preferred embodiments are 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 THE
DISCLOSURE**

So that the manner in which the features and advantages of the embodiments of hydraulic fracturing system and

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associated methods, as well as others, which will become apparent, may be understood in more detail, a more particular description of the embodiments of the present disclosure briefly summarized previously may be had by reference to the embodiments thereof, which are illustrated in the appended drawings, which form a part of this specification. It is to be noted, however, that the drawings illustrate only various embodiments of the disclosure and are therefore not to be considered limiting of the present disclosure's scope, as it may include other effective embodiments as well.

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.

One system and method for powering electrical equipment from a generator uses a physically separate mobile unit with switch gear installed to act as an electrical distribution hub between the MPUs and electric fracturing equipment of a hydraulic fracturing system. The separate mobile unit is, therefore, physically external relative to a mobile unit hosting the generator and switch gear, for instance. In such an implementation, cables are used to supply power from the MPUs to the mobile switch gear unit and between the mobile switch gear unit to the electric fracturing equipment. Here, fleet wide load sharing and load shedding are available, but such an implementation requires more mobile equipment and power cables. Alternatively, another system and method uses a smaller and less versatile Electronic Equipment Room (EER), with switch gear for the generator, to directly power a small amount of electric equipment. Such a system and method may require lesser physical equipment, but is also electrically limited. For example, such limitations may be for load sharing and load shedding, which may be limited to only the equipment being supplied by a single MPU.

The present embodiments, by at least an MPU working with the switch gear in a single platform or unit resolves the additional issues noted above with the system and methods for a physically separate (e.g., external) mobile unit and an EER. For example, the present implementation at least ensures that MPUs are configured with adequate bus work to carry the generated voltage and current from the MPU's generator. This is further supported by the single platform or unit with reduced cabling and complexity with the MPU sharing space with the switch gear, for instance. The present implementation works with well sites where space is limited and rapid mobilization and demobilization is required. With integrated components on a single skid, for example, fewer physical connections are needed to be established or stowed during transportation. In an example, mobilization and

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demobilization of a single MPU are then limited to oilfield functions, such as pump down jobs, injection testing, toe preps, low hydraulic horsepower jobs, or to supplement other equipment types (diesel, dual fuel). In addition, extra MPUs and pumps can be used to perform fracturing jobs with high hydraulic horsepower requirements.

Furthermore, the use of integrated switch gear with the MPU eliminates the need for a separate switch gear trailer or skid. This allows for fewer trailers and fewer interconnecting cables saving space and time during mobilization/demobilization. With fewer trailers and cables, capital and maintenance costs are also beneficially addressed by the present implementation. The method of equipment deployment, in the present implementation, is also modular and scalable as turbines of the MPU can be added to directly to power the electric fracturing pumps as needed without the need to add additional switch gear trailers or modify existing trailers with additional gear and cable connections. A complexity sought to be addressed herein is a difficulty to implement a common bus where much of the equipment is on the same circuit. As such, the common bus of the present disclosure supports the voltage and combined current requirements of the various equipment loads. At fracturing sites, fracturing pumps may be inoperable because of fluid distribution problems, mechanical problems, communication problems, control problems, pump problems, sensor problems, etc. While these are unrelated to the electric power generation requirements discussed herein, without a common electrical bus, excess power from a turbine generator cannot be redistributed to other equipment which will limit redundancy in equipment and may cause situations where extra turbines and fracturing pumps will need to be on standby in the event of failures. Other oilfield equipment may be connected to the common electrical bus. In an example, the other oilfield equipment includes intensifier pumps, blenders, dual blenders, hydration units, chemical additive units, data van, sand equipment, lights, CNG equipment, LNG equipment, gas compression, gas filtration, wireline, water transfer, flow back, coil tubing, nitrogen, cementing, dual pumper, drilling rigs, cranes, and workover rigs. There may also be a case where, when a turbine generator fails, the fracturing pumps or other equipment which are electrically tied to it will be rendered inoperable and power will not be available from other generators due to a lack of a common bus for power distribution. As such, the present implementation overcomes these additional issues by load sharing switch gear added to the MPUs in the same trailer or to other connected equipment, but working with the switch gear of the MPUs as discussed throughout this disclosure.

One of ordinary skill would recognize that there are space constraints of mobile equipment. As such, the turbine engine and generators of the MPU in the present implementation may need to be smaller to accommodate the extra integrated switch gear. The reduction in size and capability can create situations where extra MPUs will be needed on well sites with higher hydraulic horsepower requirements. However, to save space and weight, alternative engines and generators may be used (such as aeroderivative turbines or reciprocating engines). Many light and compact turbines may also struggle to burn wide ranges of fuel gas and may need support equipment if the upper or lower heating values are out of the required range, but with the present implementation, redundancies are widely applied to assist with any of these constraints.

The present disclosure, in an embodiment, is to a system including a mobile unit, at least one generator; and at least

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one switch gear. The at least one generator is coupled to the at least one switch gear on the mobile unit forming a singular and integrated mobile unit. The mobile unit is configured to provide power generated by the at least one generator in electrical buses for at least one load on one or more external mobile unit. In another embodiment, a method is disclosed and includes providing a mobile unit with at least one generator and at least one switchgear, such as a system as described above. The at least one generator is coupled to the at least one switch gear on the mobile unit. The method includes generating power from the at least one generator and providing the power in electrical buses for at least one load in one or more external mobile units. The system may be part of a hydraulic fracturing system that consumes the power and that includes a wellbore and at least one pressurizing system to create fractures in a subterranean formation that surrounds the wellbore.

FIG. 1 is a schematic of an example hydraulic fracturing system 10 in accordance with embodiments of the present disclosure. Such a system may be used for pressurizing a wellbore 12 to create fractures 14 in a subterranean formation 16 that surrounds the wellbore 12. System 10 may include a hydration unit 18 that receives fluid from a fluid source 20 via line 22, and may also receive additives from an additive source 24 via line 26. Additive source 24 can be separate from the hydration unit 18 as a stand-alone unit, or can be included as part of the same unit as the hydration unit 18. The fluid, which in one example is water, is mixed inside of the hydration unit 18 with the additives. The fluid and additives are mixed over a period of time to allow for uniform distribution of the additives within the fluid.

In the example of FIG. 1, the fluid and additive mixture is transferred to a blender unit 28 via line 30. A proppant source 32 contains proppant, which is delivered to the blender unit 28 as represented by line 34, where line 34 can be a conveyor. Inside the blender unit 28, the proppant and fluid/additive mixture are combined to form a fracturing slurry, which is then transferred to a fracturing pump system 36 via line 38; thus fluid in line 38 includes the discharge of blender unit 28 which is the suction (or boost) for the fracturing pump system 36. Blender unit 28 can have an onboard chemical additive system, such as with chemical pumps and augers (not shown). Optionally, additive source 24 can provide chemicals to blender unit 28; or a separate and standalone chemical additive system (not shown) can be provided for delivering chemicals to the blender unit 28. In an example, the pressure of the slurry in line 38 ranges from around 80 psi to around 120 psi. The pressure of the slurry can be increased up to around 15,000 psi by pump system 36. A motor 39, which connects to pump system 36 via connection 40, drives pump system 36 so that it can pressurize the slurry.

In one example, the motor 39 is controlled by a variable frequency drive ("VFD"). After being discharged from pump system 36, slurry is injected into a wellhead assembly 41; discharge piping 42 connects discharge of pump system 36 with wellhead assembly 41 and provides a conduit for the slurry between the pump system 36 and the wellhead assembly 41. In an alternative, hoses or other connections can be used to provide a conduit for the slurry between the pump system 36 and the wellhead assembly 41. Optionally, any type of fluid can be pressurized by the fracturing pump system 36 to form a fracturing fluid that is then pumped into the wellbore 12 for fracturing the formation 14, and is not limited to fluids having chemicals or proppant. Examples exist wherein the system 10 includes multiple pumps 36, and multiple motors 39 for driving the multiple pumps 36.

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Examples also exist wherein the system 10 includes the ability to pump down equipment, instrumentation, or other retrievable items through the slurry into the wellbore.

FIG. 1 additionally provides an example turbine 44, which receives a combustible fuel from a fuel source 46 via a feed line 48. In an example, the turbine is part of a Mobile Power Unit (MPU) or platform. The MPU may be a trailered, bodyload, or skid mounted electrical power generation unit which can use the turbine or reciprocating engine for power generation. Such a turbine or reciprocating engine can be fueled by the combustible fuel, such as diesel or natural gas, to function as an electrical generator. The MPU can comprise of one or more trailers, composed of the generator, the electrical switching gear, a prime mover (engine), auxiliary loads (cooling, heating, lubricating, diagnostics and control equipment), and fire suppression equipment. The fire suppression equipment can be located on a single chassis, or each on separate chassis or any combination thereof for mobilization purposes which are mechanically or electrically connected while in operation to act as a single power generation unit.

In one example, the fuel source 46 can be a natural gas pipeline, CNG, LNG, or a well proximate the turbine 44. Combustion of the fuel in the turbine 44 in turn powers a generator 50 that produces electricity. Shaft 52 connects generator 50 to turbine 44. The combination of the turbine 44, generator 50, and shaft 52 define a turbine generator 53. In another example, gearing can also be used to connect the turbine 44 and generator 50. An example of a micro-grid 54 is further illustrated in FIG. 1, and which distributes electricity generated by the turbine generator 53. Included with the micro-grid 54 is an optional transformer 56 for stepping up or down voltage of the electricity generated by the generator 50 to a voltage more compatible for use by electrical powered devices in the hydraulic fracturing system 10.

A "split bus" (e.g., dual or triple, or more microgrid) or "single bus" (e.g., microgrid) electric hydraulic fracturing fleet may be available to function with the present disclosure. As used herein, the microgrid may be an off-utility power grid that is closed circuit and self-contained. For example, the microgrid may include at least one electricity generator, one switch gear component, and one active electrical load. The microgrid may also be synced with the utility power grid and pull additional power from the utility power grid. The utility power may be unable to provide all of the needed power for oilfield hydraulic fracturing, drilling, intervention, and other oilfield services; and the use of the microgrid is to supplement or replace the utility power. The split or single bus use external switch gear trailers which are physically separate from the MPU to provide extra switch gear (e.g., breakers, relays, electrical buses) to allow electrical power to be placed on a common bus (e.g., combining the power of two or more generators). The present disclosure, via at least FIGS. 3 to 9, provide novel packaging of the MPU and at least the switch gear to allow a savings on quantity of trailers and to reduce the complexity of the electrical connections. Such a reduction may be by reducing a number of interconnecting power cables. This reduction in equipment will not reduce functionality but will improve mobilization times and simplicity of interfacing various components of the hydraulic fracturing system 10, while reducing space required on a well site as well as capital cost and maintenance costs. In an example, such equipment may include hydraulic fracturing equipment that represents an electrical load addressed by the MPU of the present disclosure. As such the equipment can include hydraulic fracturing

pumps, hydration units, chemical units, blenders, proppant storage, conveyer belts, lights, datavans, cranes, wireline equipment, monitoring equipment, water pumps, compressors, heaters, and other supporting equipment.

The switch gear may be any gear such as breakers, switches, and relays that are used to control the distribution of electricity. Electrical safety and diagnostics may also be provided by the switch gear. Each MPU may include at least one large breaker for connecting and disconnecting its own generator from the electrical load. The MPUs may be limited in how much switch gear can be integrated into its chassis due to size and weight requirements for mobility. Many times a separate electronic equipment room is used to supplement the generator to provide switch gear support or dedicated switch gear units (trailers, skids, bodyload trucks) are used to provide load sharing and greater distribution.

In another example, the power generated by the turbine generator and the power utilized by the electrical powered devices in the hydraulic fracturing system **10** are of the same voltage, such as 4160 V so that main power transformers are not needed other than as isolation transformers. In one embodiment, multiple 3500 kVA dry cast coil transformers are utilized. Electricity generated in generator **50** is conveyed to transformer **56** via line **58**. In another embodiment, a step-up transformer is provided for transformer **56**, where the secondary voltage of the step-up transformer is higher than its primary voltage. Such a usage may be advantageous for remote power transmission to limit transmission losses. In one example, transformer **56** steps the voltage down from 13.8 kV to around 600 V. Other example step down voltages include 4,160 V, 480 V, or other voltages. The output or low voltage side of the transformer **56** connects to a power bus **60**, lines **62**, **64**, **66**, **68**, **70**, and **72** connect to power bus **60** and deliver electricity to electrically powered end users in the system **10**. In another example, line **62** connects fluid source **20** to bus **60**, line **64** connects additive source **24** to bus **60**, line **66** connects hydration unit **18** to bus **60**, line **68** connects proppant source **32** to bus **60**, line **70** connects blender unit **28** to bus **60**, and line **72** connects motor **39** to bus **60**. In an example, additive source **24** contains ten or more chemical pumps for supplementing the existing chemical pumps on the hydration unit **18** and blender unit **28**. Chemicals from the additive source **24** can be delivered via lines **26** to either the hydration unit **18** and/or the blender unit **28**. In one embodiment, the elements of the system **10** are mobile and can be readily transported to a wellsite adjacent the wellbore **12**, such as on trailers or other platforms equipped with wheels or tracks.

FIG. 2 is an elevation schematic of example portions **200** of the hydraulic fracturing system **10** of FIG. 1. FIG. 1 particularly illustrates some basic components of the hydraulic fracturing system **10** at a wellbore site for providing electrical load sharing. An MPU **200** includes a turbine generator **202** that may be supported by a natural gas turbine engine coupled to a three-phase, 60 hertz (Hz) electric generator to produce power as the turbine engine rotates. In an alternative, the generator can generate electricity at 50 Hz, or at any other frequency useful for hydraulic fracturing fleets. In the illustrated embodiment, the MPU includes components with reference numerals **202**, **204**, **206**, and **210**. Reference numeral **202** is a turbine generator mounted within a trailer, for example. However, references to the turbine generator are interchangeably used with reference to a trailer including these components, and the reference numeral **202**. The same applies to reference numeral **204** providing an air intake filter, to reference numeral **206** providing an EER (sometimes referred to as a

control trailer), and to reference numeral **210** providing a walk area. As such, the MPU is shown as including an electronic equipment room (EER) **206**, which can house wiring, breakers, controls, monitoring systems, fire suppression support, auxiliary transformers, and a battery bank for secondary power when the turbine generator is not operating and there is no other power source. Some of the auxiliary components in the EER, such as the fans, lube motors, valves, etc., as well as some of the support equipment, such as gas compressors, gas heaters, and filtration systems, use lower voltage than what is generated. In an example, such lower voltages may be 120V, 240V, and 480V. The auxiliary transformer, in another example, is smaller than the fracturing pump step down transformers. FIG. 1 also illustrates an air intake filter house **204** that may be positioned on top of or adjacent to the MPU turbine generator arrangement **202**, and a walk area **210** that may be connected to the MPU turbine generator arrangement **202** and EER **206** to enable personnel access. The example portions **200** can be taken as an example of an electrical microgrid.

In an example, the EER **206** may include other components than recited above and may be named differently but performs the general functions noted above. For example, the EER **206** is a support unit that may be part of the MPU and may include communications, switch gear, fire suppression, motor control center (MCC) for auxiliary loads, technician monitoring space, battery backups for critical auxiliary equipment, transformers, air compressors, and data monitoring/recording. The MPU may have a dedicated trailer for these components alone, while other have parts of this may be integrated into the generator spaces of the MPU.

In some examples, the battery bank of the EER **206** can power lighting, fire suppression, emergency turbine lube pumps, and onboard electronics. A switch gear trailer **208** may provide output **212** for power distribution, high voltage breakers, and "lock-out, tag-out" capabilities. "Lock-out, tag-out" is an understood safety procedure to ensure that dangerous machines are properly shut off and not able to be started up again prior to the completion of maintenance or servicing work.

FIG. 3 is an end perspective view of an example of a mobile platform **300** that includes one or more mobile power units (MPUs) that is integrated to or with switch gear components, according to embodiments in the present disclosure. As such, the mobile platform **300** includes switch gear and MPU components within trailer **304**. While the drawings provide a single trailer to demonstrate that the MPU components reside within the single trailer with the switch gear components, this is merely for illustrative purposes. The integration may be by components of the switch gear physically or electrically coupled between and throughout the components for the MPUs. As such, the reference to trailer **304** is merely illustrative to indicate at least where the substantial components for these units may be located.

At least one first switch gear integrated in the MPU provides electrical output connections **302a-c** to handle electric power from at least one turbine generator in the trailer **304**. The MPUs, therefore, include area for the switch gear, and include the at least one turbine generator that is configured to output a voltage that matches the requirements of load components. In addition, multiple MPUs may be coupled together on a common electrical bus such that a combined electrical current generated as a result of the voltage from the multiple MPUs drives current through the common bus to the components of the hydraulic fracturing system. Example configurations to support such a voltage requirements with current capabilities are provided in FIGS.

4-9. Further, the hydraulic fracturing system of the present disclosure may include electrical fracturing equipment in a separate trailer or on the ground by the wellbore with at least one second switch gear to support the at least one first switch gear providing electrical output connections **302a-c** for handling electric power from the MPU in trailer **304**, and also, from other MPUs, using a common bus, for instance. A datavan (a separate mobile platform) for data may be included in the system for load shedding, load sharing, and power distribution for the electrical fracturing equipment comprising the at least one second switch gear. As such, a datavan is, herein, referring to a trailer housing communications and controls for all of fracturing system and to enable hydraulic fracturing operations where a focus of the operations is on the wellhead and fluid pumping instead of power generation. The load shedding system may also include load-inhibit functionality to prevent a pump operator from running a pump or system of pumps and other equipment at a higher load level than power can be supplied. In addition, the load shedding system may also take action to drop one or more loads in a predetermined sequence to ensure that the hydraulic fracturing system is not overloaded. In another example, the load shedding system may reduce the rate of pumps and other equipment that are loaded to the hydraulic fracturing system. The reduction of the load in this manner is an alternative to fully shutting off the pumps and the other equipment.

FIG. 4 is an elevation schematic of portions **400** of a hydraulic fracturing system in accordance with one example configuration of the present disclosure. MPUs **402a-c** include single or multiple turbine generators **410a-c** and switch gear **412a-c**, which are illustrated as directly powering fracturing pump trailers or units (FPs) **404a-f**. In this example configuration, separate switch gear equipment or common bus is not provided. Each respective switch gear (breakers or relays) **412a-c** is integrated into each respective trailers **402a-c** forming integrated MPUs. Power cable connections **408a-c** are provided to transmit power from the turbine generators **410a-c** integrated with or to the switch gear **412a-c**, shown by dotted lines connecting the boxes **410-412**. This may be the case in each trailer or mobile platform forming MPU **402** and couple to the respective FPs **404a-f**. Even though the drawings provide the MPU as including the turbine generators and the switch gear as two separate reference numerals **410** and **412** for illustrative purposes, a person of ordinary skill would recognize that these are integration in physical layout or connectivity. This is also the case for the other example configurations provided herein. In addition, transformers may be used between each respective FP **404** and switch gear **412** combination of the embodiment in FIG. 4 to condition the power for use by the fracturing equipment.

Due to the integrated switch gear of this example configuration, the MPUs **402** including the turbine generators **410a-c**, may have a smaller power output and can only power a limited number of FPs. Walkways **406a-c** are available to access the integrated MPUs and switch gear. The turbine and generator components are downgraded from traditional usage and a single trailer used for the integrated MPU is a heavy duty trailer that includes three or more axles. In example, instead of a traditional four 5.7 MW turbine generator configuration, an integrated MPU may use integrated switch gear with five 5 MW turbine generators. The integration and elimination of the EER and Switch Gear are beneficial to reduce complexity and to promote reliability of a new configuration as presently disclosed. As such, the at least one switchgear used in any embodiment may be

physically arranged to replace an EER of at least one mobile unit that may have been designed to include the EER. In addition, an MPU that is integrated with the switch gear in a single trailer eliminates the requirement for the walkway **406** as well. As such, the present embodiments merely illustrate the walkways for exemplary purposes. Further, MPUs **402**, may include multiple turbine generators **410a** and switch gear **412a**. Without a common bus, power cannot be distributed to or from other MPUs. As such, FIG. 4 illustrates each MPU **402** as powering two separate FPs, but it is possible to power a single FP, or multiple FPs depending on the integrated switch gear and power requirements of each pump (or conversely, the power output of each MPU **402a-c**). While the reference to an MPU is generally made, the reference may be to a single MPU of a single trailer **402a, b, or c**, or to multiple MPUs in each of the single trailers **402a, b, and c**. Different hydraulic horsepower requirements are provided and MPU/FP matches are identified for so that they can be added or removed for a modular set up based on specific needs.

FIG. 5 is an elevation schematic of portions **500** of a hydraulic fracturing system in accordance with another example configuration of the present disclosure. Here, the example reference numerals are provided for at least one MPU **502a** and FPs **504a,b** combination, but a person of ordinary skill would recognize that the description supporting the example reference numerals are available to the other combinations of the mobile platforms **502b,c** and FPs **504c-f**. In this configuration, power cable interconnects **514a,b** are provided between the MPUs **502a-c** to act as a common bus for load sharing. As in the prior configuration, optional walkways **506** are provided for personnel access. Power cable connections **508** are provided to transmit power from the turbine generator **510** integrated with the switch gear **512** to the respective FPs **504a-f**. Extra components (e.g., fuses, switches, etc.) in switch gear **512** and larger internal busses are additionally provided, as required and as discussed herein, to handle higher electrical loads than a single MPU can output. Communications between turbine control systems (computers) are also provided, as required, to support redundancy in this configuration. As such, a configuration as in FIG. 5 allows the switch gear, interconnect cables, and electrical bus bars are sized to handle all of the available electrical current that can be generated by the combined MPUs.

Alternatively, the sizing is in accordance with a selective use of interconnects for just portions of the system components. Such portions are determined based at least in part on the load ratings provided for the components. In this process, when the selective use is applied, controls are provided to open or close the load sharing switch gear for protection against overcurrent situations. Switches, fuses, and other failsafe components understood to handle overcurrent situations are available in the present disclosure to work with the switch gear. With a common bus **514**, it is also possible to apply a load shedding control system which can shutdown (e.g., using a stop command) or which can open a breaker for FPs **504** if the power demand exceeds the available power production. This can happen if extra fluid rate is needed or if wellhead pressure increases unexpectedly, or if an MPU fails. The present disclosure also anticipates that a turbine can fail and electrical load will need to be lowered immediately to prevent the other MPUs from over loading and shutting down for protection. The additional components of the integrated switch gear supports and resolve such issues.

FIG. 6 is an elevation schematic of portions **600** of a hydraulic fracturing system in accordance with yet another

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example configuration of the present disclosure. Here, like the prior example, the reference numerals are only provided for at least one MPU **602a** and FPs **604a,b** combination, but a person of ordinary skill would recognize that the description supporting the example reference numerals are available to the other combinations of the MPUs **602b,c** and FPs **604c-f**. In this configuration, power cable interconnects **614a-e** are provided between a VFD (Variable Frequency Drive)/MCC (Motor Control Center) compartment of the FP **604a-f** instead of on the areas for the turbine generator **610** in each of the MPUs **602a-c**. As in the prior configuration, optional walkways **606** are provided for personnel access. Power cable connections **608** are provided to transmit power from the MPUs **602** (with integrated switch gear **612** and turbine generator **610**) to the respective FPs **604a-f**. Extra components (e.g., fuses, switches, etc.) in switch gear **612** and the VFD/MCC and larger internal busses are additionally provided, as required and as discussed herein, to handle higher electrical loads than a single MPU can output.

This example configuration bears similarities to the example configuration of FIG. 5. A difference in this example is that extra load sharing switch gear for the common bus **614** will be in a VFD/MCC compartment of the FP **604** instead of in the area for the turbine generator **610** of the MPU **602**. Further, it may not be essential for all interconnecting cables to be used, as long as the fracturing pump trailers **604** are in electrical communication with a source of electric power, a single interconnect will suffice. For example, FP **604a,b** does not need to have an interconnect **614a**, or FP **604e** may not need to have an interconnect **608** with MPU **602c** in the illustrated mobile platform as long as it can share power from FP **604d** or FP **604f**. In this and any of the embodiments, at least one VFD at least one MCC is provided on individual ones of the one or more external mobile units of the embodiments, such that these components, via the one or more external mobile units, is therefore, physically external relative to the mobile unit—such as the MPU **602**—hosting the generator and switch-gear. However, extra load sharing switch gear may be in the one or more external mobile units.

FIG. 7 is an elevation schematic of portions **700** of a hydraulic fracturing system in accordance with further example configurations available in the present disclosure. In this example, a single MPU/FP system is provided. In an example, the FP **704** is a single trailer for fracturing pumps **704a,b**. As such, fracturing pumps and fracturing pump trailers are used interchangeably throughout this disclosure. In FIG. 7, the example configuration provides separate transformer skids **706a,b** used to step up or step down the voltage for the FP **704a,b**. The transformer in transformer skids **706a,b** can also be an isolation transformer for filtering out harmonics between the power source (generators) and the load (fracturing equipment in FP **704a,b**) with or without changing the voltage. The switch gear **712** is still integrated with the turbine generator **710** and an external switch gear unit may not necessarily be used to act as a common bus or for power distribution. Power cable connections or interconnects **708a,b,c,d** are provided to transmit power from the turbine generators **710** that are integrated to the switch gear **712** in the MPU to the respective FPs **704a-f** via the transformer skids **706a,b**. Interconnects may be implemented in this example as in the examples from FIGS. 5 and 6. A person of ordinary skill would recognize that the embodiments in each of the example configurations may be used interchangeably based on the disclosure herein. As such, one or more power cable interconnects may be configured to couple the mobile unit with a second mobile unit

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of one or more external mobile units in this and other embodiments. The second mobile unit has at least one second generator and at least one second switch gear and the one or more cable interconnects then enable transmission of power in support of redundancy or load sharing between the mobile unit and the second mobile unit.

The embodiment of FIG. 7 also supports a second implementation where the MPU **702** includes turbine generator **710** and integrated switch gear **712** so as to provide power to one or more pieces of FP equipment in FP unit **704**, but the layout of the equipment may be different from the layout of the prior implementation, above, using FIG. 7. For example, in this second implementation using the layout in FIG. 7, the transformer of transformer skid **706a,b** (if required) may include a VFD (Variable Frequency Drive) and possibly an MCC (Motor Control Center). As such, the VFD and MCC are on a different separate trailer than the FP **704**. This design may allow large fluid pumps to be better positioned relative to wellheads on wellsites, when space is limited. These transformer/VFD/MCC support trailers **706** (in such an embodiment) are herein referred to as Auxiliary Trailers.

FIG. 8 is an elevation schematic of portions **800** of a hydraulic fracturing system according to other example configurations of the present disclosure. This embodiment illustrates load sharing between the transformer skids **806b,c**. The remaining reference numerals **802a,b**, **810**, **812**, **808a,b,c,d**, **806a**, and **804a,b** read on similar components or functions from the corresponding reference numerals in FIG. 7—i.e., **702a,b**, **710**, **712**, **708a,b,c,d**, **706a,b**, and **704a,b**. As such, the same discussion from FIG. 7 applies to these components. In addition, in FIG. 8, extra switch gear will need to be integrated into the transformer skid **806b,c** which will create a larger skid and will take up more room, or the transformer in the transformer skid **806b,c** will need to be downgraded to be smaller, in effect limiting the horsepower of the attached FP unit **804b,c**. In this example, load sharing can be on the incoming side of the transformer or the outgoing side (secondary voltage). When the load sharing takes place on the incoming side, the switch gear, bus bars, and cable interconnects is sized based in part on the current available at the generated voltage. When the load sharing equipment is on the outgoing side (e.g., when it can be stepped up or stepped down) then the switch gear, bus bars, and cable interconnects are sized based in part on the current available on the secondary side of the transformer.

In an example, when an interconnect is provided between transformers of at least two mobile units of the one or more external mobile units, as in the embodiment of FIG. 8, then the interconnect for load sharing between the transformers can be configured based at least in part on currents available from a secondary side of the transformer. For example, at least one load sharing switch gear is provided that is optionally associated with at least one of the transformers and configured for load sharing on an incoming side of the at least one of the transformers. This arrangement is such that the at least one load sharing switch gear, associated bus bars, and associated cable interconnects are sized based at least in part on current available for a voltage output of a secondary side of the of the at least one of the transformers. In an alternative or together with the above load sharing example, when the at least one load sharing switch gear is configured for load sharing on an outgoing side of the at least one of the transformers, a different arrangement may be provided. The different arrangement is such that the at least one load sharing switch gear, the associated bus bars, and the

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associated cable interconnects are sized based at least in part on the current available at the secondary side of the transformer.

FIG. 9 is an elevation schematic of portions 900 of a hydraulic fracturing system according to further example configurations available in the present disclosure. This embodiment illustrates load sharing taking place on the FP units 904*b,c*. The remaining reference numerals 902*a,b*, 910, 912, 908*a,b,c,d*, 906*a*, and 904*a,b* read on similar components or functions from the corresponding reference numerals in FIG. 8—i.e., 802*a,b*, 810, 812, 808*a,b,c,d*, 806*a*, and 804*a,b*. As such, the same discussion from FIGS. 7 and 8 applies to these components. When the FP 904*b,c* have onboard VFD/MCC rooms or compartments, it may be possible to add extra switch gear for load sharing in those rooms. The load sharing will be on the secondary side of the transformer in transformer skid 906*a-c*. For example, if the transformer in transformer skid 906*a-c* is stepping the voltage down from 13,800V to 600V, the electrical current requirements will be higher than required if this was not the case. While this may not be ideal current requirements, and will require larger load sharing gear, this implementation saves space on the MPUs 902 at the cost of consuming space on the FP 904, which may be preferable in some cases. In this embodiment, a datavan can possibly perform the load shedding control duties instead of the MPUs 910. As previously noted, datavan is a trailer housing communications and controls for all of the FP equipment for hydraulic fracturing operations where the focus is on the wellhead and fluid pumping instead of power generation. All FP equipment communicate with the datavan for control, when load sharing switch gear is onboard the FP 904, it can be controlled from the datavan instead of the MPU 910.

FIG. 10 is an elevation schematic of portions 1000 of a hydraulic fracturing system according to yet another example configuration available in the present disclosure. In this embodiment, a configuration and associated method is provided for load sharing where the Auxiliary Trailers 1006*b,c* (such as described in the alternate embodiment of FIG. 7) houses extra load sharing gear. This configuration saves space on the MPUs 1002 and will allow the load sharing to be on the high voltage side of the transformer. The remaining reference numerals 1002*a,b*, 1010, 1012, 1008*a,b,c,d*, 1006*a,d* and 1004*a,b* read on similar components or functions from the corresponding reference numerals in FIG. 9—i.e., 902*a,b*, 910, 912, 908*a,b,c,d*, 906*a*, and 904*a,b*. As such, the same discussion from FIGS. 7, 8, and 9 applies to these components. When a step up transformer is used in this embodiment, the load sharing can take place on the secondary side—similarly discussed with respect to FIG. 7. When a step down transformer is used, the load sharing can take place on the primary side. This process also maintains all of the electrical gear off of the FP trailers 1004. Only one load sharing interconnect 1014 is illustrated for simplicity, but in reality, the Auxiliary Trailers 1006*b,c* can have as many load sharing breakers as need to form as common bus. In many situations, two interconnects may be sufficient, but it is feasible to maintain more available interconnects to simplify interconnecting cable layouts or to electrically bypass failed equipment. Electrical load sharing may be preferable at higher voltages due to the current (amperage) requirements being smaller, therefore smaller cables and switch gear can be used.

In addition, many of the above embodiments show additional switch gear integrated into the MPU to allow load sharing between MPUs for a common bus. In these embodiments, a large three phase power cable may be intercon-

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nected between the load sharing switch gear to any adjacent MPUs integrated with other load sharing switch gear. However, the extra gear and a larger internal bus that may be needed to carry the higher electrical current will require compensation in the form of the turbine engines and generators being even smaller to allow mobility of the system.

The above embodiments may be combined in any manner as is readily apparent to a person of ordinary skill reading the present disclosure. In the above embodiments and any combinations thereof, at least one fracturing pump (FP) mobile unit may be provided as part of one or more external mobile units. The at least one FP mobile unit is physically external relative to the mobile unit having a generator and switch gear for generating power for the at least one FP mobile unit. Further, a predetermined number of FP mobile units include in the one or more external mobile units may be determined for the system described throughout this disclosure. The predetermined number of FP mobile units may be determined by a maximum of the power available from the at least one generator and handled by the at least one switch gear.

In a further example, a predetermined number of generators including the at least one generator may be determined for the system of the present disclosure. In an aspect, the predetermined number of generators is determined such that each of the predetermined number of generators has a power output value that is lesser than a power output of an isolated single generator occupying all available space in an independent mobile unit physically external to the mobile unit. As the generator and switch gear are being integrated to a singular and integrated mobile unit, the space is limited and lower rating equipment may be provided instead. Other embodiments to the above embodiments allow for extra integrated switch gear for a common bus integrated into the FP trailers or with an external transformer and/or VFD skids—i.e., in the Auxiliary Trailers. This extra integrated switch gear may require additional space consumption which may force the FP trailer to incorporate equipment with lower hydraulic horsepower rating due to smaller motors/pumps to allow all of these components to fit onto a mobile platform. Further, large three phase cables, or multiple single phase cables can be used for electrical power interconnects. The above embodiments are described as capable of supporting several common voltages, such as 25 KV, 13.8 KV, 6.6 KV, 4160V, 2000V, 600V, 690V, 480V, all at +/-5%. However, any voltage is feasibly based on the capabilities of the generators used and on the ratings of the components requiring the generated power. For load sharing capabilities, higher voltage may be better appreciated and issues may arise with voltages below 5,000V. While it may not be possible to practically size switch gear, bus bars, and interconnecting cables to be able to handle the electrical current for an entire fracturing fleet at voltages below 5,000V to form a common bus, minor load sharing between two individual pumps (FP units) may still be possible even at low voltages.

The technology herein can be used for equipment where the voltage is constant, such as when the load operates at the same voltage as the generated voltage. Alternatively, the technology and equipment herein can be used where step up or step transformers are used to alter the voltage for the attached load (FP units). Examples of components in the FP units include blenders, hydration units, chemical units, propellant equipment, lights, auxiliary water pumps, monitoring equipment, data collection offices, personnel trailers, cranes,

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gas compression equipment, gas filtering equipment, heating equipment, and other third party equipment that is used on well sites.

FIG. 11 is a flowchart 1100 of a hydraulic fracturing method using to example configurations of the embodiments herein. The method includes a sub-process 1102 for providing a mobile unit with at least one generator and at least one switchgear, such as a system as described above. The at least one generator is coupled to the at least one switch gear on the mobile unit. The method includes sub-process 1104 for generating power from the at least one generator. The system may be part of a hydraulic fracturing system that consumes the power and that includes a wellbore and at least one pressuring system to create fractures in a subterranean formation that surrounds the wellbore. A verification is performed via sub-process 1106 for the power generated being sufficient to drive at least one load of the one or more external mobile units. When such verification is positive, sub-process 1108 provides the power in electrical busses for at least one load in the one or more external mobile units. Power may be generated via sub-process 1104 till the capacity is achieved if the verification in sub-process 1106 is negative.

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. For example, other the recesses can be put into arrangements other than those described, such as all being in a vertical or other arrangement. 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.

In the various embodiments of the disclosure described, a person having ordinary skill in the art will recognize that alternative arrangements of components, units, conduits, and fibers could be conceived and applied to the present invention.

The singular forms “a,” “an,” and “the” include plural referents, unless the context clearly dictates otherwise.

Examples of computer-readable medium used in the data-van and in the communications achieved in the present embodiments can include but are not limited to: one or more nonvolatile, hard-coded type media, such as read only memories (ROMs), CD-ROMs, and DVD-ROMs, or erasable, electrically programmable read only memories (EEPROMs); recordable type media, such as floppy disks, hard disk drives, CD-R/RWs, DVD-RAMs, DVD-R/RWs, DVD+R/RWs, flash drives, memory sticks, and other newer types of memories; and transmission type media such as digital and analog communication links. For example, such media can include operating instructions, as well as instructions related to the systems and the method steps described previously and can operate on a computer. It will be understood by those skilled in the art that such media can be at other locations instead of, or in addition to, the locations described to store computer program products, e.g., including software thereon. It will be understood by those skilled in the art that the various software modules or electronic components described previously can be implemented and maintained by electronic hardware, software, or a combination of the two, and that such embodiments are contemplated by embodiments of the present disclosure.

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What is claimed is:

1. A system comprising:

a first mobile unit;

at least one switch gear to be associated with at least one transformer, an interconnect, and a bus bar; and

at least one first generator coupled to the at least one switch gear and located on the first mobile unit with the at least one switch gear, the first mobile unit configured to provide power generated by the at least one first generator using electrical buses of the at least one switchgear and using the at least one transformer, the interconnect, and the bus bar, the power for loads on one or more external mobile units, the at least one switchgear, the electrical buses, the interconnect, and the bus bar sized to support voltage and current requirements of the loads and to support voltage and current outputs of the at least one transformer with the at least one first generator in a load sharing arrangement with a second generator of a second mobile unit.

2. The system of claim 1, wherein the system is part of a hydraulic fracturing system that consumes the power and that comprises a wellbore and at least one pressuring system to create fractures in a subterranean formation that surrounds the wellbore.

3. The system of claim 1, further comprising:

at least one fracturing pump (FP) mobile unit of the one or more external mobile units, the at least one FP mobile unit physically external relative to the first mobile unit, wherein the at least one transformer is provided to condition the power supplied to the at least one FP mobile unit.

4. The system of claim 1, further comprising:

a predetermined number of FP mobile units comprised in the one or more external mobile units, the predetermined number of FP mobile units determined by a maximum of the power available from the at least one first generator and handled by the at least one switch gear.

5. The system of claim 1, further comprising:

a predetermined number of first generators comprising the at least one first generator, the predetermined number of first generators having individual power output values that is lesser than a power output of an isolated single generator occupying all available space in an independent mobile unit physically external to the first mobile unit.

6. The system of claim 1, further comprising:

the at least one switchgear being physically arranged to replace an electronic equipment room (EER) of at least one of the one or more external mobile units that is designed to comprise the EER.

7. The system of claim 1, further comprising:

at least one Variable Frequency Drive (VFD); and at least one Motor Control Center (MCC), the VFD and the MCC being on individual ones of the one or more external mobile units that is physically external relative to the first mobile unit.

8. The system of claim 1, further comprising:

the interconnect configured to couple the first mobile unit with the second mobile unit, the second mobile unit having at least one second switch gear in addition to the second generator, the interconnect to transmit power in support of redundancy in addition to the load sharing arrangement between the first mobile unit and the second mobile unit.

9. The system of claim 1, further comprising:

the at least one switch gear configured in the load sharing arrangement by being in part on an incoming side of the

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at least one transformer such that the sizing is based at least in part on current available for the voltage output of a secondary side of the at least one transformer that is coupled to the at least one first generator and the second generator; or

the at least one switch gear configured in the load sharing arrangement by being in part on an outgoing side of the at least one of the at least one transformer such that the sizing is based at least in part on the current available at the secondary side of the at least one transformer that is coupled to the at least one first generator and the second generator.

10. The system of claim 1, further comprising:
at least one load sharing FP mobile unit coupled, as at least one of the loads, with a second FP mobile unit of the one or more external mobile units; and
a datavan in the one or more external mobile units for control of the at least one load sharing FP mobile unit, the datavan offering the control of the at least one load sharing FP mobile unit instead of a second control available from within the first mobile unit.

11. The system of claim 1, further comprising:
the at least one transformer being an isolation transformer that is located in the one or more external mobile units, the isolation transformer being physically external relative to the first mobile unit and being configured for filtering harmonics between the at least one first generator and the loads in the one or more external mobile units.

12. A method comprising:
providing a first mobile unit with at least one first generator and at least one switchgear located together in the first mobile unit, the at least one first generator coupled to the at least one switch gear on the first mobile unit, the at least one switch gear to be associated with at least one transformer and with an interconnect and a bus bar;
generating power from the at least one generator;
providing the power using electrical buses of the at least one switchgear and using the at least one transformer, the interconnect, and the bus bar, the power for loads in one or more external mobile units, the at least one switchgear, the interconnect, the bus bar, and the electrical buses sized to support voltage and current requirements of the loads and to support voltage and current outputs of the at least one transformer with the at least one first generator in a load sharing arrangement with a second generator of a second mobile unit.

13. The method of claim 12, further comprising:
providing at least one fracturing pump (FP) mobile unit of the one or more external mobile units that is physically external relative to the first mobile unit; and

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conditioning the power supplied to the at least one FP mobile unit using the at least one transformer.

14. The method of claim 12, further comprising:
determining a number of FP mobile units for the one or more external mobile units based at least in part on a maximum of the power available from the at least one first generator and handled by the at least one switch gear.

15. The method of claim 12, further comprising:
determining a number of generators for the at least one first generator based at least in part on the number of first generators having individual power output values that is lesser than a power output of an isolated single generator occupying all available space in an independent mobile unit physically external to the first mobile unit.

16. The method of claim 12, further comprising:
physically arranging the at least one switch gear to replace an electronic equipment room (EER) of at least one of the one or more external mobile units that is designed to comprise the EER.

17. The method of claim 12, further comprising:
providing at least one Variable Frequency Drive (VFD); and
providing at least one Motor Control Center (MCC), the VFD and the MCC being on individual ones of the one or more external mobile units that is physically external relative to the first mobile unit.

18. The method of claim 12, further comprising:
coupling the first mobile unit with the second mobile unit using the interconnect, the second mobile unit having at least one second switch gear in addition to the second generator, the interconnect to transmit power in support of redundancy in addition to the load sharing between the first mobile unit and the second mobile unit.

19. The method of claim 12, further comprising:
coupling at least one load sharing FP mobile unit to share the at least one load of a second FP mobile unit of the one or more external mobile units; and
controlling, via a datavan in the one or more external mobile units, the at least one load sharing FP mobile unit, the datavan offering the control of the at least one load sharing FP mobile unit instead of a second control available from within the first mobile unit.

20. The method of claim 12, further comprising:
filtering harmonics between the at least one first generator and the loads in the one or more external mobile units using an isolation transformer as the at least one transformer that is in the one or more external mobile units, the isolation transformer being physically external relative to the first mobile unit.

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