

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LIBERTY ENERGY, INC. AND LIBERTY ENERGY SERVICES LLC
Petitioners,

v.

U.S. WELL SERVICES, LLC,
Patent Owner.

Case IPR2025-00661
Patent No. 11,459,863

DECLARATION OF DR. ROBERT A. DURHAM

TABLE OF CONTENTS

I.	INTRODUCTION & QUALIFICATIONS	9
II.	TASK SUMMARY AND MATERIALS REVIEWED	15
III.	LIST OF EXHIBITS	15
IV.	SUMMARY OF CONCLUSIONS AND GROUNDS FOR CHALLENGE	19
V.	LEGAL STANDARDS	21
	A. Level of Ordinary Skill in the Art.....	21
	B. Legal Standard for Claim Construction	22
	C. Anticipation.....	23
	D. Obviousness	24
	E. Priority Date	27
VI.	OVERVIEW OF THE CHALLENGED PATENT	29
	A. The Challenged Claims of the '863 Patent	29
	B. Prosecution History of the '863 Patent	32
	C. Priority Date of the '863 Patent	33
VII.	LEVEL OF ORDINARY SKILL IN THE ART	34
VIII.	CLAIM CONSTRUCTION	34
IX.	TECHNOLOGY BACKGROUND AND STATE OF THE ART	34
	A. EE-Reference (Ex. 1019)	34
	B. Basic Electric Systems	36
	C. Power Generation.....	41
	D. Transmission Lines	43
	E. Circuit Breakers and Switchgear	44
	F. Transformers	49
	G. Alternating Current (AC) systems	56
	H. Electric Motors.....	59
	I. Adjustable Speed Drives / Variable Frequency Drives	60
	J. VFD Packages.....	63
	K. Power Semiconductor Heat Sinks.....	67

L.	Types of Pumps – Fracturing Pump Chain.....	71
X.	OVERVIEW OF THE PRIOR ART.....	83
A.	<i>Fischer</i> (Ex. 1008)	83
a.	Status of <i>Fischer</i>	83
b.	Disclosure of <i>Fischer</i>	84
B.	<i>Morris</i> (Ex. 1010).....	87
a.	Status of <i>Morris</i>	87
b.	Disclosure of <i>Morris</i>	87
C.	<i>Orban</i> (Ex. 1011)	88
a.	Status of <i>Orban</i>	88
b.	Disclosure of <i>Orban</i>	89
D.	<i>Oehring-I</i> (Ex. 1012).....	89
a.	Status of <i>Oehring-I</i>	89
b.	Disclosure of <i>Oehring-I</i>	90
E.	<i>Karassik</i> (Ex. 1013)	92
a.	Status of <i>Karassik</i>	92
b.	Overview of the Disclosure of <i>Karassik</i>	92
F.	<i>Oehring-II</i> (Ex. 1016)	92
a.	Status of <i>Oehring-II</i>	92
b.	Overview of the Disclosure of <i>Oehring-II</i>	93
XI.	COMPARISON OF PRIOR ART TO THAT REVIEWED BY THE EXAMINER	95
XII.	GROUND 1: ANTICIPATED / OBVIOUS OVER <i>FISCHER</i>.....	95
A.	Independent Claim 1	96
a.	1[p]: “1. A hydraulic fracturing system, comprising:”	96
b.	1[a]: “a support structure having a first area at a first height and a second area at a second height, the first and second areas adjacent one another;”	98
c.	1[b]: “an electric powered, multi-plunger pump with an odd number of plungers, arranged in the first area, the electric powered pump coupled to a well, via outlet piping, and	

powered by at least one electric motor, also arranged in the first area;”	101
d. 1[c]: “a variable frequency drive (VFD), arranged in the second area, connected to the at least one electric motor, the VFD configured to control at least a speed of the at least one electric motor; and”	110
e. 1[d]: “a transformer, arranged in the second area, the transformer positioned within an enclosure with the VFD, the transformer configured to distribute power for operation of the electric pump.”	112
B. Claim 9	116
XIII. GROUND 2: OBVIOUS OVER FISCHER IN VIEW OF OEHRING-I.....	119
A. Motivation to Combine	119
B. Claim 2	125
XIV. GROUND 3: OBVIOUS OVER FISCHER IN VIEW OF OEHRING-II.....	131
A. Motivation to Combine	131
B. Claim 3	134
XV. GROUND 4: OBVIOUS OVER FISCHER IN VIEW OF ORBAN.....	138
A. Motivation to Combine	138
B. Claim 4	141
C. Claim 5	145
XVI. Ground 5: OBVIOUS OVER FISCHER IN VIEW OF KARASSIK	146
A. Motivation to Combine	146
B. Claim 6	150
C. Claim 7	151
D. Claim 8	153
XVII. Ground 6: OBVIOUS OVER FISCHER IN VIEW OF THE KNOWLEDGE OF A POSITA AND, IN THE ALTERNATIVE, KARASSIK	153
A. Motivation to Combine	153

B.	Claim 10	153
C.	Independent Claim 11	155
a.	11[p]: “A hydraulic fracturing system, comprising:”	156
b.	11[a]: “an electric powered, multi-plunger pump, arranged on a support structure, the electric powered multi-plunger pump powered by at least one electric motor;.....	156
c.	11[b]: “a variable frequency drive (VFD), arranged on the support structure, connected to the at least one electric motor to control a speed of the at least one electric motor, the VFD positioned separate from the electric powered, multi-plunger pump and within an enclosure; and”	156
d.	11[c]: “a transformer, arranged on the support structure, configured to distribute power for operation of the electric powered, multi-plunger pump, the power being received from at least one generator at a voltage higher than an operating voltage of the electric powered pump , the transformer positioned within the enclosure;”	156
e.	11[d]: “wherein the electric powered, multi-plunger pump includes an odd number of plungers configured to reduce kinematic flow ripple.”	160
D.	Claim 19	163
E.	Claim 20	164
XVIII.	Ground 7: OBVIOUS OVER FISCHER IN VIEW OF Oehring-I, the knowledge of a Posita and, in the alternative, karassik.....	167
A.	Motivation to Combine	167
B.	Claim 12	167
XIX.	Ground 8: OBVIOUS OF FISCHER IN VIEW OF Oehring-II, the knowledge of a POSITA and, in the alternative, KARASSIK.....	168
A.	Motivation to Combine	168
B.	Claim 13	169
XX.	Ground 9: OBVIOUS OVER FISCHER IN VIEW OF ORban, the knowledge of a POSITA and, in the alternative, KARASSIK.....	170
A.	Motivation to Combine	170
B.	Claim 14	170

C. Claim 15	171
XXI. Ground 10: Obvious over Fischer, Karassik, the knowledge of a posita and, in the alternative, Karassik.....	172
A. Motivation to combine	172
B. Claim 16	172
C. Claim 17	173
D. Claim 18	173
XXII. GROUND 11: OBVIOUS OVER MORRIS	174
A. Independent Claim 1	174
a. 1[p]: “1. A hydraulic fracturing system, comprising:”	174
b. 1[a]: “a support structure having a first area at a first height and a second area at a second height, the first and second areas adjacent one another;”	175
c. 1[b]: “an electric powered, multi-plunger pump with an odd number of plungers, arranged in the first area, the electric powered pump coupled to a well, via outlet piping, and powered by at least one electric motor, also arranged in the first area;”	177
d. 1[c]: “a variable frequency drive (VFD), arranged in the second area, connected to the at least one electric motor, the VFD configured to control at least a speed of the at least one electric motor; and”	181
e. 1[d]: “a transformer, arranged in the second area, the transformer positioned within an enclosure with the VFD, the transformer configured to distribute power for operation of the electric pump.”	184
XXIII. Ground 12: Obvious over <i>Morris</i> in view of <i>Oehring-I</i>.....	186
A. Motivation to Combine	186
B. Claim 2	189
XXIV. Ground 13: OBVIOUS OVER MORRIS IN VIEW OF <i>OEHRING-II</i>	190
A. Motivation to Combine	190
B. Claim 3	193
XXV. Ground 14: OBVIOUS OVER MORRIS IN VIEW OF ORBAN.....	197

A. Motivation to Combine	197
B. Claim 4	200
C. Claim 5	201
XXVI. Ground 15: OBVIOUS OVER MORRIS IN VIEW OF KARASSIK	201
A. Motivation to Combine	201
B. Claim 6	205
C. Claim 7	206
D. Claim 8	206
XXVII.. Ground 16: Morris in view of the Knowledge of a POSITA and, in the Alternative, Karassik	207
A. Motivation to Combine	207
B. Claim 10	207
C. Claim 11	209
a. 11[p]: “11. A hydraulic fracturing system, comprising:”	209
b. 11[a]: “an electric powered, multi-plunger pump, arranged on a support structure, the electric powered multi-plunger pump powered by at least one electric motor;.....”	210
c. 11[b]: “a variable frequency drive (VFD), arranged on the support structure, connected to the at least one electric motor to control a speed of the at least one electric motor, the VFD positioned separate from the electric powered, multi-plunger pump and within an enclosure; and”	210
d. 11[c]: “a transformer, arranged on the support structure, configured to distribute power for operation of the electric powered, multi-plunger pump, the power being received from at least one generator at a voltage higher than an operating voltage of the electric powered pump , the transformer positioned within the enclosure;”	210
e. 11[d]: “wherein the electric powered, multi-plunger pump includes an odd number of plungers configured to reduce kinematic flow ripple .”	212
D. Claim 19	216
E. Claim 20	218

XXVIII. Ground 17: OBVIOUS OVER Morris IN VIEW OF KARASSIK AND OEHRING-I.....	220
A. Motivation to Combine	220
B. Claim 12	221
XXIX. Ground 18: OBVIOUS OVER Morris IN VIEW OF KARASSIK AND OEHRING-II	222
A. Motivation to Combine	222
B. Claim 13	222
XXX. Ground 19: OBVIOUS OVER Morris IN VIEW OF KARASSIK AND ORBAN.....	224
A. Motivation to Combine	224
B. Claim 14	224
C. Claim 15	225
XXXI. Ground 20: Obvious over Morris, Karassik, the knowledge of a POSITA and, in the alternative, Karassik	225
A. Motivation to combine	225
B. Claim 16	226
C. Claim 17	226
D. Claim 18	227
XXXII.....	SECONDARY
CONSIDERATIONS.....	227
XXXIII.	CONCLUSION
228	

I, Robert A Durham, hereby declare as follows:

I. INTRODUCTION & QUALIFICATIONS

1. My name is Dr. Robert A. Durham. I make this declaration based upon my own personal knowledge and, if called upon to testify, would testify competently to the matters contained herein.

2. I have been asked to provide technical assistance in the inter partes review of U.S. Patent No. 11,459,863, which I may abbreviate as “the ’863 Patent” or refer to as the “Challenged Patent.” This declaration is a statement of my opinions on issues related to the unpatentability of claims of the ’8863 Patent. I am being compensated at my normal hourly rate for my analysis, plus reimbursement for expenses. My compensation does not depend on the content of my opinions or the outcome of this proceeding.

3. In formulating my opinions, I have relied upon my knowledge, training, and experience in the relevant art. My qualifications are stated more fully in my curriculum vitae, which has been provided in Appendix A. My CV also lists publications on which I am a named author and identifies parties on behalf of whom I have previously offered expert testimony within the past four years. Here, I provide a brief summary of my qualifications.

4. I am a consulting engineer with experience in a number of technical areas. I have oil and gas industry expertise from drilling and completion to

downstream. As a consultant, I have worked with oil field production companies, refining and chemical plants, equipment manufacturers, and technology development companies for over twenty years. My work relates to the subject matter of the U.S. Pat. No. 11,459,863 (“the ’863 Patent”), which I describe below in Section VI (“Overview of the Challenged Patent”).

5. I received my Bachelor of Science in Electrical Engineering and Master of Engineering and Technology Management degrees from the University of Tulsa in 1992 and 1997, respectively. After years of professional work and research, I received my Ph.D. in Engineering Management from Kennedy Western University in 2004.

6. I have also served in leadership positions in the Petroleum and Chemical Industry Committee (PCIC) of the Institute of Electrical and Electronics Engineers (IEEE) for nearly twenty years. IEEE is the world’s largest technical professional association. The PCIC is the premier forum for the exchange of electrical applications technology related to the petroleum and chemical industry. From 2005 to 2012, I served as secretary, vice chair, and ultimately chair of the Production Subcommittee of the PCIC. The Production Subcommittee is the primary method for PCIC members to communicate technical papers related to drilling, wellhead, and facilities operations of oil and gas wells. In 2013, I was appointed as Vice-Chair of the Standards Subcommittee of the PCIC, a role which transitioned to

Chair in 2014. I served as Chair until 2022. The Standards Subcommittee of the PCIC is the Sponsor of IEEE standards relating to electrification and electrical equipment operations in the Oil and Gas Industry. The PCIC Standards Subcommittee sponsors nearly 50 electrical and oil and gas related standards. In September 2022, I was elected as an Executive Officer of the PCIC. I will serve as an Executive Officer for eight years, serving two-year terms in each position: Secretary, Vice Chair, Chair, and Chair of Advisory and Awards.

7. My peers have recognized my contributions, particularly in the area of electrical equipment in the oil and gas industry. Because of this recognition, in 2019, I was elevated to the grade of Fellow of the IEEE for “contributions to submersible electrical equipment analysis and multi-point ground methods in hazardous petroleum and chemical environments.” The IEEE Fellow grade is limited to the top 0.1% of the IEEE membership worldwide.

8. I have worked directly in the area of electrification of oil and gas fields both as an employee and as a consulting engineer. From 2000 until the end of 2002, I was employed as Manager of Electric Infrastructure for New Dominion, LLC (NDL). In that capacity, I administratively owned and was responsible for all electrical equipment, including overhead power lines, transformers, switchgear, drives, and motors, throughout NDL’s production, exploration, and drilling areas.

9. After a brief stint as Vice President for EDG Power Group, responsible for Engineering and Project Management of generation and co-generation facilities across the U.S., I transitioned to the role of consulting engineer. In that role, I have served as a consulting engineer in designing, constructing, and analyzing all kinds of power systems, especially those in the oil and gas industry. This has included the design and selection of equipment and the analysis of equipment failures in the oil and gas field from drilling/completion sites to production facilities, midstream, and downstream (refinery) locations.

10. I am also a principal of PEDOCS, Inc., an oil and gas production company operating over 50 oil and gas production wells in Oklahoma. As such, I am familiar with oil and gas well operations, including well stimulation, completion, hydraulic fracturing, and production.

11. I have been familiar with oil and gas drilling, fracturing (fracking), completion, production, midstream, and downstream operations for over twenty years.

12. I have been familiar with power distribution, including generation transmission and distribution equipment. As an employee, I worked as a design and construction engineer for generation facilities for Central and Southwest (now American Electric Power AEP). I was also responsible for designing and

constructing generation facilities when employed by EDG Power Group, as discussed above. While at AEP, I spent three years as a transmission planner, modeling transmission systems and developing plans for increased power distribution capacities at high voltages. While at New Dominion LLC, I owned and was responsible for the design, construction, and maintenance of several hundred miles of medium voltage (5 – 25 kV) distribution lines, switchgear, drives, and motors used for oil and gas drilling, completion, and production. Over the last ~ 20 years, I have consulted with numerous clients ranging from utilities to oil and gas development and production companies on designing, upgrading and maintaining generation and power distribution facilities.

13. I have been familiar with the design, installation, tuning, and programming of process control systems for nearly my entire career. As an engineering intern and later as an engineer for Central & Southwest (now AEP), I was responsible for designing, configuring, and installing control systems for continuous process operations in power generation applications. These included relatively simple systems, such as process air control or treatment of water for general use, called “service water.” Additionally, I worked on much more advanced control systems such as boiler water feed, ASD (VFD) control for combustion air, and control of the entire steam generating, recovery, and reuse process for steam-driven turbines. As chief electrical engineer (later VP of Engineering & PM) at EDG

Power Group, I had primary responsibility for the design and configuration of control systems for gas turbine generators, as well as heat recovery systems to heat water for use in associated applications, such as refinery steam or hot water driven heating/cooling operations. Further, as a consultant, I have consulted on several control system projects inside and outside the oil and gas industry over the past 20-plus years. I am a licensed professional controls engineer.

14. I have been familiar with the Occupational Safety and Health Administration (“OSHA”) and its responsibilities at oil and gas locations. I have consulted and investigated incidents on multiple oil and gas sites where OSHA has also performed investigations about injuries and fatalities that have occurred at oil and gas locations, including drilling, fracturing and completion operations. As Principal Scientist of THEWAY Labs, part of my responsibilities include overseeing the Health Safety and Environmental (HSE) program at THEWAY Labs, including establishing policies and procedures commensurate with OSHA requirements at all locations, including requirements for oil and gas sites.

15. I author or co-author over fifty published papers and five books. A list of publications that I have written over the last thirty years is included in my professional CV, which is attached as Appendix A.

16. Therefore, based on my education, professional experience of over 30 years, and scholarly books and publications, I am an expert in the relevant field of the '863 Patent and have been an expert in this field since before the '863 Patent was filed with the United States Patent and Trademark Office ("USPTO"). I am familiar with how a person having ordinary skill in the art would have understood and used the terminology found in the '863 Patent at the time of filing.

II. TASK SUMMARY AND MATERIALS REVIEWED

17. I have been asked to review the Challenged Patent and its prosecution history, to provide an understanding of the technology relevant to the Challenged Patent, to review certain prior-art references, and to analyze whether or not those references disclose or teach limitations of claims from the Challenged Patent. The opinions stated in this declaration are from the perspective of a person of ordinary skill in the art (POSITA).

III. LIST OF EXHIBITS

18. In forming my opinions, I have reviewed the Challenged Patent, its prosecution history and references cited by the Examiner, the materials cited in the List of Exhibits, and the materials cited throughout my declaration.

Ex.	Description
1001	U.S. Patent No. 11,459,863 to Robinson <i>et al.</i> , “Electric Powered Hydraulic Fracturing Pump System With Single Electric Powered Multi-plunger Fracturing Pump” (the “’863 Patent”)
1002	File History for U.S. Patent No. 11,459,863
1004	Plaintiffs’ Original Complaint, <i>U.S. Well Services, LLC, et al v. Liberty Energy, Inc. et al</i> , 4:24-cv-00839-KPE (S.D. Tex.), March 6, 2024
1005	Return of Service, <i>U.S. Well Services, LLC, et al v. Liberty Energy, Inc. et al</i> , 4:24-cv-00839-KPE (S.D. Tex.), March 11, 2024
1006	Plaintiffs’ Amended Complaint, <i>U.S. Well Services, LLC, et al v. Liberty Energy, Inc. et al</i> , 4:24-cv-00839-KPE (S.D. Tex.), June 3, 2024
1007	Claim Listing of Challenged Claims of ’863 Patent
1008	U.S. Patent No. 10,988,998 to Fischer <i>et al.</i> , “Electric Driven Hydraulic Fracking Operation” (“ <i>Fischer</i> ”), filed Feb. 14, 2020 and issued April 27, 2021
1009	U.S. Provisional Application No. 62.805,521 to Fischer, “Electric Driven Hydraulic Fracking System” (“ <i>Fischer Provisional</i> ”), filed February 14, 2019
1010	U.S. Patent Publication No. 2020/0040863 to Morris, “Engagement and Disengagement with External Gear Box Style Pumps” (“ <i>Morris</i> ”), filed July 29, 2019 and published February 6, 2020
1011	International Publication No. WO 2018/201118 to Orban <i>et al.</i> , “Integrated Power and Electronics Unit for Drilling Machine” (“ <i>Orban</i> ”), filed April 30, 2018 and published November 1, 2018
1012	U.S. Patent Publication No. 2017/0030177 to Oehring <i>et al.</i> , “Slide Out Pump Stand for Hydraulic Fracturing Equipment” (“ <i>Oehring</i> ”), published February 2, 2017

1013	Karassik, Igor J., et al., “Pump Handbook,” 4 th Edition, McGraw Hill, 2008 (“ <i>Karassik</i> ”)
1014	Nesbitt, B., “Handbook of Pumps and Pumping: Pumping Manual International,” Elsevier, 2006 (“Nesbitt”)
1015	Declaration of Sylvia Hall-Ellis, Ph.D.
1016	U.S. Patent No. 9,893,500 to Oehring et al., “Switchgear Load Sharing for Oil Field Equipment” (“Oehring-II”), filed April 14, 2017 and issued February 13, 2018
1017	“Weir Oil & Gas introduces new continuous duty 5000-horsepower pump,” Drilling Contractor Magazine, published July 25, 2019, archived on July 28, 2019 at https://web.archive.org/web/20190728223155/http://www.drillingcontractor.org/weir-oil-gas-introduces-first-continuous-duty-5000-horsepower-pump-for-electric-or-gas-turbine-driven-applications-52953
1018	U.S. Patent No. 2,789,714 to Norris, “Heavy Duty Gooseneck Trailer,” filed August 11, 1954 and issued April 23, 1957
1019	Camara, John A., “Electrical Engineering Reference Manual for the Electrical and Computer PE Exam,” 6th ed. (Professional Publications, Inc. 2002), ISBN: 1-888577-56-8.
1020	Lionel B. Roe, Practices and Procedures of Industrial Electrical Design (McGraw-Hill: 1972), ISBN: 0-07-053390-3
1021	IEEE100: The Authoritative Dictionary of IEEE Standards Terms, 7th ed. (IEEE Press: 2000), ISBN: 0-7381-2601-2 (“IEEE Standards Dictionary”)
1022	U.S. Patent No. 1,743,771 to Hall et al., entitled “System of Electric Distribution,” filed March 25, 1926 and issued January 14, 1930
1023	Donald G. Fink, Standard Handbook for Electrical Engineers, 13th ed. (McGraw-Hill, New York: 1993), ISBN: 0-07-020984-7
1024	U.S. Patent Publication No. 2011/0241590 to Horikoshi et al., entitled “Motor Driving Apparatus Having Fault Diagnostic Function,” filed Feb. 11, 2011 and published Oct. 6, 2011

1025	U.S. Patent Publication No. 2012/0255734 to Coli et al., entitled “Mobile, Modular, Electrically Powered System for Use in Fracturing Underground Formations,” filed April 6, 2012 and published Oct. 11, 2012
1026	U.S. Patent No. 9,410,410 to Broussard et al., entitled “System for Pumping Hydraulic Fracturing Fluid using Electric Pumps,” filed Nov. 16, 2012 and issued Aug. 9, 2016
1027	U.S. Patent No. 2,533,001 to Eberhard, entitled “Flip-Flop Counter Circuit,” filed April 30, 1949 and issued December 5, 1950
1028	NEMA ICS-61800-4 Adjustable Speed Electrical Power Drive Systems, Part 4: General Requirements – Rating Specifications for A.C. Power Drive Systems Above 1000 V A.C. and Not Exceeding 35 kV, National Electrical Manufacturers Association, 2004
1029	C. M. Chang, “An N-P-N high power fast germanium core driver transistor,” 1957 International Electron Devices Meeting, Washington, DC, USA, 1957, pp. 114-114, doi: 10.1109/IEDM.1957.187057
1030	F. B. Golden, “Liquid Cooling of Power Thyristors,” in IEEE Transactions on Industry Applications, vol. IA-8, no. 5, pp. 601-606, Sept. 1972, doi: 10.1109/TIA.1972.349789
1031	A. H. Iversen and S. Whitaker, “A uniform temperature, ultra high heat flux liquid cooled, power semiconductor package,” Conference Record of the IEEE Industry Applications Society Annual Meeting,, San Diego, CA, USA, 1989, pp. 1340-1347 vol.2, doi: 10.1109/IAS.1989.96817
1032	Hefner, A. R. 1992. “A dynamic electro-thermal model for the IGBT.” In Conference Record of the 1992 IEEE Industry Applications Society Annual Meeting, 1094-104 vol.1
1033	Morton, M., “Unlocking the Earth: A Short History of Hydraulic Fracturing,” GEO ExPro, Vol. 10, No. 6, December 2013 (https://geoexpro.com/unlocking-the-earth-a-short-history-of-hydraulic-fracturing/) (last accessed September 16, 2024)
1034	Gardner Denver GD-2500 Quintuplex Well Servicing Pump Operating and Service Manual, captured by the Internet Archive on Sept. 17, 2005, available at

	< https://web.archive.org/web/20120917102614/http://www.quincieoilfield.com/pdf/3.0%20Gardner%20Denver/2500/GD2500Q%20Op%20&%20Service%20Manual.pdf >
1035	Merriam-Webster Online Dictionary, “Quintuple,” captured by the Internet Archive on February 2, 2017, available at < https://web.archive.org/web/20170202121725/https://www.merriam-webster.com/dictionary/quintuple >
1036	Mark’s Standard Handbook for Mechanical Engineers, Eleventh Edition, McGraw-Hill Companies, New York, 2007

IV. SUMMARY OF CONCLUSIONS AND GROUNDS FOR CHALLENGE

19. After reviewing the materials identified in the List of Exhibits, I have concluded that each of the Challenged Claims of the ’863 Patent would have been obvious to a person of ordinary skill in the art based on the following grounds.

Ground	’863 Claims	Basis for Challenge	Prior Art
1	1, 9	103	<i>Fischer</i>
2	2	103	<i>Fischer, Oehring-I</i>
3	3	103	<i>Fischer, Oehring-II</i>
4	4, 5	103	<i>Fischer, Orban</i>
5	6-8	103	<i>Fischer, Karassik</i>
6	10, 11, 19, 20	103	<i>Fischer</i> in view of the knowledge of a POSITA and, in the alternative, <i>Karassik</i>

7	12	103	<i>Fischer, Oehring-I</i> in view of the knowledge of a POSITA and, in the alternative, <i>Karassik</i>
8	13	103	<i>Fischer, Oehring-II</i> in view of the knowledge of a POSITA and, in the alternative, <i>Karassik</i>
9	14, 15	103	<i>Fischer, Orban</i> in view of the knowledge of a POSITA and, in the alternative, <i>Karassik</i>
10	16-18	103	<i>Fischer, Karassik</i> in view of the knowledge of a POSITA and, in the alternative, <i>Karassik</i>
11	1	103	<i>Morris</i>
12	2	103	<i>Morris, Oehring-I</i>
13	3	103	<i>Morris, Oehring-II</i>
14	4, 5	103	<i>Morris, Orban</i>
15	6-8	103	<i>Morris, Karassik</i>
16	10, 11, 19, 20	103	<i>Morris</i> in view of the knowledge of a POSITA and, in the alternative, <i>Karassik</i>
17	12	103	<i>Morris, Oehring-I</i> in view of the knowledge of a POSITA and, in the alternative, <i>Karassik</i>
18	13	103	<i>Morris, Oehring-II</i> in view of the knowledge of a POSITA and, in the alternative, <i>Karassik</i>

19	14, 15	103	<i>Morris, Orban</i> in view of the knowledge of a POSITA and, in the alternative, <i>Karassik</i>
20	16-18	103	<i>Morris, Karassik</i> in view of the knowledge of a POSITA and, in the alternative, <i>Karassik</i>

V. LEGAL STANDARDS

A. LEVEL OF ORDINARY SKILL IN THE ART

20. When interpreting a patent, I understand that it is important to identify the relevant art pertaining to the patent-in-suit as well as the level of ordinary skill in that art at the time of the claimed invention. The “art” is the field of technology to which the patent is related.

21. Counsel has instructed me that the person of ordinary skill in the art (“**POSITA**”) is a hypothetical person who is presumed to know the relevant prior art. I understand that the actual inventor’s skill is not determinative of the level of ordinary skill. I further understand that the factors that may be considered in determining the level of skill include: the types of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field. I understand that not all such factors may be present in every case, and one or more of them may predominate.

B. LEGAL STANDARD FOR CLAIM CONSTRUCTION

22. I understand that the first step in determining whether a patent claim would have been anticipated or obvious is to ascertain how a POSITA would have understood the claim terms.

23. I have been instructed by counsel on the law regarding claim construction and patent claims, and I understand that a patent may include two types of claims: independent claims and dependent claims. An independent claim stands alone and includes only the limitations it recites. A dependent claim can depend from an independent claim, or it can further depend from another dependent claim. I understand that a dependent claim includes all the limitations that it recites, in addition to all the limitations recited in the claim(s) from which it depends.

24. I understand that in proceedings before the USPTO, a patent's claims are to be construed under what is referred to as the "Phillips standard." This means that claim terms of a patent are given the meaning they would have to a POSITA in view of the description provided in the patent itself and the patent's file history.

25. I understand that to determine how a person of ordinary skill would understand a claim term, one should look to those sources available that show what a person of skill in the art would have understood the disputed claim language to mean. In construing a claim term, I understand that one looks primarily to the

intrinsic patent evidence, including the words of the claims themselves, the remainder of the patent, and the patent's prosecution history. I understand that extrinsic evidence, which is evidence external to the patent and the prosecution history, may also be useful in interpreting patent claims when the intrinsic evidence itself is insufficient.

26. I understand that words or terms should be given their ordinary and accepted meaning unless it appears that the inventors were using them to mean something else. In making this determination, the claims, the remainder of the patent, and the prosecution history are of paramount importance. Additionally, the patent and its prosecution history must be consulted to confirm whether the patentee has acted as its own lexicographer (i.e., provided its own special meaning to any disputed terms) or intentionally disclaimed, disavowed, or surrendered any claim scope.

27. In comparing the claims of the Challenged Patent to the prior art, I have considered the Challenged Patent and its file history in light of the understanding of a person of skill at the time of the alleged invention.

C. ANTICIPATION

28. It is my understanding that a prior art reference anticipates the claims of a patent if each and every element of the claim is found either explicitly or

inherently in a single prior art reference or system. I understand that inherency requires a showing that the missing descriptive matter in the claim is necessarily or implicitly present in the allegedly anticipating reference and that it would have been so recognized by a POSITA. In addition, I understand that an enabling disclosure is a disclosure that allows a POSITA to make the invention without undue experimentation. Although anticipation typically involves the analysis of a single prior art reference, I understand that additional references may be used to show that the primary reference has enabling disclosure, to explain the meaning of a term used in the primary reference, and/or to show that a characteristic is inherent in the primary reference.

D. OBVIOUSNESS

29. I understand that the prior art may render a patent claim “obvious.” I understand that two or more prior art references (e.g., prior art articles, patents, or publications) that each discloses fewer than all elements of a patent claim may nevertheless be combined to render a patent claim obvious if the combination of the prior art collectively discloses all elements of the claim and one of ordinary skill in the art at the time would have been motivated to combine the prior art in such a way. I understand that this motivation to combine needs not be explicit in any of the prior art, but it may be inferred from the knowledge of one of ordinary skill in the art at the time the patent was filed. I also understand that one of ordinary skill in the art is

not an automaton, but is a person having ordinary creativity. I further understand that one or more prior art references, articles, patents or publications that disclose fewer than all of the elements of a patent claim may render a patent claim obvious if including the missing element would have been obvious to one of skill in the art (e.g., the missing element represents only an insubstantial difference over the prior art or a reconfiguration of a known system).

30. I understand that under the doctrine of obviousness, a claim may be invalid if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a POSITA to which the subject matter pertains.

31. To assess obviousness, I understand that I am to consider the scope and content of the prior art, the differences between the prior art and the claim, the level of ordinary skill in the art, and any secondary considerations to the extent they exist.

32. I understand that any evidence of secondary indicia of non-obviousness should be considered when evaluating whether a claimed invention would have been obvious to one of ordinary skill at the time of invention. These secondary indicia of non-obviousness may include, for example:

- a long-felt but unmet need in the prior art that was satisfied by the claimed invention;
- commercial success of processes claimed by the patent;

- unexpected results achieved by the invention;
- praise of the invention by others skilled in the art;
- the taking of licenses under the patent by others; and
- deliberate copying of the invention.

33. I understand there must be a nexus between any such secondary indicia and the claimed invention.

34. It is also my understanding that there are additional considerations that may be used as further guidance as to when the above factors will result in a finding that a claim is obvious, including the following:

- the claimed subject matter is simply a combination of prior art elements according to known methods to yield predictable results;
- the claimed subject matter is a simple substitution of one known element for another to obtain predictable results;
- the claimed subject matter uses known techniques to improve similar devices or methods in the same way;
- the claimed subject matter applies a known technique to a known device or method that is ready for improvement to yield predictable results;
- the claimed subject matter would have been “obvious to try” choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- there is known work in one field of endeavor that may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to a POSITA;

- there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims; and
- there is some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed subject matter.

35. Finally, I understand that a claim may be deemed invalid for obviousness in light of a single prior art reference, without the need to combine references, if the elements of the claim that are not found in the reference can be supplied by the knowledge or common sense of one of ordinary skill in the relevant art.

E. PRIORITY DATE

36. I understand that, subject to the next paragraph, the asserted "priority date" of a patent is the earlier of: (a) the date on which a patent application is filed; or (b) the date on which an earlier-filed patent application is filed if the patentee claims the benefit of priority to that earlier-filed patent application.

37. I understand that it is not enough for a patent to merely claim the benefit of an earlier-filed application, but that additional criteria must be met. In particular, the prior application itself must describe the claimed invention, and must do so in sufficient detail that one skilled in the art can clearly conclude that the inventor invented the claimed invention as of the filing date sought. First, I understand that a priority-date analysis is on a claim-by-claim basis. Second, I understand that, in

order for a patent claim to be entitled to the filing date of an earlier patent application, a “Section 112 analysis” must be conducted. I am informed that a “Section 112” analysis encompasses looking to the earlier patent application, and ascertaining whether that earlier patent application meets both the written-description and enablement requirements as of the filing date of the earlier application. I understand that it is not enough that the claim would have been obvious from the earlier application, but that application itself must describe the claimed invention.

38. I understand that in order to satisfy the written description requirement the earlier application must reasonably convey to those skilled in the art that the inventors had possession of the subject matter of the patent as of the filing date of the earlier application. I have been informed that it is the disclosures of the earlier patent application that count, and that while the meaning of terms, phrases, or diagrams in the earlier patent application must be interpreted from the vantage point of one skilled in the art, all of the claimed limitations must appear in the specification. Further, I understand that this analysis is not a question of whether one skilled in the art might be able to construct the claimed invention from the teachings of the disclosure. The question is not whether a claimed invention is an obvious variant of that which is disclosed in the specification; rather, I understand that an earlier application must itself describe each of the claim limitations.

39. I also understand that to satisfy the enablement requirement, the earlier application must enable a person of ordinary skill in the art to practice the claimed invention without undue experimentation.

VI. OVERVIEW OF THE CHALLENGED PATENT

A. THE CHALLENGED CLAIMS OF THE '863 PATENT

The Challenged Claims of the '863 Patent, which are Claims 1-10, are set forth below. Some of the claim elements have been further subdivided for ease of reference.

Cl.	Limitation
1p	1. A hydraulic fracturing system, comprising:
1[a]	a support structure having a first area at a first height and a second area at a second height, the first and second areas adjacent one another;
1[b]	an electric powered, multi-plunger pump with an odd number of plungers, arranged in the first area, the electric powered pump coupled to a well, via outlet piping, and powered by at least one electric motor, also arranged in the first area;
1[c]	a variable frequency drive (VFD), arranged in the second area, connected to the at least one electric motor, the VFD configured to control at least a speed of the at least one electric motor; and
1[d]	a transformer, arranged in the second area, the transformer positioned within an enclosure with the VFD, the transformer configured to distribute power for operation of the electric pump.
2	2. The hydraulic fracturing system of claim 1, further comprising: a slide out platform integrated into the first area, the slide out platform being driven between a retracted position and a deployed position, wherein the

	deployed position provides a work area proximate the electric powered, multi-plunger pump
3	3. The hydraulic fracturing system of claim 1, further comprising: a work platform proximate the enclosure in the second area, the work platform providing access to the enclosure, the work platform arranged such that the enclosure is between the work platform and the first area.
4	4. The hydraulic fracturing system of claim 1, further comprising: a cooling system for the enclosure, the cooling system being a liquid cooling system thermally coupled to at least one of the VFD or the transformer.
5	5. The hydraulic fracturing system of claim 4, wherein the liquid cooling system includes water or glycol.
6	6. The hydraulic fracturing system of claim 1, wherein the electric powered, multi-plunger pump is a septuplex pump having seven plungers.
7	7. The hydraulic fracturing system of claim 1, wherein the electric powered, multi-plunger pump includes at least one of 9 plungers or 11 plungers.
8	8. The hydraulic fracturing system of claim 1, wherein the electric powered, multi-plunger pump includes more than 5 plungers.
9	9. The hydraulic fracturing system of claim 1, wherein the first area is opposite the second area and the second area includes a hitch for coupling to a prime mover.
10	10. The hydraulic fracturing system of claim 1, wherein the electric powered, multi-plunger pump is a single pump and a first pump output meets or exceeds a second pump output associated with two quintuplex pumps.
11[p]	11. A hydraulic fracturing system, comprising:
11[a]	an electric powered, multi-plunger pump, arranged on a support structure, the electric powered multi-plunger pump powered by at least one electric motor;
11[b]	a variable frequency drive (VFD), arranged on the support structure, connected to the at least one electric motor to control a speed of the at least

	one electric motor, the VFD positioned separate from the electric powered, multi-plunger pump and within an enclosure; and
11[c]	a transformer, arranged on the support structure, configured to distribute power for operation of the electric powered, multi-plunger pump, the power being received from at least one generator at a voltage higher than an operating voltage of the electric powered pump, the transformer positioned within the enclosure;
11[d]	wherein the electric powered, multi-plunger pump includes an odd number of plungers configured to reduce kinematic flow ripple.
12	12. The hydraulic fracturing system of claim 11, further comprising: a slide out platform proximate the electric powered, multi-plunger pump being driven between a retracted position and a deployed position, wherein the deployed position provides a work area proximate the electric powered, multi-plunger pump.
13	13. The hydraulic fracturing system of claim 11, further comprising: a work platform proximate and external to the enclosure, the work platform providing access to the enclosure, wherein the work platform is positioned at an elevation greater than the electric powered, multi-plunger pump.
14	14. The hydraulic fracturing system of claim 11, further comprising: a cooling system for the enclosure, the cooling system being a liquid cooling system thermally coupled to at least one of the VFD or the transformer.
15	15. The hydraulic fracturing system of claim 14, wherein the liquid cooling system includes water or glycol.
16	16. The hydraulic fracturing system of claim 11, wherein the electric powered, multi-plunger pump is a septuplex pump having seven plungers.
17	17. The hydraulic fracturing system of claim 11, wherein the electric powered, multi-plunger pump includes at least one of 9 plungers or 11 plungers.
18	18. The hydraulic fracturing system of claim 11, wherein the electric powered, multi-plunger pump includes more than 5 plungers.

19	19. The hydraulic fracturing system of claim 11, wherein the motor is powered by at least one of a turbine generator, a diesel generator, a natural gas generator, grid power, or a combination thereof.
20	20. The hydraulic fracturing system of claim 11, wherein a first length of the support structure is less than or equal to a second length of a second support structure associated with two quintuplex pumps.

B. PROSECUTION HISTORY OF THE '863 PATENT

40. The Patent Office issued a first Non-Final Office Action on September 20, 2021, rejecting Claims 1, 3-11, and 13-20 as being anticipated by, or, in the alternative, rendered obvious over, U.S. Patent No. 10,988,998 (“*Fischer*,” Ex. 1008), and rejecting Claims 2 and 12 as being rendered obvious under *Fischer* in view of U.S. Patent Publication 2017/0030177 (“*Oehring-I*,” Ex. 1012).¹

41. In response, the Applicant argued that *Fischer* is not prior art. *Fischer*’s filing date is February 14, 2020, and it claims priority to U.S. Provisional Application No. 62/805,521 (“*Fischer Provisional*,” Ex. 1009), which has a filing date of February 4, 2019. The Applicant argued that *Fischer* is not entitled to *Fischer Provisional*’s filing date, because *Fischer* does not meet the *Dynamic Drinkware* requirement that a reference patent’s claims must have written description support in its provisional application to be entitled to the filing date of the provisional application.² In particular, the Applicant argued that *Fischer*

¹ Ex. 1002 (’863 Patent *File History*), 219-229.

² Ex. 1002 (’863 Patent *File History*), 185-186

Provisional does not describe elements in Claims 1 and 2 of *Fischer* related to “a first vibration damping assembly” and a “power cell assembly.”³

42. Further, the Applicant argued that “the cited portions of *Fischer* are directed to subject matter not found in the *Provisional*,” such as “the disclosure of FIGS. 4-6” in *Fischer*.⁴

43. Following these arguments, the Patent Office withdrew *Fischer* as a prior art reference and issued a notice of allowance on May 25, 2022.⁵

C. PRIORITY DATE OF THE '863 PATENT

44. The application leading to the '863 Patent was filed on October 1, 2020 as Application 17/060,647 and claimed priority to provisional application No. 62/910,163, which was filed on October 3, 2019.⁶ For purposes of this declaration, I assume without conceding that the effective filing date of the '863 Patent is October 3, 2019.

³ Ex. 1002 ('863 Patent File History), 186.

⁴ Ex. 1002 ('863 Patent File History), 187-188 (also arguing that the “switchgear transformer 335” of *Fischer Provisional* “is illustrated as being part of a power distribution system 320 and does not appear to be associated with the VFD 340n,” and therefore does not read on Claim 1 of the '863 Patent)

⁵ Ex. 1002 ('863 Patent File History), 13.

⁶ Ex. 1001 ('863 Patent), items (21), (22), and (60).

VII. LEVEL OF ORDINARY SKILL IN THE ART

45. A person of ordinary skill in the art would have either (1) a Bachelor of Science in Mechanical Engineering, Electrical Engineering, Petroleum Engineering, or an equivalent field as well as at least 2 years of academic or industry experience in the oil and gas industry, including well drilling, completion, or production, or (2) at least four years of industry experience in the oil and gas industry including well drilling, completion, or production.

VIII. CLAIM CONSTRUCTION

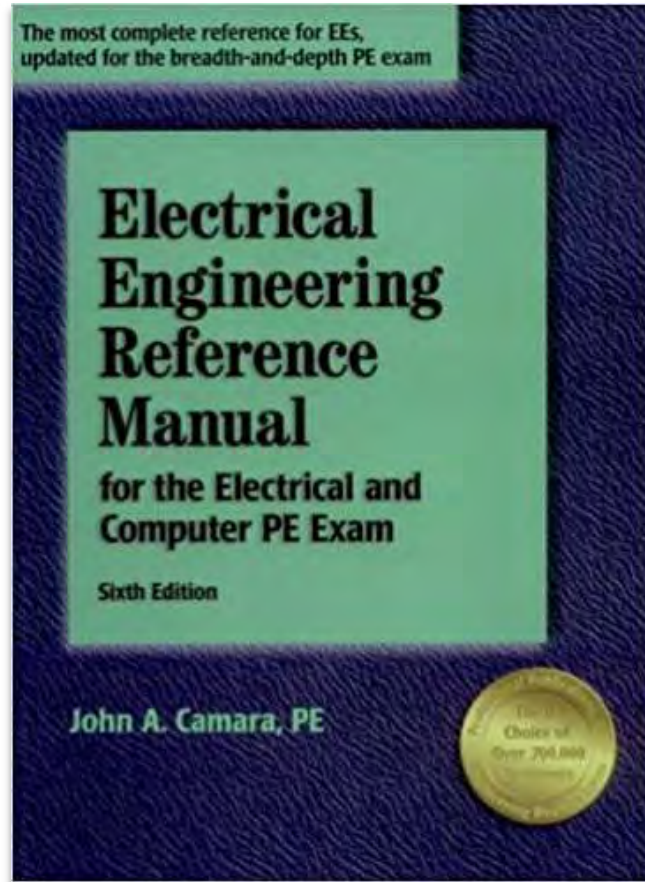
46. It is my opinion that a POSITA would understand all the claim terms to have their plain and ordinary meaning, and I have applied the plain and ordinary meaning, in the context of the '863 Patent, for all claim terms.

IX. TECHNOLOGY BACKGROUND AND STATE OF THE ART

A. EE-REFERENCE (EX. 1019)

47. EE-Reference refers to a textbook authored by John A. Camara, entitled "Electrical Engineering Reference Manual for the Electrical and Computer PE Exam." This particular version of EE-Reference is the Sixth Edition, was published in 2002 by Professional Publications, Inc., and has ISBN: 1-888577-56-8. Exhibit 1019 contains true and correct copies of pages from EE-Reference. I acquired my copy of EE-Reference around 2005, have used it in my regular practice of engineering since then, and have taught Professional Engineering (PE) Exam

courses out of it. The cover of EE-Reference states that it is “[t]he most comprehensive resource available for the electrical PE exam.”



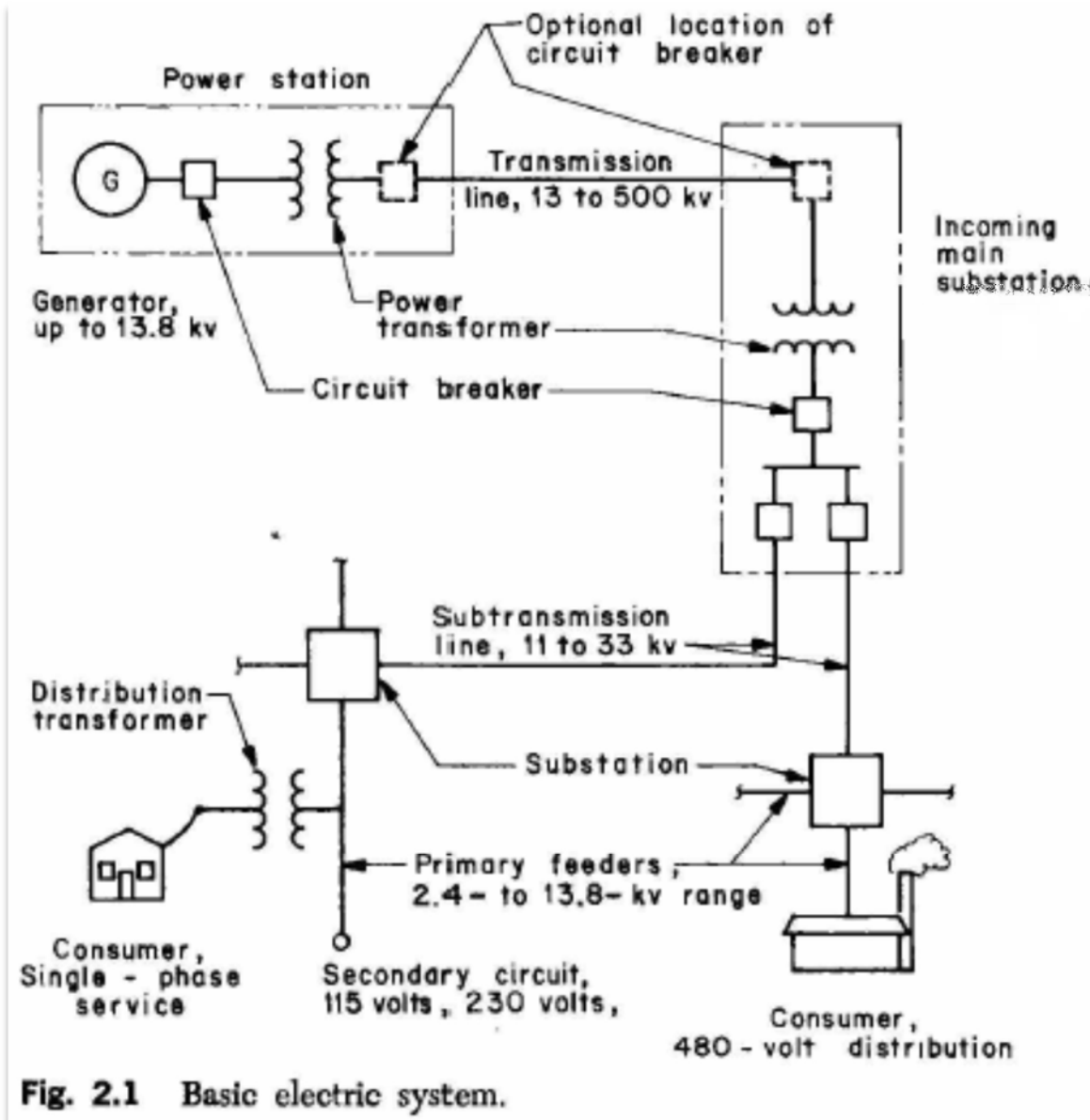
Ex. 1019 (cover)

48. EE-Reference provides evidence of general engineering knowledge, known in the field decades before the priority date of the Challenged Patent. Further discussion of Exhibit 1019 and the well-known and fundamental engineering information it contained is discussed below.

B. BASIC ELECTRIC SYSTEMS

49. The configuration of transmission lines, substations, power generation, and dedicated power generation sub-systems, and how they deliver power to electric motors, was well-known general engineering knowledge.

50. For example, Chapter 2 of Roe is entitled “The Basic Electric System.” The layout of a basic electric system was known at least by 1972 at the time of Roe, and is shown below in Figure 2.1 from Roe:



Ex. 1020 (Roe) p. 9 (Fig. 2.1).

51. Roe then discusses basic components, which I summarize in the subsections below, including generators, transmission lines, switchgear, step-up transformers, step-down transformers, and other such components.

52. Another example of the pervasiveness of the general-engineering knowledge associated with a basic electric system is shown in EE-Reference (Exhibit 1019), whose full title is *Electrical Engineering Reference Manual for the Electrical and Computer PE Exam*. As implied by the title, this was a basic engineering reference manual that engineers used in 2002 (more than a decade before the earliest possible priority date of the '863 Patent), including to study for their Professional Engineer examinations. EE-Reference includes Chapter 35, entitled "Power Distribution." Within this chapter, EE-Reference includes Section 35.1, entitled "Fundamentals." The Fundamentals section shows a power distribution system, figure copied below, with components similar to those shown in Exhibit 1020 (Roe).

EE-Reference defines an "electric distribution system" as follows:⁷
The *electric distribution system* is the circuitry, high-voltage switchgear, transformers, and related equipment that receives high voltage from the source and delivers it at lower voltages. Its function is to receive power from large bulk sources, that is, generation sources, and distribute it to users at the voltage level and degree of reliability required. A hypothetical distribution system one-line diagram is shown in Fig. 35.1. The electric utility may consider the distribution system as that portion of Fig. 35.1 from the distribution substation to the consumer. The symbols used are explained in Fig. 35.2.

Figures 35.1 and 35.2 from EE-Reference are shown below.

⁷ Ex. 1019 (EE-Reference) p. 35-1

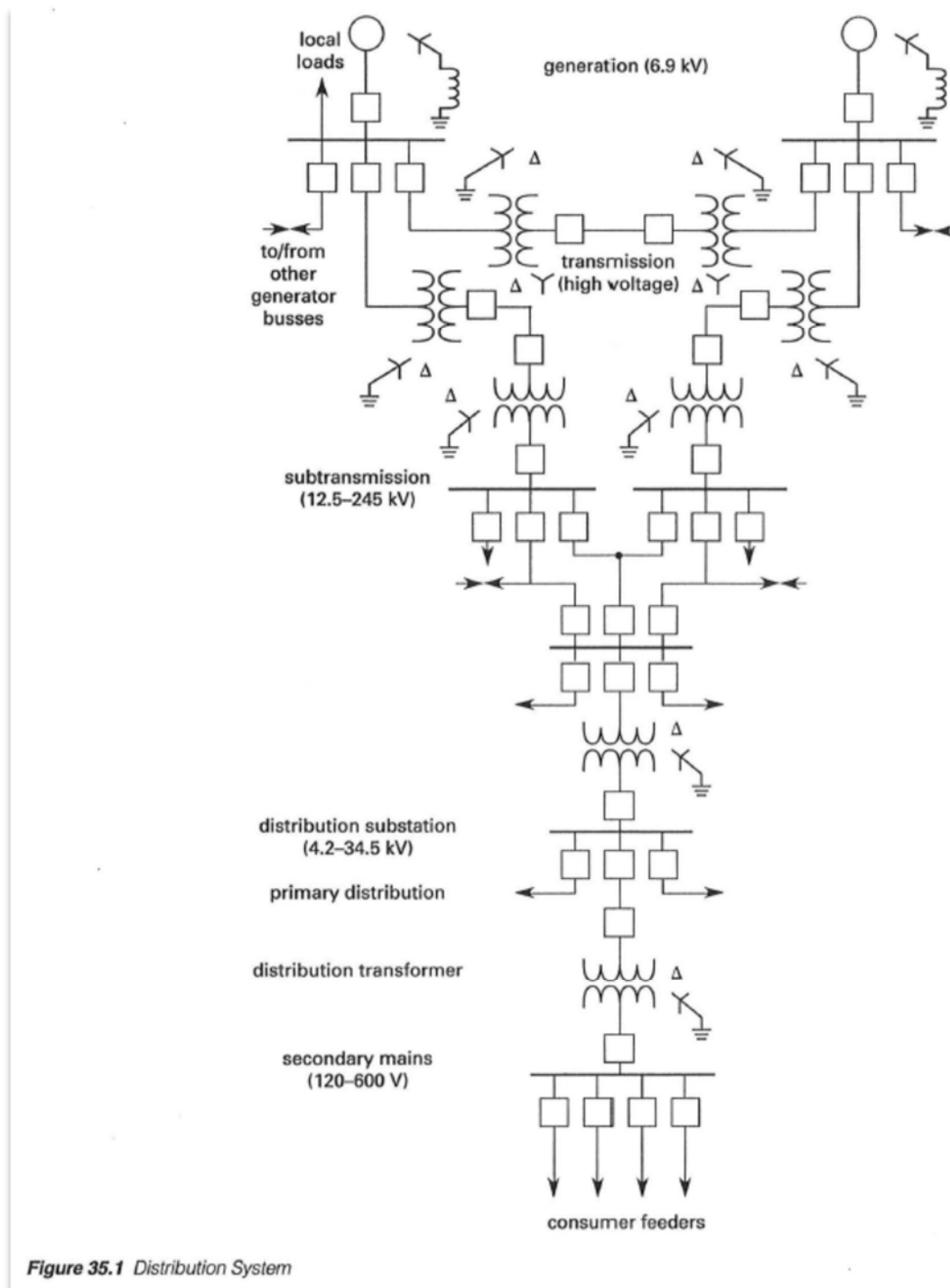
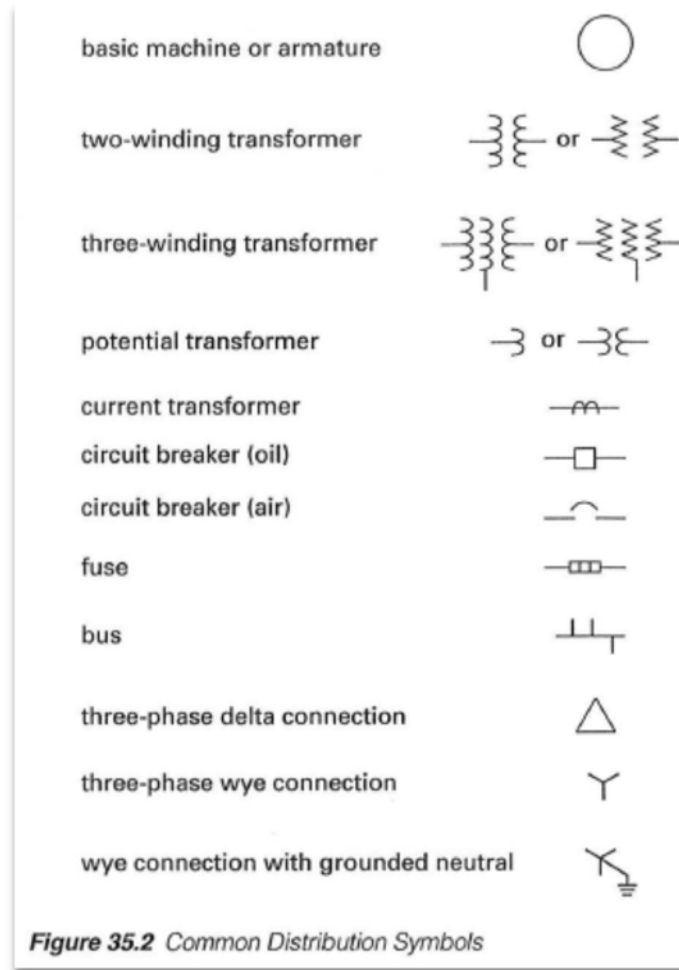


Figure 35.1 *Distribution System*

53.

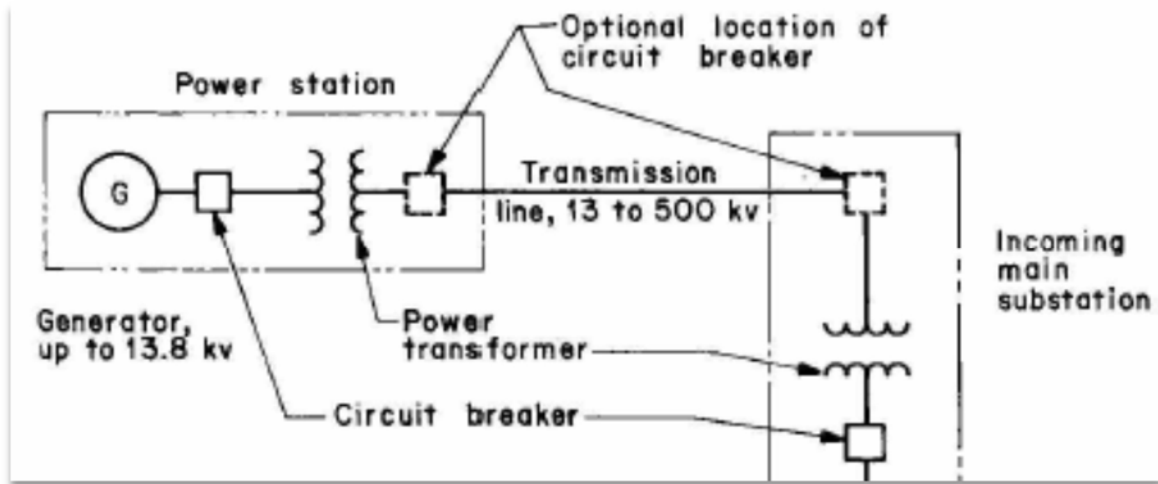


Ex. 1019 (EE-Reference) p. 35-2, 35-3 (Figs. 35.1, 35.2).

54. Components of the basic electric system are further explained below, each of which would have been well-known in the art and part of general engineering knowledge long before the filing date of the '863 Patent.

C. POWER GENERATION

55. It was general engineering knowledge that a “generator is a device used to transform energy into electrical energy.”⁸ The generator is identified with a circled “G” in the top-left corner:



Ex. 1020 (Roe) p. 9 (Fig. 2.1) (excerpted).

56. Roe teaches that “[t]he standard frequency in the United States” for transmission of electrical energy “is 60 cycles per second (cps) for normal utility systems.”⁹ The generator is connected to a “prime mover” (e.g., engine or turbine), which is fueled with a source of energy such as “fossil fuels.”¹⁰ The generator “produces electricity at a relatively low voltage,” such as “up to 13.8 kV.”¹¹

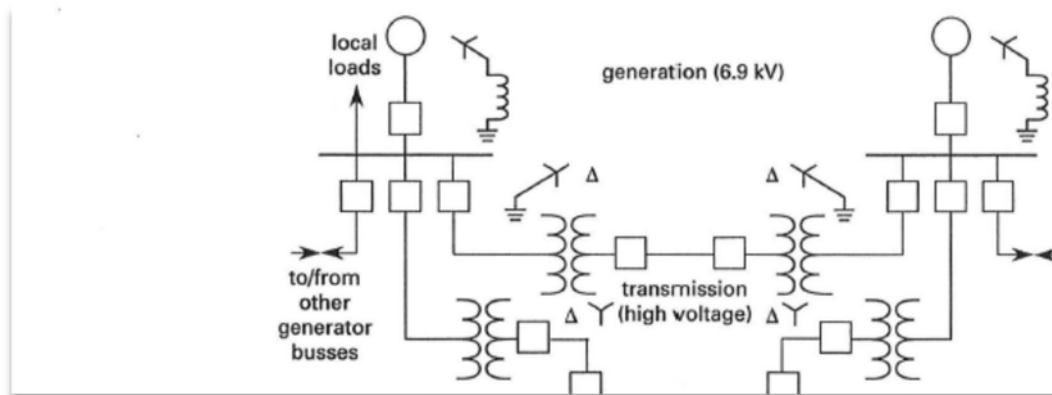
⁸ Ex. 1020 (Roe), p. 9.

⁹ Ex. 1020 (Roe), p. 9-10.

¹⁰ Ex. 1020 (Roe), p. 8.

¹¹ Ex. 1020 (Roe), p. 8-9 (Fig. 2.1).

57. EE-Reference provides an example of a generator operating at 6.9 kV (kilovolts).



Ex. 1019 (EE-Reference) p. 35-2 (Fig. 35.1) (excerpted).

58. Chapter 33 of EE-Reference provides further descriptions of generators, and prime movers such as turbines, mechanical drives, etc. Further, Chapter 33 (section 33.7) discusses the "Parallel Operation" of generators. Parallel operation of generators is simply operating generators in a fashion so that they share the load. EE-Reference states, "One or more generators may be attached to a given power bus."¹² "Parallel operation of generators occurs for myriad reasons, including shifting of the load to shut down a generator for maintenance, to increase the capacity available and so on."¹³ Further, "the division of real load among generators operating

¹² Ex. 1019 (EE-Reference), p. 35-1

¹³ Ex. 1019 (EE-Reference), p. 33-6.

in parallel [i.e., load sharing] is determined by the speed of the generators and the characteristics of the prime mover speed-governing system.”¹⁴

D. TRANSMISSION LINES

59. It was general engineering knowledge that a “transmission line is a system of conductors, such as wires, waveguides, or coaxial cables, that conducts power or transmits signals from one terminal to another.”¹⁵ For a single-phase system, it was generally known that transmission lines would include two “wires” (hot and neutral), sometimes with a separate ground wire. For a three-phase system, it was generally known that transmission lines would include 3-5 wires (3 phase wires, sometimes a neutral wire, and sometimes a ground wire).

60. It was generally known that transmission lines could be essentially any length, as needed, based on the distance from one electrical components to another.¹⁶ According to Roe, the purpose of transmission lines “is to span long distances.”¹⁷ Accordingly, transmission lines of a distance of ½ mile or more were readily known and applied. The calculations used to analyze transmission lines of varying lengths were well-known, such as those described in Chapters 27 and 37 of EE-Reference.

¹⁴ Ex. 1019 (EE-Reference), p. 33-7.

¹⁵ Ex. 1019 (EE-Reference), p. 37-2; *see* Ex. 1020 (Roe) p. 11.

¹⁶ *See* Ex. 1019 (EE-Reference), p. 37-3 (describing transmission lines that can be between “0” and “240 km (150 mi)” long).

¹⁷ Ex. 1020 (Roe), p. 11-12.

E. CIRCUIT BREAKERS AND SWITCHGEAR

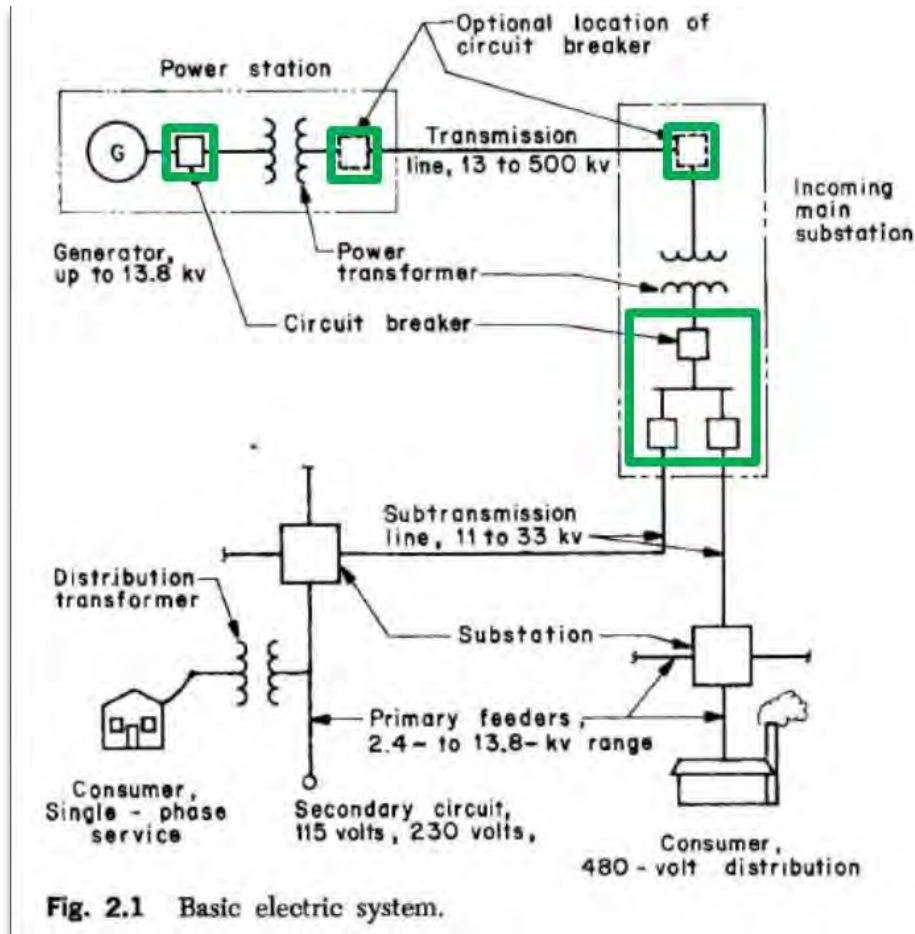
61. It was general engineering knowledge to include multiple terminus points within a power-distribution system in order to readily connect and disconnect certain components, such as for purposes of maintenance or to prevent damage from excessive currents. In 1972, Roe described circuit breakers as follows:¹⁸

The conductors leaving the generator terminate in a *circuit breaker*. The function of this piece of equipment is to prevent excessive currents in the system beyond the generator. At the same time, it can be made to serve as a protective device to prevent overloading of the generator. Circuit breakers come in many forms, shapes and sizes. . . .

With all these differences, all circuit breakers have one thing in common: They disconnect a circuit from the supply when the current in the system exceeds predetermined limits. The circuit breaker may also serve double duty as a disconnect device or switch, being operated manually instead of automatically.

Roe depicts multiple sets of circuit breakers, some of which have been annotated in green below:

¹⁸ Ex. 1020 (Roe) p. 10.



Ex. 1020 p. 9 (Fig. 2.1) (annotated).

62. As can be seen in Roe, it was generally known to place a circuit breaker between a generator and a transformer, in order to isolate one from another.

63. It was also generally known that a circuit breaker along with its associated control, instrumentation, metering, protective devices and supporting structures is referred to as “switchgear.” For example, the IEEE Standards Dictionary in 2000 described switchgear in such a manner.

switchgear (1) A general term covering switching and interrupting devices and their combination with associated control, instrumentation, metering, protective and regulating devices, also assemblies of these devices with associated interconnections, accessories and supporting structures used primarily in connection with the generation, transmission, distribution, and conversion of electric power.

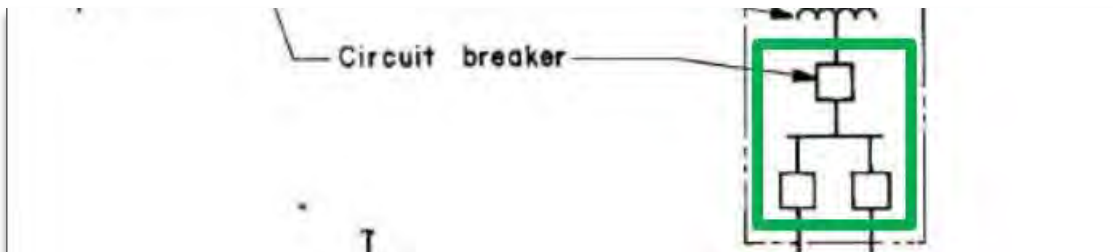
(SWG/PE/IA/PSP) C37.20.3-1996, 1015-1997,
C37.20.2-1993, C37.20.1-1993r, C37.100-1992

(2) (hydroelectric power plants) An assembly of equipment used to switch and control electrical power.

(PE/EDPG) 1020-1988r

Ex. 1021 (IEEE Standards Dictionary) p. 1135.

64. It was also generally known that switchgear often contains multiple circuit breakers, as depicted in annotated Figure 2.1 from Roe.



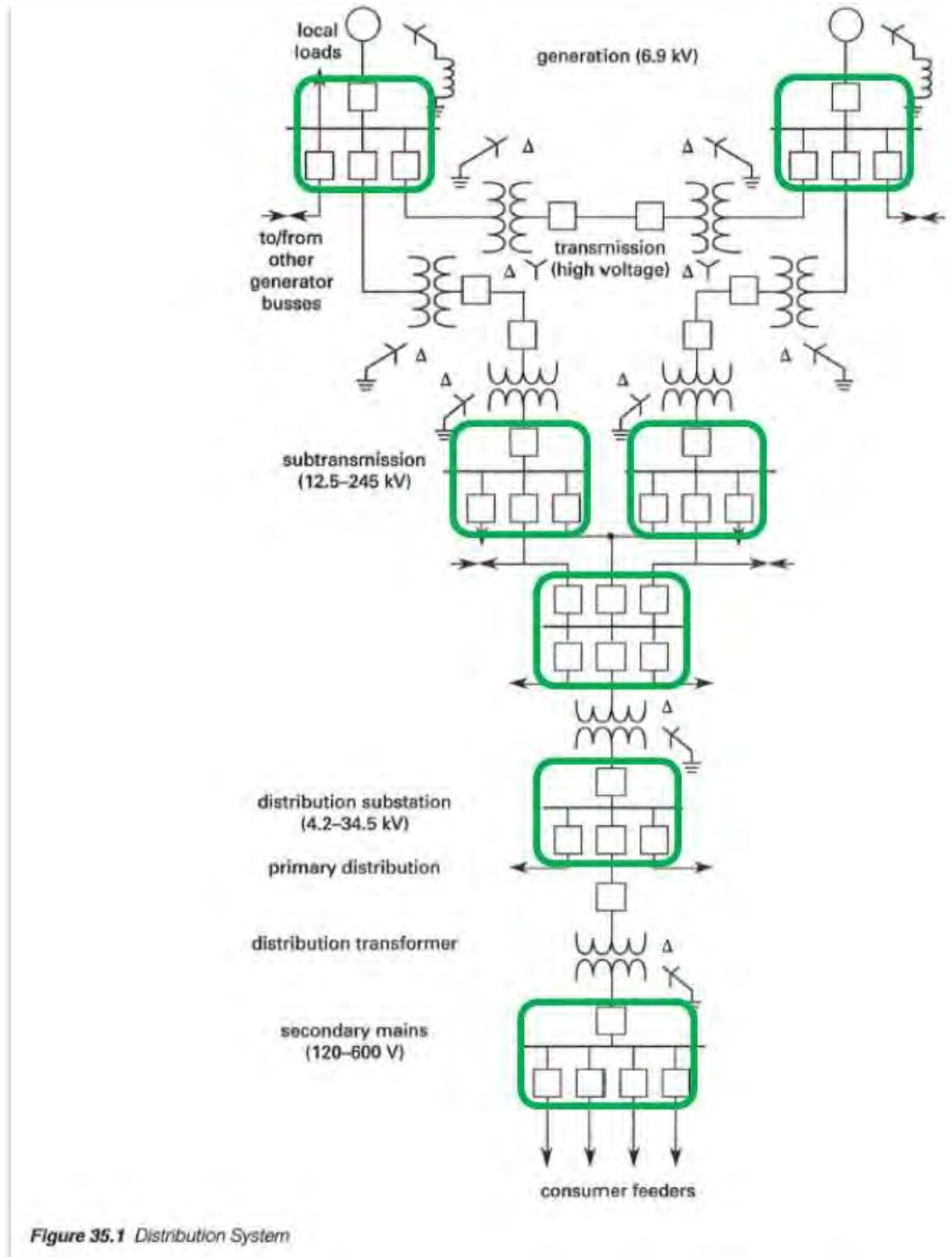
Ex. 1020 (Roe) p. 9 (Fig. 2.1) (excerpted and annotated).

65. The above switchgear is depicted as a component of a substation—
“the part of an electric system containing one or more power transformers, switchgear, bus-bar distribution, regulating equipment and (sometimes) a control building.”¹⁹

¹⁹ Ex. 1020 (Roe) p. 13

66. Multiple switchgears are also depicted in Figure 35.1 of EE-Reference.

These are annotated in green.



Ex. 1019 (EE-Reference) p. 35-2 (Fig. 35.1) (annotated).

67. As seen above, it was generally known to place switchgear in multiple locations in the power distribution system, particularly where voltage changes or portions of the power system need to be disconnected manually or automatically.

68. As another example of the widespread use of switchgear, U.S. Patent 1,743,771 (“Hall,” Exhibit 1022, filed in 1926) describes a “system of electric distribution” containing “an automatic switching arrangement for controlling the connections between a plurality of sources and a plurality of distribution circuits.”²⁰ Hall describes “two distribution busses which are adapted to be connected together by a tie breaker,” sources including “generator 4 which is adapted to be connected to the bus 1 by means of a circuit breaker 5,” and loads that can be supplied by multiple generators or a single generator, depending on the size of the load.²¹ While Hall does not use the word “switchgear” verbatim, it does nevertheless disclose a switchgear. The “automatic switching arrangement for controlling the connections,” “tie-breaker,” and “circuit breaker 5” are all examples of switchgear and would have been recognized as such by a POSITA.²²

²⁰ Ex. 1022 (Hall), p. 1 lines 1-5.

²¹ Ex. 1022 (Hall), p. 1 lines 34-52.

²² See Ex. 1021 (IEEE Standards Dictionary), p. 1135 (defining “switchgear”).

F. TRANSFORMERS

69. It was general engineering knowledge that transformers were components that enable efficient transmission of electrical energy in power-distribution systems:

A transformer is an electrical device consisting of two or more multiturn coils of wire placed in close proximity in order to link the magnetic field of one to the other. This linkage allows the transfer of electrical energy from one or more alternating circuits to one or more other alternating circuits through the process of magnetic induction. The transformer can be used to raise or lower the value of a capacitor, inductor, or resistor. It enables the efficient transmission of electrical energy at high voltage over great distances [i.e., using a step-up transformer], and then is used to lower the voltage to safe values for industrial, commercial, and household use [i.e., using a step-down transformer].

Ex. 1019 (EE-Reference), p. 28-1.

70. It was general engineering knowledge that transformers can be broadly classified as “step-down” (decreases voltage) or “step-up” (increases voltage) transformers, depending on the number of winding turns on the transformer:

If the turns ratio is greater than unity, the transformer decreases the voltage and is termed a *step-down* transformer. If the turns ratio is less than unity, the transformer increases the voltage and is termed a *step-up* transformer.

Ex. 1019 (EE-Reference), p. 28-4.

71. ***Step-up transformer:*** It was general engineering knowledge that a generator “produces electricity at a relatively low voltage,” such as “up to 13.8 kV”

(shown in Fig. 2.1).²³ “To prepare the electricity for transmission over long distances, it is fed into a device known as a transformer. The voltage is then raised by transformer action.”²⁴ The step-up transformer allows for longer-distance electric power transmission while reducing electric losses. As was known to engineers, stepping up the voltage reduces the amount of power lost in transmission due to the well-known relationship between voltage, current, and power. Electric power is the product of the voltage and current as shown below:²⁵

$$P = V \cdot I$$

72. In the above equation, P is the power being transmitted (Watts), V is the voltage (Volts), and I is the current (Amps). As a POSITA would have readily understood, for a fixed amount of power being transmitted, as voltage increases, current will necessarily decrease. Resistive losses in transmission are governed by the relationship shown below:

$$P_{loss} = I^2 \cdot R$$

73. In the above equation, P_{loss} is the amount of power lost in transmission (Watts), I is current (Amps), and R is resistance (Ohms). As current decreases, the

²³ Ex. 1020 (Roe), p. 8-9.

²⁴ Ex. 1020 (Roe), p. 8

²⁵ This is the simplest definition used for DC and single-phase AC systems. For three-phase AC systems, the relationship is $\sqrt{3} \cdot V \cdot I^*$, where I^* is the mathematical conjugate of the current.

transmission line's losses decrease by a squared factor. For example, if voltage is increased by a factor of 10 (e.g., from 5 kV to 50 kV), the amount of current will decrease by a factor of 10, and losses will decrease by a factor of 100 (i.e., 10^2). Thus, it was generally known to increase the efficiency of an electrical transmission system by using step-up transformers to increase voltage for transmission and by using step-down transformers to lower the voltage for use.

74. Roe provides a section entitled “The Stepup Transformer,” which explains the generally known concept (even in 1972 and well before) that the “purpose of the transformer is to raise the voltage from the rated voltage of the generator to a new voltage level, suitable for transmitting over long distances.”²⁶ Functionally, a “step up” transformer is used anytime voltage needs to be increased.

75. ***Step-down transformer:*** It was general engineering knowledge that after the voltage has been transmitted long distance, it is too high to be safe “for industrial, commercial, and household use.”²⁷ The purpose of the step-down transformer is to reduce the voltage from the level used in the transmission line to one more suitable for distribution to various locations or equipment. As described by Roe, “The transmission line terminates in a stepdown transformer,” with

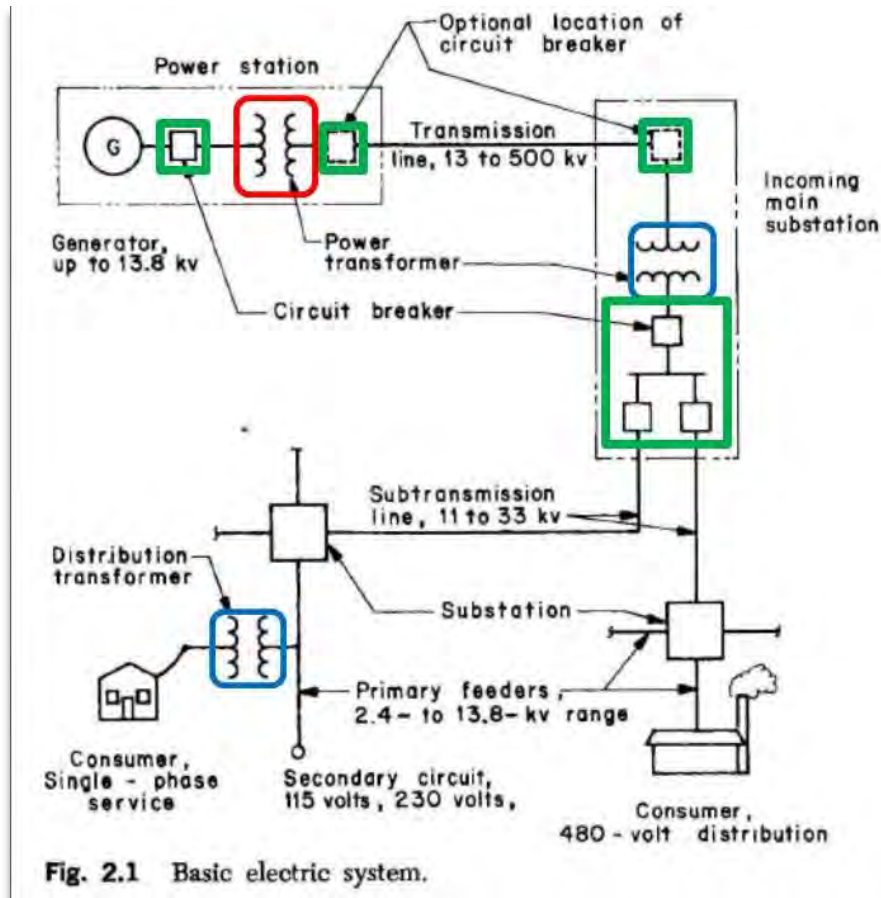
²⁶ Ex. 1020 (Roe) p. 10.

²⁷ Ex. 1019 (EE-Reference), p. 28-1.

appropriate switchgear, as shown in Figure 2.1.²⁸ Functionally, a “step-down” transformer is used at any place where voltage levels need to be reduced. Step-up and step-down transformers may also be located inside substations, as described further in the sections below.

76. Example locations of step-up and step-down transformers are shown in both Roe Figure 2.1 and EE Reference Figure 35.1. In the diagrams below, step-up transformers have been annotated with red rectangles, and step-down transformers have been annotated with blue rectangles. Some switchgear are annotated in green. Switchgear are also part of the substations, as described in Section IX.E.

²⁸ Ex. 1020 (Roe), p. 12.

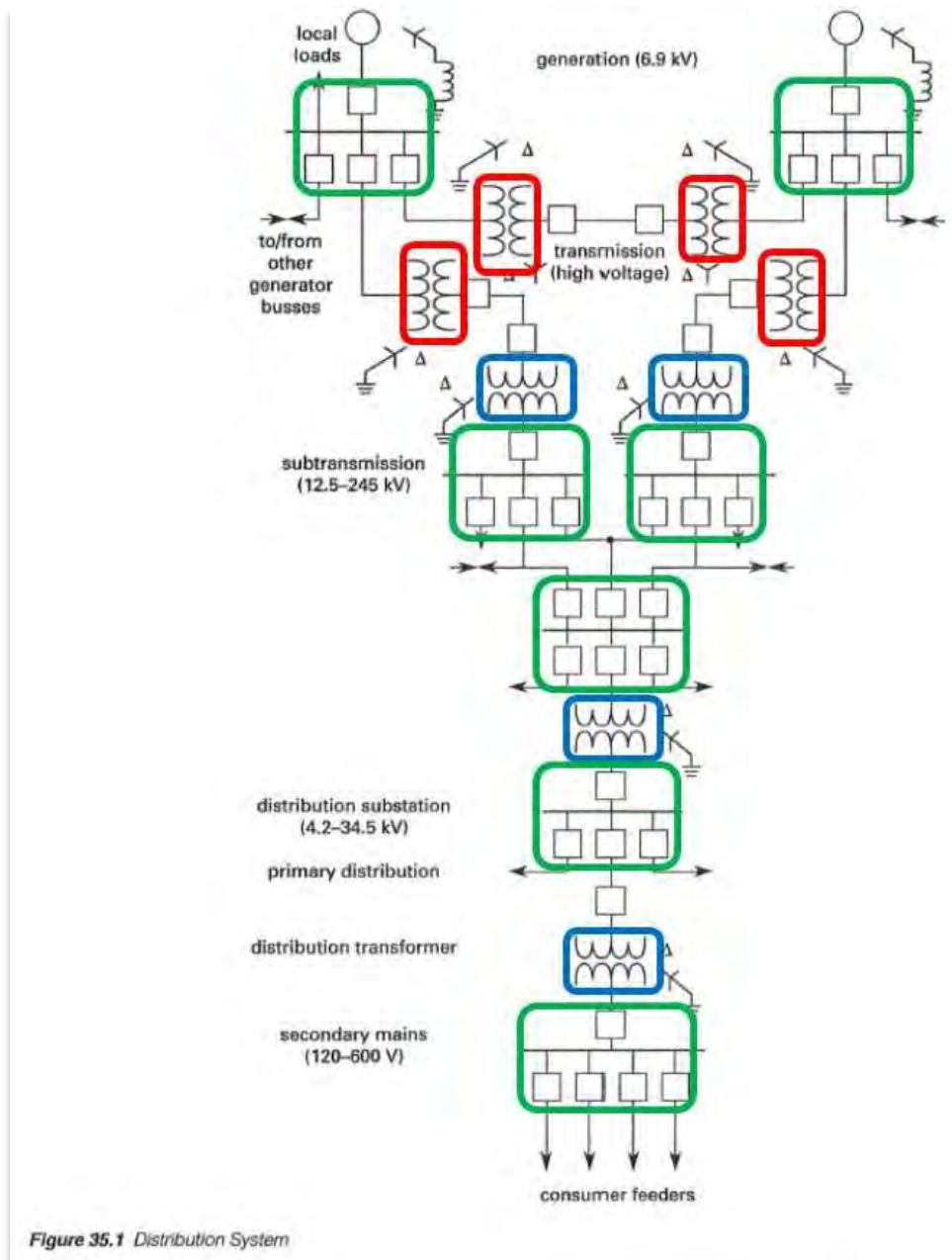


Ex. 1020 (Roe) p. 9 (Fig. 2.1) (annotated).

77. In the figure above from Roe, a step-up transformer (red) is located between the generator and transmission line and is used to increase the voltage from “up to 13.8 kV” to “13 to 500 kV” for transmission over the transmission line. A step-down transformer (blue) then decreases the voltage at the main station down to “11 to 33 kV.” Another step-down transformer (labeled “Distribution transformer”) is then used to further decrease the voltage. Transformers are also included in the substations, as described in Section IX.E.

78. EE-Reference also provided numerous examples of step-up transformers (red) and step-down transformers (blue). Certain switchgear are also shown (green).²⁹

²⁹ Some locations of switchgear are not annotated in order to improve clarity of the figure.



Ex. 1019 (EE-Reference) p. 35-2 (Fig. 35.1) (annotated).

79. In the above example, the generator (at the top) provides electricity at 6.9 kV. Step-up transformers (red) are located by the generator and are used to increase the voltage for “transmission (high voltage).” The voltage is then reduced to 12.5-245 kV with a step-down transformer (blue) at the subtransmission

substation, to 4.2-34.5 kV at the distribution substation, followed by further reductions in voltage to 120-600 V for distribution through the secondary mains. Switchgear (green) are placed throughout the power system to isolate components from one another.

G. ALTERNATING CURRENT (AC) SYSTEMS

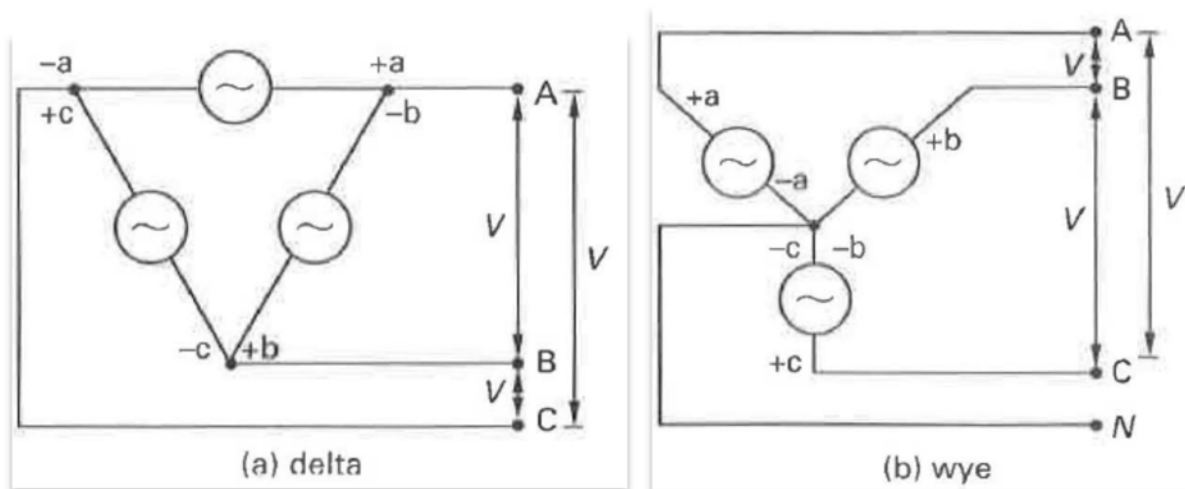
80. It was general engineering knowledge that Alternating Current (AC or a.c.) power systems are those in which “Alternating waveforms have currents and voltages that vary with time in a symmetrical manner ... for the most part, the variations are sinusoidal in time.”³⁰ The use of the term alternating current indicates “that the current is produced by the application of a sinusoidal voltage. This means that the flow of electrons changes directions, unlike DC circuits where the flow of electrons is unidirectional”³¹

81. Single-phase AC systems are those in which there is a single voltage source driving the current. For single-phase systems, at least two connections to the load are needed for the current to flow. These are generally referred to as “hot” and “neutral” connections or “L1” and “L2” when used with motor connections. A separate ground wire is often used to provide personnel and equipment protection and to allow protective devices to operate effectively.

³⁰ Ex. 1019 (EE-Reference), p. 27-1.

³¹ Ex. 1019 (EE-Reference), p. 27-1.

82. Three-phase AC systems are those in which there are three voltage sources driving current. A single physical structure can provide those three sources, such as an “AC generator that produces three equal sinusoidal voltages,” which “are 120° apart in phase.”³² As described in EE-Reference, “a six conductor transmission line could be used to transmit the three voltages” by treating them as three separate single-phase voltages, but “it is more efficient to interconnect the windings.”³³ Two connection types are delta and wye, as shown in Figure 34.2 from *EE Reference*.



Ex. 1019 (EE-Reference) p. 34-2.

83. Delta-connected power systems require three phase wires (plus a ground if required). Wye-connected power systems require three phase wires plus

³² Ex. 1019 (EE-Reference), p. 34-1.

³³ Ex. 1019 (EE-Reference), p. 34-2.

a neutral (plus a ground if required)³⁴. The neutral wire carries any imbalance from the loads back to the source.

84. It was general engineering knowledge that there are several benefits to using three-phase systems over single-phase systems, particularly in the context of large electrical loads such as large electric motors.

Three-phase energy distribution systems use fewer and smaller conductors and, therefore are more efficient than multiple single-phase systems providing the same power. Three-phase motors provide a uniform torque, not a pulsating torque as do single-phase motor. Three-phase induction motors do not require additional starting windings or associated switches. When rectified [converted to DC], three-phase voltage has a smoother waveform and less ripple to be filtered out.

Ex. 1019 (EE-Reference) p. 34-1.

85. This is due to the difference in power relationships between single-phase and three-phase systems. The power relationship for single-phase systems is:

$$P = V \cdot I$$

while the power relationship for three-phase systems is:

$$P = \sqrt{3} \cdot V \cdot I^*$$

86. Thus, for a three-phase system, current is reduced by a factor of $\sqrt{3}$ (~1.73) compared to a single-phase system. This allows for smaller conductors,

³⁴ Certain balanced three phase wye connected system are operated with only three wires, though this is limited in application primarily to single loads, such as a three-phase motor.

decreased losses, and increased efficiency. As a result, nearly all larger power systems are configured as three-phase systems.

H. ELECTRIC MOTORS

87. It was general engineering knowledge that electric motors are a subset of rotating electric machinery (rotating machines) in which electric power is converted to rotational mechanical energy.³⁵

Rotating machines are broadly categorized as AC and DC machines. Both categories include machines that use [electric] power (i.e. motors) and those that generate [electric] power (alternators and generators). Most machines can be constructed in either single-phase or polyphase [three-phase] configurations, although single-phase machines may be outclassed in terms of economics and efficiency. [] Large AC motors are almost always three-phase.

88. Electric motors have been manufactured to one or more standards, depending on the application and size. For example, motors up to 500 horsepower (Hp) are manufactured at least to the specifications of the National Electrical Manufacturer's Association (NEMA) Standard MG-1. Severe duty motors larger than 500 HP used in oil and gas applications are manufactured to the American Petroleum Institute (API) standard 541 specifications.

89. The National Electrical Manufacturer's Association (NEMA) was founded in the 1920s and is an ANSI- (American National Standards Institute)

³⁵ Ex. 1019 (EE-Reference) p. 40-1.

accredited Standards Developing Organization (SDO) made up of business leaders, electrical experts, engineers, scientists, and technicians. NEMA convenes a neutral forum for Members to discuss industry-wide concerns and objectives under a legal umbrella by trained NEMA Staff.

90. It is inherent that electric motors have a plurality of connections to the power source in order to operate. As in all electric circuits, there must be a complete path between the power source (e.g., generator) and the load (motor) for current to flow and for the electric equipment (motor) to operate. The complete path requires a minimum of two connections for each load, generally designated as L1 and L2 for single-phase or DC motors and L1, L2, and L3 for three-phase motors.

I. ADJUSTABLE SPEED DRIVES / VARIABLE FREQUENCY DRIVES

91. By way of background, a Variable Frequency Drive (VFD) is another term for and type of Adjustable Speed Drive (ASD). ASD is the preferred term. Nevertheless, based on my experience, the term VFD has been commonly used, so I also use the terms interchangeably in this declaration.

92. *Standard Handbook for Electrical Engineers* from 1993 (Exhibit 1033, “Fink”) describes the basic operation of an ASD (VFD) as follows:³⁶

To supply an adjustable frequency to an ac motor, the incoming constant-frequency [fixed frequency] voltage or current must first be

³⁶ Ex. 1023 (Fink), p. 20-85.

rectified to a dc current or voltage. This dc voltage or current is then inverted to an adjustable frequency output. This is accomplished by power semi-conductor devices.

These devices allow current to flow in only one direction. They act as electronic switches. Various types can be fired on and off at certain times in the cycle. This selected firing allows control of the resultant voltage or current.

93. Exhibit 1023 contains true and correct copies of pages from the Fink reference. As an additional example, U.S. Patent Publication No. 2011/0241590 (“Horikoshi,” Exhibit 1024, filed in 2011) describes that such an ASD (VFD) was known for three-phase AC power as well:³⁷

Providing a motor driving apparatus, which is connected to a three-phase AC power supply and which comprises an AC/DC converter for converting three-phase AC power supplied from the three-phase AC power supply into DC power and a DC/AC converter for converting the DC power output from the AC/DC converter into three-phase AC power for supply to a motor, is known.

94. The outgoing DC-AC converter modifies the waveform's frequency and/or voltage to control the motor's speed and/or torque.

95. One of the more common ASD topologies, particularly for larger motors, is a “pulse-width modulated (PWM)” drive topology. PWM drives have several advantages over other drive topologies, including “high line-side power factor (near unity)” and the “distortion seen by the electrical network is ... reduced.”

³⁷ Ex. 1024 (Horikoshi), [0004].

Additionally, “high dynamic performance can also be realized. Full torque can be maintained and controlled throughout the speed range – even at zero speed.”³⁸

96. One of the methods of determining the power of a rotating piece of equipment (*e.g.*, a motor) is the well-known relationship: Power = (Torque) x (rotational speed). This formula is expressed as: $P = \tau \cdot \omega$. Thus, by controlling the speed and/or torque (inherently functions of PWM drives), the drive also controls the power of a motor and maintains that power within the motor's operating range.

97. ASDs (VFDs) were also known to be used to control motors in hydraulic fracturing operations. By at least 2012, Coli described “an electrically powered fracturing system” that used variable frequency drives to control the speed of the fracturing pumps. Coli discloses how the electrification of the fracturing operation can improve costs,³⁹ efficiency, safety,⁴⁰ and environmental impact.⁴¹ Regarding safety, Coli discloses that “[e]lectric motors controlled via variable frequency drive are far safer and easier to control than conventional diesel-powered equipment.”⁴² Coli explains that because “electric motors are controlled by variable

³⁸ Ex. 1023 (Fink), p. 20-89.

³⁹ Ex. 1025 (Coli) at [0075].

⁴⁰ Ex. 1025 (Coli) at [0066].

⁴¹ Ex. 1025 (Coli) at [0080].

⁴² Ex. 1025 (Coli) at [0066].

frequency drives [] the control software and variable frequency drives [“VFD”] calculate a maximum current available to the motors.”⁴³

98. Similarly, by 2012, *Broussard* taught “[a] system for hydraulically fracturing an underground formation” that “includes a plurality of electric pumps fluidly connected to the well, and configures to pump fluid into the wellbore at high pressure so that the fluid passes from the wellbore into the [formation] and fractures the formation.”⁴⁴ *Broussard* further teaches that the “electric pumps” comprise “pumps 10 [that] are powered by electric motors 14.”⁴⁵ “In addition,” *Broussard* teaches, “each electric motor 14 can be equipped with a variable frequency drive (VFD) [] that controls the speed of the electric motor 14, and hence the speed of the pump 10.”⁴⁶

J. VFD PACKAGES

99. As another example of general engineering knowledge, standards governing construction of ASD/teach the combination of transformers and VFDs in a package to control the speed and torque of an electric motor. For example, NEMA

⁴³ Ex. 1025 (Coli) [0065].

⁴⁴ Ex. 1026 (Broussard) at Abstract.

⁴⁵ Ex. 1026 (Broussard) 3:23.

⁴⁶ Ex. 1026 (Broussard) 3:39 – 42.

ICS 61800-4 (“61800-4”) is a manufacturing standard for adjustable speed drives published in 2004.⁴⁷

100. NEMA is the National Electrical Manufacturer’s Association. NEMA was founded in the 1920s and is an ANSI-accredited Standards Developing Organization (SDO) made up of business leaders, electrical experts, engineers, scientists, and technicians. NEMA convenes a neutral forum for Members to discuss industry-wide concerns and objectives under a legal umbrella by trained NEMA Staff.

101. One group of standards developed by NEMA are the Industrial Control and Systems (“ICS”) family of standards. The ICS standards provide practical general information concerning ratings, construction, testing, performance and manufacture of industrial control and systems equipment and terminal blocks. One of the NEMA ICS Standards is NEMA ICS 61800-4 Adjustable Speed Electrical power Drive Systems Part 4: General Requirements – Rating Specifications for a.c. Power Drive Systems above 1000 V a.c. and Not Exceeding 35kV. Ex. 1020 (ICS-61800-4) (published in 2004). ICS 61800-4 reflects general engineering knowledge of power drive systems, including ASDs/VFDs, known over a decade before the priority date of the ’863 Patent.

⁴⁷ Ex. 1028 (NEMA ICS-61800-4)

102. Clause 1.1 of 61800-4 discusses the “Scope and Object” of the standard and contains the following language:

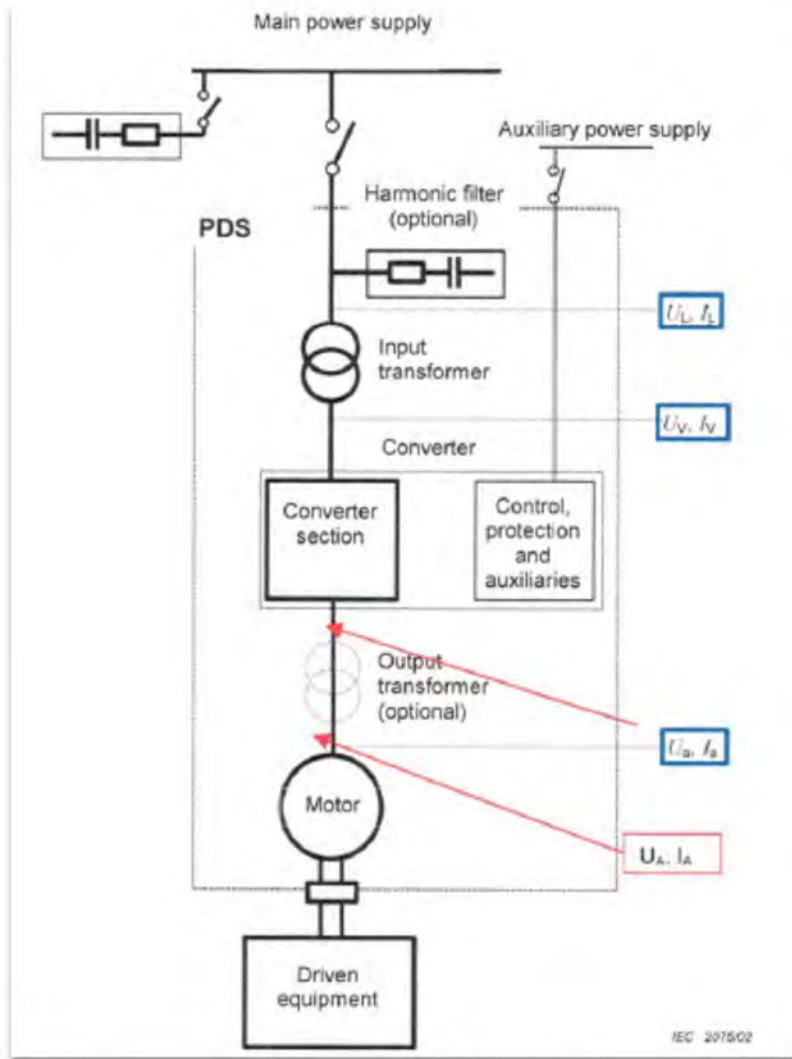
This standard gives the characteristics of the converters, their topologies and their relationship with the complete a.c. drive system. It also states their performance requirements with respect to ratings, normal operating conditions, overload conditions, surge withstand capabilities, stability, protection, a.c. line earthing, topologies and testing. Furthermore, it deals with application guidelines, such as control strategies, torsion analysis, recommendations for earthing and drive system component integration.⁴⁸

103. Thus ICS-61800-4 is a repository of knowledge, and manufacturing requirements, of a.c. power drive systems (PDS).

104. A PDS is defined as a “system with a voltage above 1kV (see figure 1) is an interconnected combination of equipment with provides a means of adjusting the speed of a mechanical load coupled to a motor.” Ex. 1028 (ICS-61800-4), p. 6 (§3.1.1). Figure 1 further describes the PDS, with annotations in the original.⁴⁹

⁴⁸ Ex. 1028 (ICS-61800-4), p. 1 (§1.1)

⁴⁹ Ex. 1028 (ICS-61800-4), p. 7 (§3.1.1) (coloring in original)



Ex. 1028 (ICS-61800-4), Fig. 1 (p. 7).

105. A POSITA would have understood ICS-61800-4 to describe adjustable speed drives (ASD or VFD) and requirements of such drives. It should also be noted that this figure shows switchgear (in the form of circuit breakers and fuses), and a transformer between the switchgear and the motor, both of which are common components of an ASD system.

K. POWER SEMICONDUCTOR HEAT SINKS

106. It has long been known that power semiconductor devices generate substantial heat that must be dissipated (i.e., the devices must be cooled) to prevent damage to the devices. This is particularly true for semiconductor devices used in power applications. Even for the earliest semiconductor devices—namely, transistors—it was generally understood that heatsinks were needed. In fact, in most applications (for example, those described herein), the author simply assumed that the user knew that a heat sink would be necessary.

107. In April 1949, E. Eberhard filed a patent application titled “Flip-Flop Counter Circuit,” which issued under the same name as United States Patent No. 2,533,001 on December 5, 1950.⁵⁰ *Eberhard* refers to “a three-electrode semiconductor amplifier which has been termed a “transistor.”⁵¹ In such amplifiers “a large portion of the power must be dissipated as heat.”⁵²

108. As early as 1957, when discussing the development of an N-P-N Fast Germanium Core Driver Transistor, Chang referenced “the heat sink kept at room temperature.”⁵³

⁵⁰ Ex. 1027 (*Eberhard*) generally

⁵¹ Ex. 1027 (*Eberhard*) at 1:33–35.

⁵² Ex. 1027 (*Eberhard*) at 1:20–22.

⁵³ Ex. 1029 (*Chang*) at 114.

109. As an additional example, in 1972, *Golden* wrote an article discussing the “heat-transfer problems associated with high-power thyristors,” a type of semiconductor device.⁵⁴ *Golden*’s article discusses a method of analyzing “heat sinks used in high-power thyristor equipment” from the perspective of the user.⁵⁵ *Golden* observes that “[a] vacuum exists concerning the establishment of a mathematical or graphical relationship for a given completed heat-sink design that would be useful to the heat-sink user—the solid-state equipment designer.” *Golden* is directed toward liquid cooled heat sinks, as shown below in Figure 1.

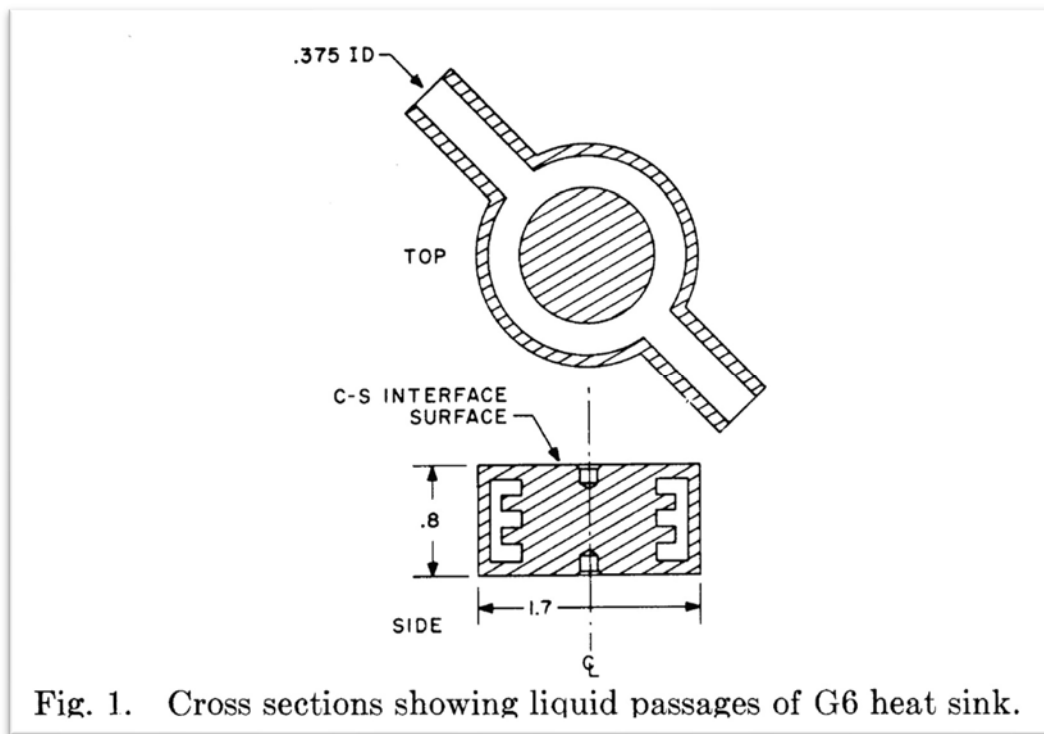


Fig. 1. Cross sections showing liquid passages of G6 heat sink.

Ex. 1030 (*Golden*) , Fig. 1.

⁵⁴ Ex. 1030 (*Golden*) at 601.

⁵⁵ Ex. 1030 (*Golden*) at 601.

110. *Golden* discusses the fact that the cooling effect of the heat sink has a relationship to the flow of coolant through the heat sink. By controlling flow, the amount of heat dissipation (cooling) of the heat sink can be controlled. This is exemplified in Fig. 4 below, which compares the cooling effect of the heat sink to the flow rate of water (H_2O).

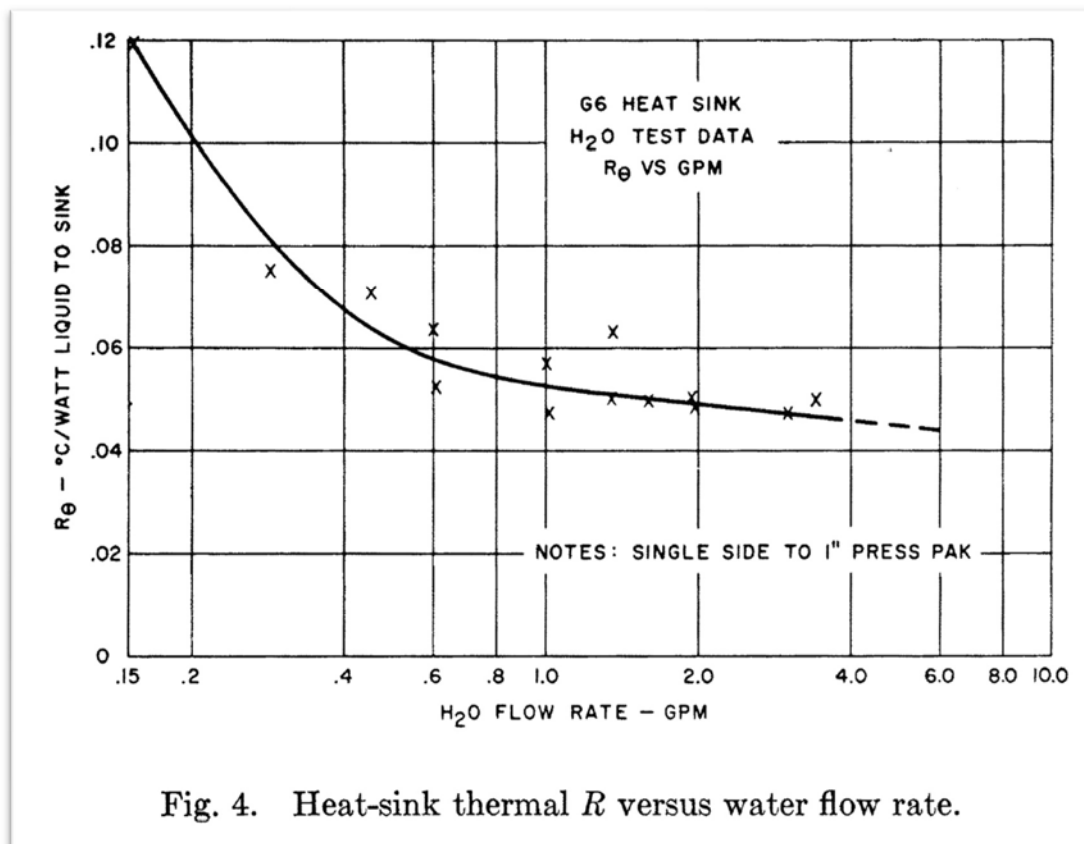


Fig. 4. Heat-sink thermal R versus water flow rate.

Ex. 1030 (*Golden*) , Fig. 4.

Golden then goes on to suggest that plots of heat dissipation versus fluid flow “be made available to the equipment designer together with charts that simplify the

conversion of a given liquid flow rate in gal/min and the liquid property, a Reynolds number based on the heat sink in question.”⁵⁶

111. Liquid cooled heat sinks continued to be used for cooling of power semiconductors through the 1980s. In 1989, Arthur Iversen and Stephen Whitaker wrote a paper titled “A Uniform Temperature, Ultra High Heat Flux Liquid Cooled, Power Semi-Conductor Package,” and directed to “[a] new type of heat exchange process is used for semiconductor heat sinks.”⁵⁷ According to Iversen and Whitaker, “[t]he performance of high power devices such as diodes, thyristors, GTO’s, MOSFETs, etc. is often limited by the heat removal capabilities of the thermal package. [] A common method for power device cooling is the use of high mechanical forces (up to 10 tons) to press the Disc Type package against the external heat sink.”⁵⁸ The paper discusses “a novel packaging and cooling scheme” for high power devices. This novel approach uses specific cooling liquids and curved surface heat sinks used to improve the efficiency of the heat sink.⁵⁹

112. It was also well-known to use heat sinks to cool Insulated Gate Bipolar Transistors (IGBTs), another form of power semiconductor. In 1992, Allen Hefner described an “Electro-Thermal model for the IGBT” by combining “a temperature-

⁵⁶ Ex. 1030 (*Golden*) p. 604.

⁵⁷ Ex. 1031 (*Iversen and Whitaker*) pg 1340.

⁵⁸ Ex. 1031 (*Iversen and Whitaker*) pg 1340.

⁵⁹ See Ex. 1031 (*Iversen and Whitaker*) generally.

dependent IGBT electrical model with dynamic thermal models for the IGBT silicon chip, packages, and heat sinks.”⁶⁰ *Hefner* describes a commercially available, off the shelf heat sink “the TTC1406 heatsink” used in his model. Hefner, like Hilbert discusses both “forced and natural convection heat transfer” from the heat sink. “Forced ... convection” is the result of using fans.⁶¹

113. These are only a few examples of the ubiquitous nature of heat sinks, liquid cooled heat sinks, and power electronics. A POSITA would have recognized that the use of heat sinks and thermal sensors (such as thermocouples) to monitor and control forced cooling devices (pumps, fans, etc.) would help to maintain a safe temperature for the power electronics. Even an ordinary user of basic power semiconductor devices, such as a computer or mobile phone charger, recognizes that these devices generates heat which must be dissipated (allowed to cool) to prevent damage to the electronics, and that often, this heat is dissipated from the heat sinks using forced cooling methods such as fans.

L. TYPES OF PUMPS – FRACTURING PUMP CHAIN

114. The basics of hydraulic fracturing have not changed significantly since 1949 when Halliburton first commercialized the “hydrafrack” process.⁶² Hydraulic fracturing still involves pumping water (or another fluid) blended with a proppant

⁶⁰ Ex. 1032 (*Hefner*) p 1094.

⁶¹ Ex. 1032 (*Hefner*) p. 1100.

⁶² Ex. 1033 (Morton), 87.

(e.g., sand) and other chemicals into the downhole reservoir at a sufficient pressure to crack (fracture) the downhole rock. The sand-water mixture is then forced into the cracks, where the sand keeps the cracks (fractures) open to allow hydrocarbons, such as oil and natural gas, to flow out of the formation into the well bore. What has changed are the pressures and flow rate of the fracturing jobs, the sizes of equipment and the particular proppants, chemicals, and liquids used.

115. A modern fracturing process requires multiple pumps operating together as a system to provide fracturing fluid with the suitable composition at the right flow rate,⁶³ and at a pressure sufficient to fracture the formation. At the beginning of the pumping chain are the water transfer pumps. These pumps operate at a relatively low pressure to move water from storage (e.g., ponds, tanks) to the blender or the hydration unit.

116. In the blender, the water is mixed with a proppant, such as sand, resin-coated sand, or ceramics, to form the fracturing slurry. Other chemicals, such as acids, gels, friction reducers, biocides, and the like, are added to the slurry. Dry products, such as sand, are transported into the blender tub using gravity, conveyors, or augers. Liquid products, such as acids, are transported into the blender tub using various sizes and types of pumps. These are typically relatively small horsepower

⁶³ “Flowrate,” “flow rate,” “flow-rate,” and “pump rate” are used interchangeably in the industry and herein.

pumps operating at lower pressures, as the blender tub operates at more or less ambient pressures.

117. Once the fracturing slurry is blended to the proper makeup and consistency, it is transferred to the fracturing pumps using a blender discharge pump. This pump typically operates at a higher pressure than the water or chemical transfer pumps for several reasons. First, the viscosity of the slurry is typically higher than that of water, which requires higher pressures to move the same volume of slurry. Second, the slurry is heavier than plain water, requiring additional horsepower to move the slurry (as compared to plain water). Finally, the large fracturing pumps are piston (or plunger) positive displacement pumps, requiring a higher suction (input) pressure to ensure flow sufficient to prevent cavitation, as explained below.

118. A common type of pump used in fracturing operations is a plunger pump. A fracturing plunger pump works similarly to a car engine without the step of igniting the fuel to provide energy to the shaft. In a plunger pump, the shaft is rotated by an external power source, such as an engine or electric motor. Plungers, typically 3-5, are arranged along the shaft and connected so that the rotational motion of the shaft is translated into the linear motion of the pistons. As the shaft rotates, the plunger (piston) moves away from the head, creating suction which draws the slurry into the piston chamber. As the plunger (piston) moves toward the head,

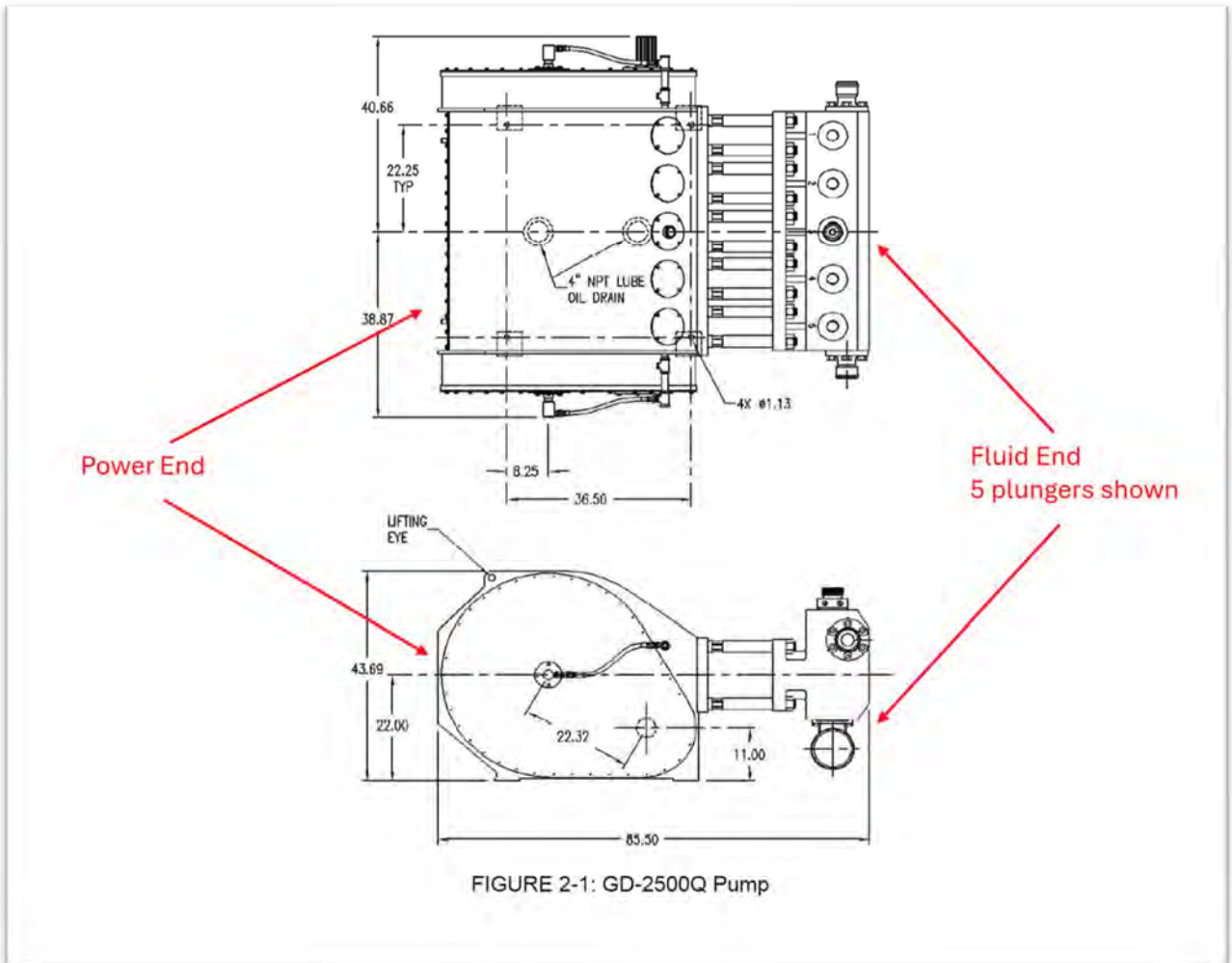
pressure is created which drives the fluid out of the chamber and down the line to and into the wellbore.

119. One example of a plunger pump commonly used in fracturing is a Gardner Denver “GD-2500Q Quintuplex Well Servicing Pump.” Gardner Denver describes the GD-2500Q as a “high horsepower, high rod load multi-purpose pump for various applications such as oil and gas well fracturing and acidizing.”⁶⁴ Gardner describes that “[t]he GD-2500Q quintuplex pump uses only two major assemblies: power end and fluid end.”⁶⁵ A “quintuplex”⁶⁶ pump has 5 cylinders. In the case of the GD-2500Q Gardner provides Figure 2.1 which shows the dimensions and key components of the GD02500Q.

⁶⁴ Ex. 1034 (Gardner) pg 9.

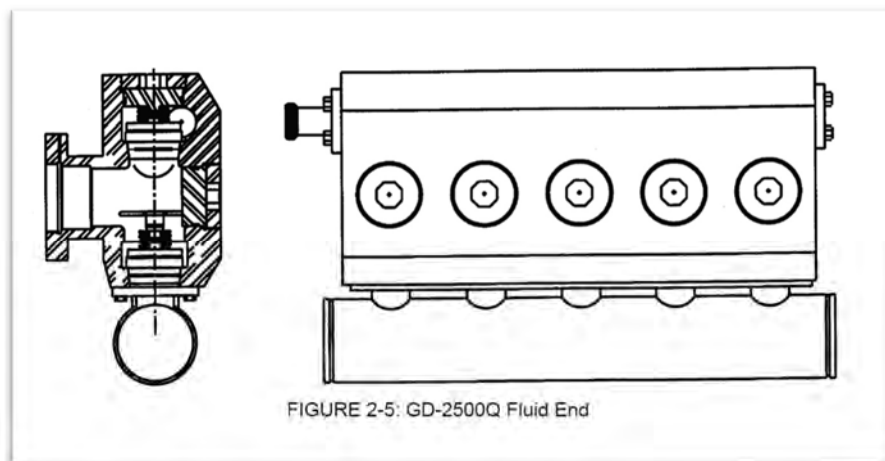
⁶⁵ Ex. 1034 (Gardner) pg. 10.

⁶⁶ *See, e.g.*, Ex. 1035 (Merriam-Webster online dictionary definition of “quintuple”: “having five units or members”).



Ex. 1034 (Gardner) Figure 2-1 (annotated)

Figure 2-5 Provides further detail of the fluid end, showing the front suction covers for 5 plunger cylinders.



Ex. 1034 (*Gardner*) Figure 2-5

120. A key characteristic of these type of fracturing pumps is that the same amount of liquid is discharged from the pump with every stroke, largely independent of the pressure downstream. For example, *Marks* (Ex. 1036) teaches that “[a] displacement pump (also called positive-displacement or just p-d) is a pump which imparts energy to the pumpage (the material pumped) by trapping a fixed volume at suction (inlet) conditions, compressing it to discharge pressure, then pushing it into the discharge (outlet) line.”⁶⁷ Further, *Marks*’ teaches reciprocating pump is a displacement pump which reciprocates the pumping element (piston, plunger or diaphragm). The capacity of a reciprocating pump is proportional to its speed and is relatively independent of discharge pressure.”⁶⁸

⁶⁷ Ex. 1036 (*Marks*) pg 14-2.

⁶⁸ Ex. 1036 (*Marks*) pg 14-2.

121. Accordingly, the flow rate of a positive displacement pump is a function of the “fixed volume” trapped in the cylinder and the number of times that the cylinder is emptied in a given period of time. The “fixed volume” of the cylinder is a function of the cylinder cross sectional area (CSA) and the stroke length. The CSA is a function of the cylinder diameter (d).⁶⁹

$$CSA = \frac{\pi d^2}{4}$$

$$volume = \frac{\pi d^2}{4} \times stroke length$$

The number of times the cylinder is emptied is a function of the pump speed. For a given pump arrangement, as speed goes up, the number of times the cylinder is emptied increases and flowrate increases and vice versa. Similarly, at a given speed if stroke length or cylinder diameter increases, the fixed volume goes up and flowrate increases. For a fixed flowrate, the required pump speed is inversely related to both stroke length and cylinder diameter. In other words, if the fixed volume increases, the number of times the cylinder must be emptied would decrease, assuming volume does not change.

⁶⁹ Ex. 1014 (*Nesbitt*), 140 (showing “displacement” of a single-cylinder pump to be the CSA of the cylinder multiplied by the stroke length).

122. As one example, Gardner provides specifications of the GD-2500Q Quintuplex well servicing pump. Specifications of the pump indicate a stroke length of 8.0 inches.⁷⁰ As shown below, the GD-2500Q is available with plunger size (diameters) between 3.75 and 6.75 inches. The table provides flowrates for pump speeds between 100 and 330 RPM.

Plunger Size	Displacement per Revolution	Displacement at Pump RPM - Well Stimulation Application							
		100		150		250		330	
in.	gal/rev.	GPM	PSI	GPM	PSI	GPM	PSI	GPM	PSI
3.75	1.91	191	17800	287	13500	478	8100	631	6100
4	2.17	217	15600	326	11800	544	7100	718	5400
4.5	2.75	275	12400	413	9300	688	5600	908	4200
5	3.40	340	10000	510	7600	850	4500	1121	3400
5.5	4.11	411	8300	617	6300	1028	3800	1357	2800
5.75	4.49	449	7600	674	5700	1124	3400	1483	2600
6	4.89	489	6900	734	5300	1223	3200	1615	2400
6.5	5.74	574	5900	861	4500	1436	2700	1895	2000
6.75	6.19	619	5500	929	4200	1548	2500	2044	1900
Input Power	BHP	2200		2500		2500		2500	

Ex. 1016 (Gardner) pg 14

123. Since in the GD-2500Q the stroke length is fixed, the relationship between speed, plunger size and flowrate is shown in the table. For example, for a flow of ~620 GPM, a POSITA could select: a 6.75" plunger size and operate just

⁷⁰ Ex. 1034 (Gardner) pg 14.

above 100 RPM; a 5.5” plunger size and operate a little above 150 RPM; a 4.5” plunger size and operate below 250 RPM; or a 3.75” plunger size and operate at a little below 330 RPM. Thus, there is an inverse relationship between volume (stroke length and plunger size) and flowrate.

124. As another example, *Nesbitt* teaches in a “basic” “single cylinder reciprocating pump shown in Figure 4.38 [] the ideal flow is delivered is calculated from”⁷¹ the following equation:

$$Q_{th} = 0.001 \times s \times \frac{\pi d^2}{4} \times n/60 \quad (\text{Equ 4.25})$$

where:

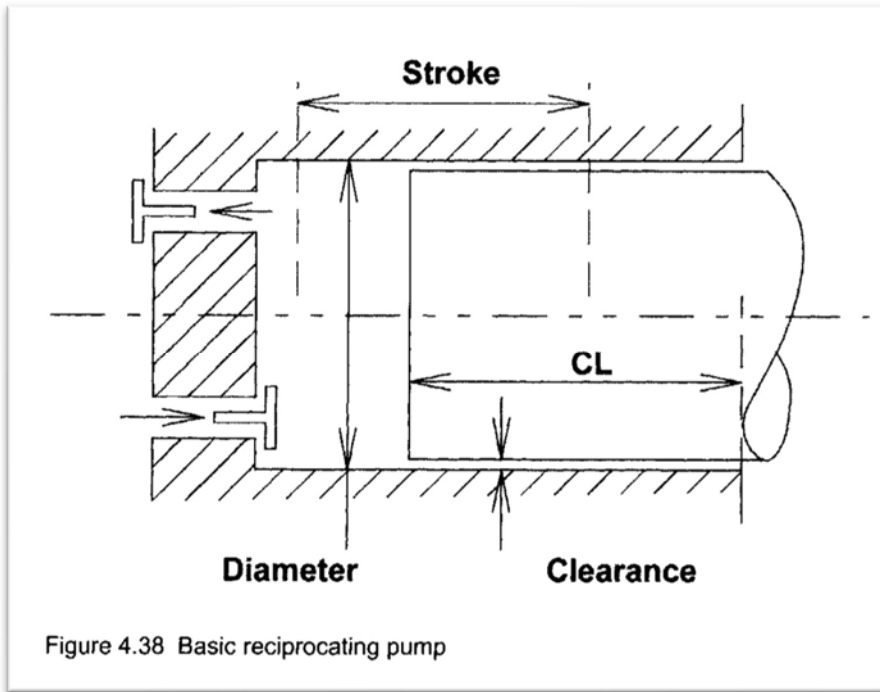
Q_{th} = theoretical flow (cc/s)

n = strokes per minute (1/minute)

d = piston [plunger] diameter (mm)

s = stroke (mm)

⁷¹ Ex. 1014 (*Nesbitt*) pg 140.



125. By mathematically rearranging Equation 4.25, to calculate pump speed with a fixed stroke length and flowrate yields the following equation:

$$n = \frac{Q_{th} \times 60 \times 4}{0.001 \times s \times \pi d^2}$$

In order to calculate stroke length with a fixed flowrate and pump speed, equ 4.25 would be arranged as follows:

$$s = \frac{Q_{th} \times 60 \times 4}{0.001 \times n \times \pi d^2}$$

As can be seen from each of the above equations, there is an inverse relationship between stroke length (and piston/plunger diameter) and pump speed for a fixed flowrate. This is an inherent characteristic of plunger pumps. For a pump with more

than one cylinder (e.g. quintuplex pump with 5 cylinders), the above equation would be simply multiplied by the number of cylinders in order to obtain the total flowrate from the pump.

126. The result of the above is that flow for a given pump at a particular pump speed is relatively constant, while pressure changes as downstream conditions change. Accordingly, as fracturing begins, reducing the downstream impedance of the fluid flow system, pressure tends to drop as flow rate stays relatively constant. Conversely, pressure rises with a relatively stable flow rate as downstream impedance increases. As a boundary condition, if a valve is closed downstream of a fracturing pump, flow rate through the pump will remain relatively constant while pressure rises extremely fast. Pressure will continue to rise until some conditions reduce the downstream impedance. This is typically equipment failure, such as pump seals, piping failure, or rupturing of valve bodies.

127. As shown by *Gardner*, the flowrate of a plunger pump is a function of the speed of the pump, the diameter of the plunger and the length of the stroke.

128. Because the plungers are so large (~5" in diameter with ~8" stroke), a large amount of fluid must flow into the cylinder on each stroke. This tends to lower the suction pressure, as the void of the plunger must be filled by the incoming slurry. If the suction pressure gets too low, then cavitation occurs. Cavitation is the condition where bubbles form in the liquid because the vapor pressure of the liquid

is higher than the suction pressure. When the bubbles collapse, such as when the piston reaches the bottom of its stroke, noise, vibration and damaging forces are created. To avoid cavitation and the associated problems, the suction pressure must be maintained higher than the fluid's vapor pressure of the fluid (e.g., slurry), even during the intake phase of the piston. This is called maintaining a Net Positive Suction Head (NPSH). The amount of NPSH necessary to avoid cavitation is dependent on many factors, including the suction line design, pump speed, suction valve spring strength, and temperature and viscosity of the fluid. Gardner teaches several methods to reduce or eliminate cavitation. These techniques include, for example, using a suction stabilizer or pulsation damper, changing the supply line design, and reducing pump speed.⁷²

⁷² Ex. 1034 (Gardner) pg 30.

Cavitation, Fluid Knock
or Hammer.

- | | |
|--|---|
| 1. Improper suction system layout. | 1. See recommended system layout in manual. |
| 2. Low suction pressure. | 2. See Low Suction Pressure problem. |
| 3. Suction stabilizer and pulsation damper not used. | 3. Install suction stabilizer and pulsation damper. |
| 4. Defective stabilizer or damper. | 4. Repair and recharge or replace. |
| 5. High fluid temperature or viscosity. | 5. Reduce pump speed. |
| 6. High fluid vapor pressure. | 6. Increase NPSH. |
| 7. High acceleration head. | 7. Increase supply line size.
Decrease supply line length. |
| 8. Suction valve spring too stiff.
with low NPSH. | 8. Use weaker spring. |
| 9. Air/Gas in pumped fluid. | 9. Allow more settling
time in supply tank.
Reduce pump speed. |
| 10. Air entering suction line. | 10. Repair suction line. |
| 11. Air entering charging pump. | 11. Tighten or replace shaft
packing or seal. |
| 12. Air entering or charge gas
escaping from suction
stabilizer. | 12. Repair and recharge
stabilizer |
| 13. Multiple pumps operating in
phase. | 13. Use a suction stabilizer
on each pump. Separate
lines may also be needed. |

X. OVERVIEW OF THE PRIOR ART

A. FISCHER (EX. 1008)

a. Status of *Fischer*

129. *Fischer* is a United States Patent issued to *Fischer et al.* granted on April 27, 2021. The application that led to *Fischer* (Appl. No. 16/790,897) was filed

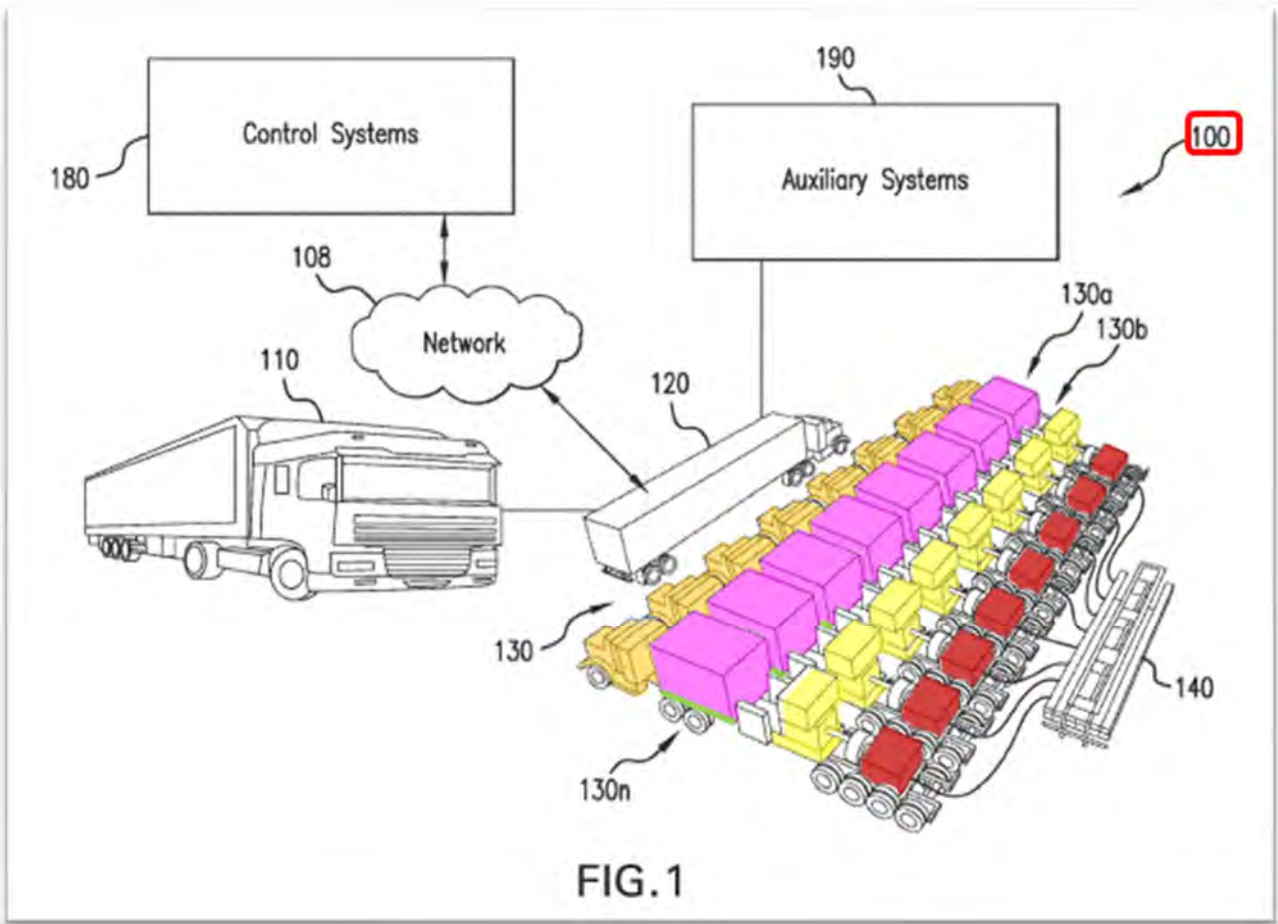
on February 14, 2020 and claims priority to provisional application no. 62/805,521.⁷³ The title of *Fischer* is “Electric Driven Hydraulic Fracking Operations.” *Fischer* claims priority to U.S. Provisional Application No. 62/805,521 (Ex. 1009, “*Fischer Provisional*”) filed on August 20, 2020. I have reviewed *Fischer Provisional*, and as discussed in the Grounds below, the subject matter relied upon in *Fischer* is disclosed in *Fischer Provisional*. Accordingly, I understand that *Fischer* (using the subject matter disclosed in *Fischer Provisional*) predates the claimed priority date of the Challenged Patent.

b. Disclosure of *Fischer*

130. Like the ‘863 Patent, *Fischer* discloses in Figs.1 and 2 “a hydraulic fracking operation 100 [annotated in red] in which hydraulic pumps [annotated in orange] may pump a fracking media into a fracking well 109 [not shown] to execute a fracking operation in order to extract a fluid from the fracking well 109.”⁷⁴

⁷³ Ex. 1008 (*Fischer*) Cover, Ex. 1009 (*Fischer Provisional*) cover.

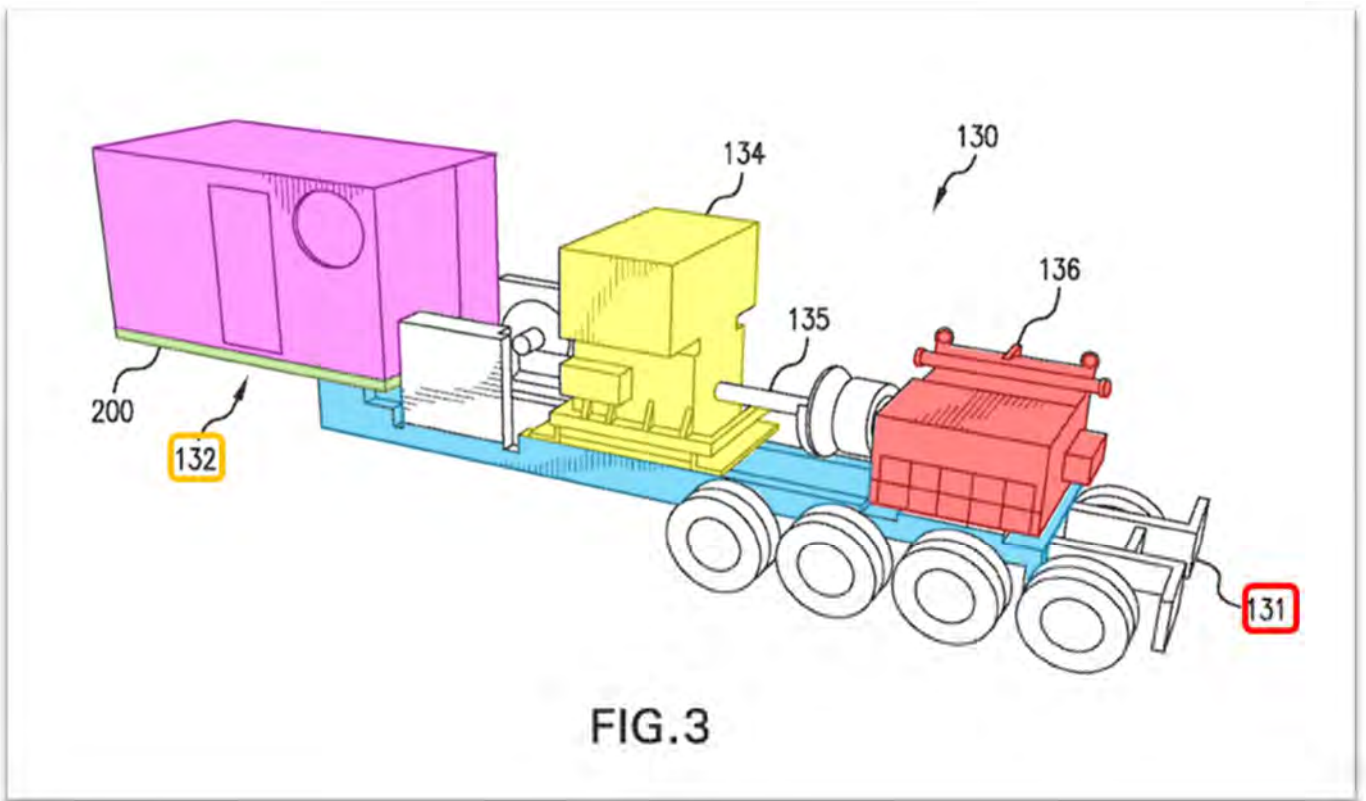
⁷⁴ Ex. 1008 (*Fischer*) 4:16 – 20; Ex. 1009 (*Fischer Provisional*) [0016], Fig. 1, Fig. 2.



Ex. 1008 (*Fischer*) Fig. 1 (annotated)⁷⁵

131. As seen in Fig. 1, the fracturing system comprises a variety of trailers. *Fischer* teaches that these trailers contain fracturing equipment.

⁷⁵ see also Ex. 1009 (*Fischer* Provisional), Fig. 1.



Ex. 1008 (*Fischer*) Fig. 3 (annotated)⁷⁶

132. *Fischer* discloses that the trailer “includes a medium-voltage VFD [variable frequency drive] 132 [annotated in magenta], a single, single-shaft electric motor 134 [annotated in yellow] and a single hydraulic pump 136 [annotated in maroon], each of which is mounted on a single pump trailer 131 [annotated in red]” as can be seen in Fig. 3, the first area (annotated in blue) is at a second, lower height than the second area (annotated in green), and the first and second areas are adjacent one another.⁷⁷ *Fischer* further discloses “the medium-voltage VFD 132 generally

⁷⁶ See also Ex. 1009 (*Fischer Provisional*), Fig. 2.

⁷⁷ Ex. 1008 (*Fischer*) 12:12:3-8, Fig. 3; Ex. 1009 (*Fischer Provisional*) [0031], Fig. 2.

includes a transformer assembly 230 and a power cell assembly 240.”⁷⁸ The transformer is used to reduce voltage from a generator system to the motor.⁷⁹ Thus, *Fischer* is from the same field of endeavor as the ’863 Patent and describes a pump trailer that is similar to the support structure described in the ’863 Patent.

B. MORRIS (EX. 1010)

a. Status of *Morris*

133. *Morris* is a U.S. Patent Application Publication to *Morris et al.* filed on July 24, 2019, and published on February 6, 2020.⁸⁰ The title of *Morris* is “Switch Gear Transport that Distributes Electric Power for Fracturing Operations.” *Morris* claims priority to U.S. Provisional Application No. 62/713,393 (Ex. 1005, “*Morris Provisional*”) filed on August 1, 2018.

b. Disclosure of *Morris*

134. Like the ’863 Patent, *Morris* discloses a system for fracturing a subterranean formation, including, multiple “fracturing pump transports” used for “hydraulic fracturing.”⁸¹ *Morris*’s pump transport includes a pump powered by an

⁷⁸ Ex. 1008 (*Fischer*) 35: 32 – 34; see also 20:62 – 66; Ex. 1009 (*Fischer Provisional*) [0082].

⁷⁹ Ex. 1008 (*Fischer*) 35:36–41; see also 7:51-8:7, 35:58-36:10; Ex. 1009 (*Fischer Provisional*) [0035], [0082], [0084].

⁸⁰ Ex. 1010 (*Morris*) Cover, Ex. 1005 (*Morris Provisional*) cover.

⁸¹ Ex. 1004 (*Morris*) [0002], [0030], Fig. 1. Ex. 1005 (*Morris Provisional*) [0005], [0001] – [0002].

electric motor⁸² that receives electric power from “one or more turbine generator[s]”⁸³ through one or more transformers that “step down the target output voltage level to one or more lower voltage levels that fracturing equipment (e.g., electric prime movers) mounted on the transports [] may utilize),⁸⁴ along with “drives” for motor control.⁸⁵ *Morris* further discloses that the fracturing pump transport (including the transformer) and the switchgear are connected “using a single electrical cable.”⁸⁶ *Morris*’ system includes a “lay-down trailer” that comprises “main trailer beams” on which an electric motor and two pumps are mounted as well “an upper section above the trailer axles that may hold or have mounted the power and control systems 104.”⁸⁷ Thus, *Morris* is from the same field of endeavor as the ’863 Patent and describes a lay-down trailer that is similar to the support structure described in the ’863 Patent.

C. ORBAN (EX. 1011)

a. Status of Orban

135. *Orban* is an International Patent Application Publication to *Orban et al.*, filed on April 28, 2017, and published on November 1, 2018.⁸⁸ The title of *Orban*

⁸² Ex. 1004 (*Morris*) [0022], [0031]; Ex. 1005 (*Morris Provisional*) [0019], [0024].

⁸³ Ex. 1010 (*Morris*) [0023], Fig. 1.

⁸⁴ Ex. 1010 (*Morris*) [0022].

⁸⁵ Ex. 1010 (*Morris*), [0031], [0034], Fig. 1.

⁸⁶ Ex. 1010 (*Morris*) [0022].

⁸⁷ Ex. 1010 (*Morris*) [0047].

⁸⁸ Ex. 1011 (*Orban*) cover.

is “Integrated Power and Electronics Unit for Drilling Machine.” Accordingly, *Orban* predates the priority date of the ’863 Patent.

b. Disclosure of *Orban*

136. *Orban* relates to an “integrated power and electronics unit (IPEU) [] for driving an electric motor of a drilling rig machine.”⁸⁹ *Orban* teaches that the its system and unit may be implemented in other applications such as a “fracturing pumping system.”⁹⁰ The IPEU includes a “VFD” coupled to a radiator for transferring heat out of the VFD.⁹¹ *Orban* explains that the VFD may be “a conventional water-cooled VFD” in which heat dissipation occurs by “pump[ing] cooling fluid [] through channels.”⁹² Thus, *Orban* is reasonably pertinent to a problem faced by the inventor of ’863 Patent, namely, cooling a VFD.⁹³

D. OEHRING-I (EX. 1012)

a. Status of *Oehring-I*

137. *Oehring-I* is a U.S. Patent Application Publication by *Oehring et al.* (“*Oehring-I*”). *Oehring-I* was filed on July 24, 2015, and published on February 2,

⁸⁹ Ex. 1011 (*Orban*) at Abstract.

⁹⁰ Ex. 1011 (*Orban*) [0042].

⁹¹ Ex. 1011 (*Orban*) [0070].

⁹² Ex. 1011 (*Orban*) [0070], Fig. 13.

⁹³ See Ex. 1001 (’863 patent), 7:28-42 (describing implementation of a cooling system to “maintain a temperature and/or humidity level for the various electronic components”).

2017.⁹⁴ The title of *Oehring I* is “Slide Out Pump Stand for Hydraulic Fracturing Equipment.” Accordingly, *Oehring* predates the claimed priority date of the Challenged Patent.

b. Disclosure of Oehring-I

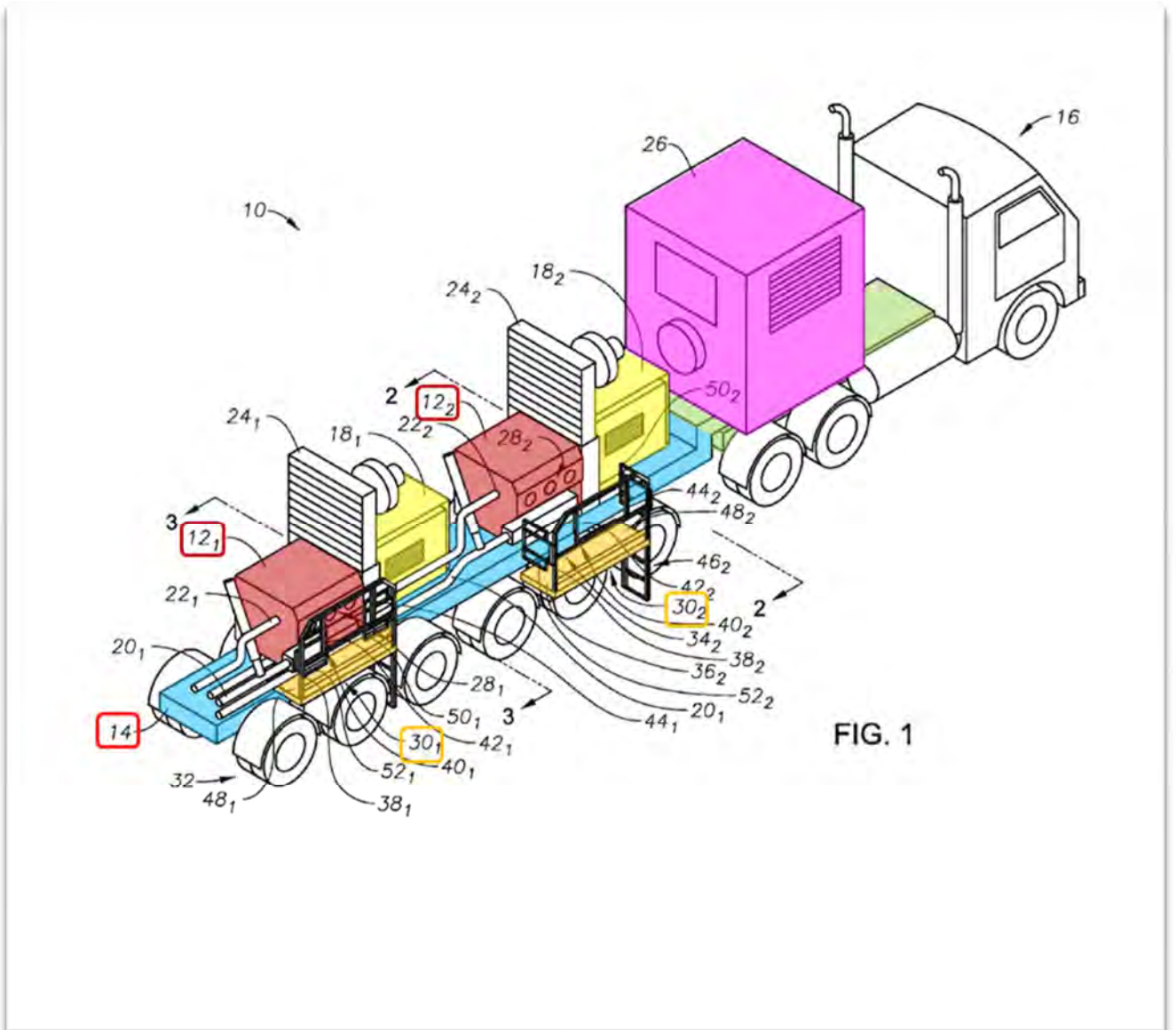
138. *Oehring-I* discloses “[a] hydraulic fracturing system [that] has a pump driven by an electrically powered motor,”⁹⁵ and shows the motor and pump mounted on a trailer. Fig. 1, annotated below, shows “pumps 12₁, 12₂ [highlighted in maroon] mounted on a trailer 14 (annotated in red). Further, like *Fischer*, *Oehring-I* teaches “[a]lso mounted on trailer 14 are motors 18₁, 18₂ [annotated in yellow] which are used for driving pumps 12₁, 12₂ and which are electrically powered.”⁹⁶ Finally, like *Fischer*, *Oehring-I* teaches that the motor is driven by a VFD.⁹⁷ Thus, *Oehring-I* is in from the same field of endeavor—a trailer-mounted fracturing system that includes a platform assembly for accessing the fracturing equipment—as the ’863 Patent, which describes a similar configuration.

⁹⁴ Ex. 1012 (*Oehring-I*) cover.

⁹⁵ Ex. 1012 (*Oehring-I*) at Abstract

⁹⁶ Ex. 1012 (*Oehring-I*) [0018].

⁹⁷ Ex. 1012 (*Oehring-I*) [0025], see also [0027],



Ex. 1012 (*Oehring-I*) Fig. 1 (annotated)

E. KARASSIK (EX. 1013)

a. Status of Karassik

139. “*Karassik*” is a book titled *Pump Handbook*, by Igor Karassik *et al*, and was publicly available no later than April 29, 2008.⁹⁸ *Karassik* was therefore publicly available before the earliest possible priority date of all Challenged Claims of the ’533 Patent.

b. Overview of the Disclosure of *Karassik*

140. *Karassik* describes pump theory and operation, including the use of seven, nine and eleven plunger pumps.⁹⁹ Thus, *Karassik* is from the same field of endeavor—the utilization of multi-plunger pumps—as the ’863 Patent.

F. OEHRING-II (EX. 1016)

a. Status of *Oehring-II*

141. *Oehring-II* is a U.S. Patent Application Publication by *Oehring et al.* (“*Oehring-II*”). *Oehring-II* was filed on April 14, 2017, and published on August 3, 2017.¹⁰⁰ The title of *Oehring-II* is “Switchgear Load Sharing for Oil Field Equipment.” Accordingly, *Oehring-II* predates the claimed priority date of the Challenged Patent.

⁹⁸ Ex. 1015 (Hall-Ellis Declaration), ¶¶40-41.

⁹⁹ Ex. 1013 (*Karassik*), 3.11.

¹⁰⁰ Ex. 1016 (*Oehring-II*) cover.

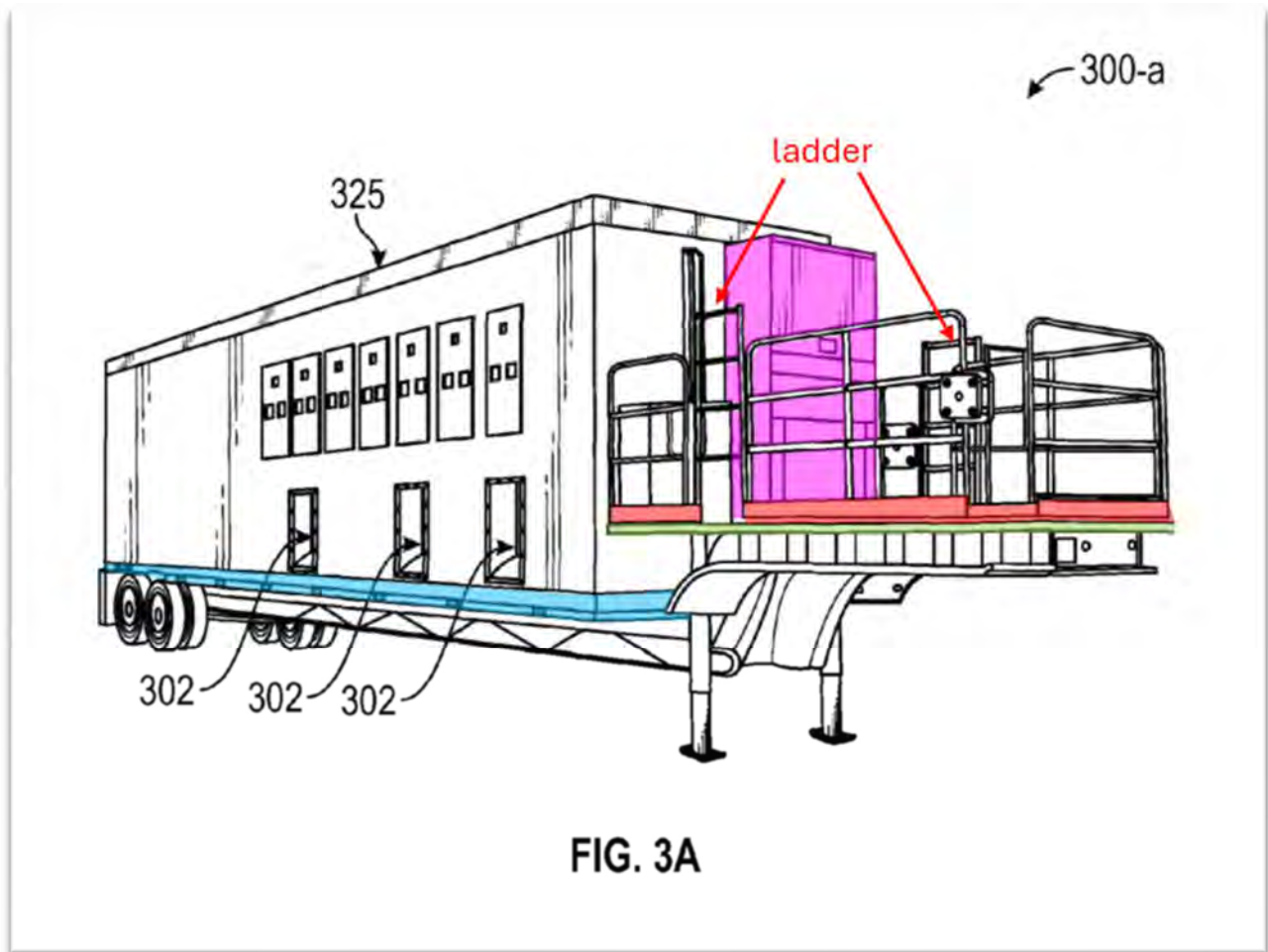
b. Overview of the Disclosure of *Oehring-II*

142. *Oehring-II* is directed towards a “hydraulic fracturing system for fracturing a subterranean formation.”¹⁰¹ *Oehring-II*’s system uses electrical motors, which are powered by generators, to drive electric pumps.¹⁰² *Oehring-II* further describes a “switchgear trailer” that provides electric connections for various components of the fracturing system.¹⁰³ Annotated Figure 3A of *Oehring-II*, provided below, depicts the switchgear trailer:

¹⁰¹ Ex. 1016 (*Oehring-II*) at Abstract

¹⁰² Ex. 1016 (*Oehring-II*), Abstract.

¹⁰³ Ex. 1016 (*Oehring-II*), 7:21-28.



Ex. 1016 (*Oehring-II*), Fig. 3A (annotated).

143. As depicted, the switchgear trailer further comprises an elevated platform that is located along the trailer's longitudinal axis and provides access to the switchgear trailer as well as an enclosure adjacent to the trailer (annotated in red above). Thus, *Oehring-II* is from the same field of endeavor—a hydraulic fracturing system that includes trailers and platforms for access components of the system—as the '863 Patent.

XI. COMPARISON OF PRIOR ART TO THAT REVIEWED BY THE EXAMINER

144. *Fischer* was considered by examiner and cited in an office action in rejection of Claims 1, 3-11 and 13-20.¹⁰⁴ *Oehring-I* was considered by the examiner and cited in an office action in rejection of claims 2 and 12.¹⁰⁵ Once *Fischer* was rejected as prior art, *Oehring-I* was not considered in combination with any other art. Morris is listed on the face of the '863 Patent, but Morris was not used in a rejection of the claims.¹⁰⁶ It is my opinion that the examiner erred in rejecting *Fischer* as prior art. The sections of *Fischer* that I have relied on to show anticipation or obviousness of the challenged claims are supported by the *Fischer Provisional*. Thus, those portions of *Fischer* would have been prior art to the '863 Patent. Further, to the extent that the examiner considered *Morris*, it is my opinion that the examiner erred in not rejecting Claim 1 over *Morris*, and not rejecting Claim 2 over *Morris* in view of *Oehring-I*.

XII. GROUND 1: ANTICIPATED / OBVIOUS OVER *FISCHER*

145. It is my opinion that *Fischer* alone anticipates Claims 1 & 9 of the '863 Patent. To the extent that the Board finds that *Fischer* does not anticipate Claims 1

¹⁰⁴ Ex. 1002 ('863 Patent File History), 219-229.

¹⁰⁵ Ex. 1002 ('863 Patent File History), 219-229.

¹⁰⁶ Ex. 1001 ('863 Patent), page 3, item (56).

& 9, a POSITA would have found Claims 1 & 9 obvious in view of the teachings of *Fischer* and the general knowledge of a POSITA.

A. H INDEPENDENT CLAIM 1

146. It is my opinion that *Fischer* anticipates Claim 1 or at least renders Claim 1 obvious. As discussed below, *Fischer* discloses or at least renders each and every limitation of Claim 1 obvious.

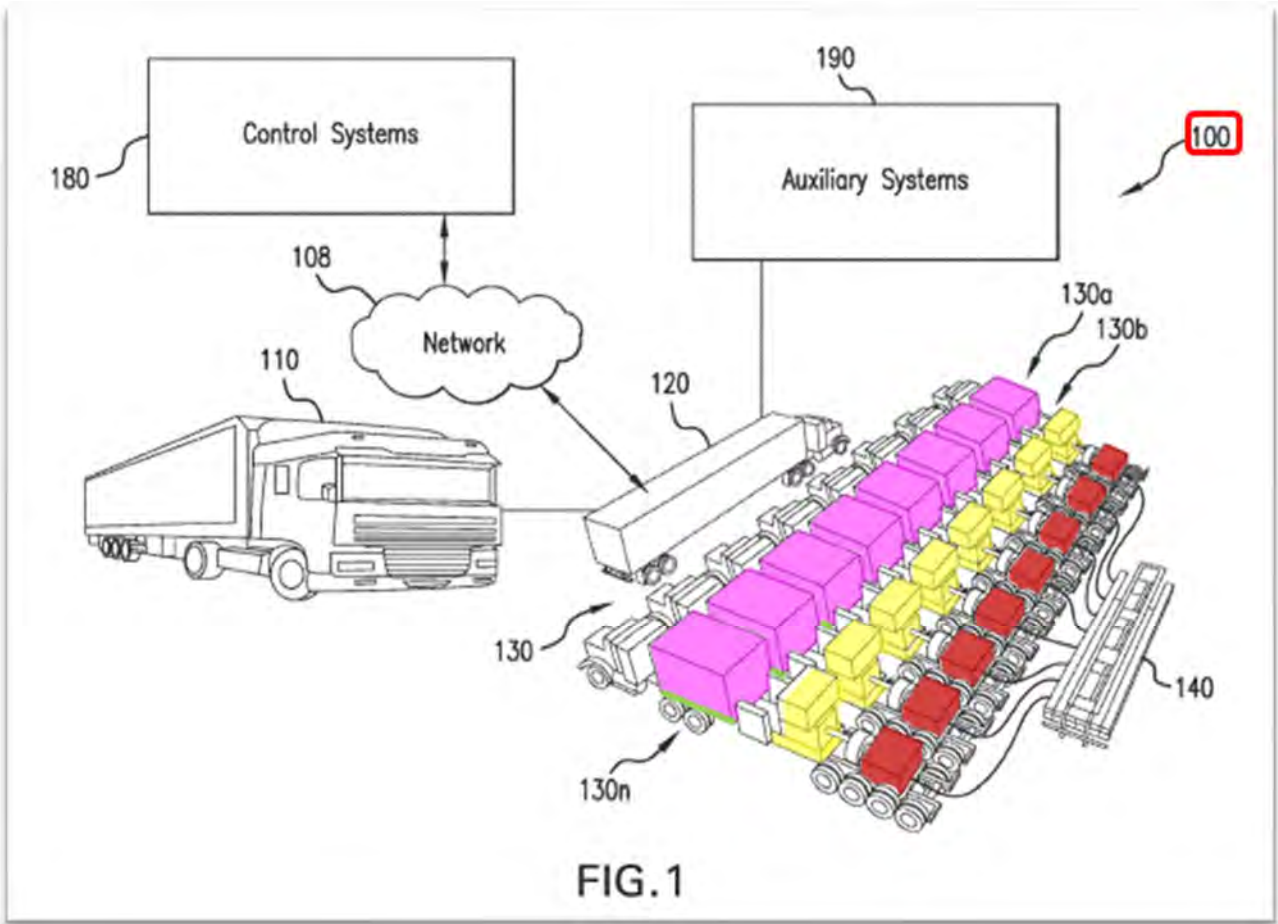
a. 1[p]: “1. A hydraulic fracturing system, comprising:”

147. *Fischer* discloses a hydraulic fracturing system.¹⁰⁷ *Fischer* “generally relates to electrically-driven hydraulic fracking systems, and more specifically but not exclusively relates to a systems, subsystems, and methods for such electrically-driven hydraulic fracking systems.”¹⁰⁸ Further, *Fischer* discloses in Figs. 1 and 2 “a hydraulic fracking operation 100 [annotated in red] in which hydraulic pumps [annotated in maroon] may pump a fracking media into a fracking well 109 [annotated in blue] to execute a fracking operation in order to extract a fluid from the fracking well 109.”¹⁰⁹

¹⁰⁷ I understand that the preamble may not be limiting. I include a discussion of the preamble to Claim 1 out of an abundance of caution.

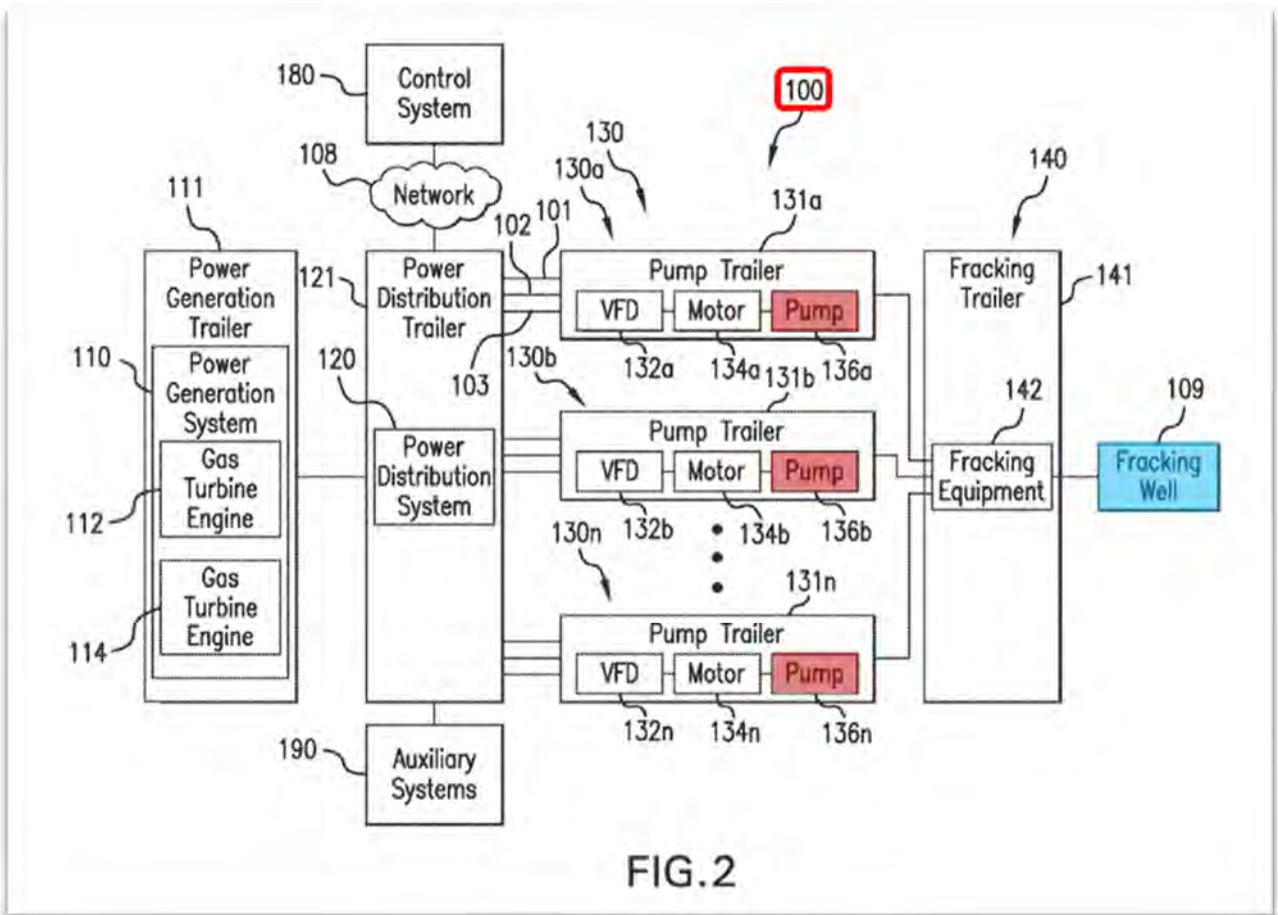
¹⁰⁸ Ex. 1008 (*Fischer*) 1:14 – 17; Ex. 1009 (*Fischer Provisional*) [0001].

¹⁰⁹ Ex. 1008 (*Fischer*) 4:16 – 20; Ex. 1009 (*Fischer Provisional*) [0016], Fig. 1.



Ex. 1008 (Fischer) Fig. 1 (annotated);¹¹⁰

¹¹⁰ see also Ex. 1009 (Fischer Provisional) Fig. 1.



Ex. 1008 (Fischer) Fig. 2

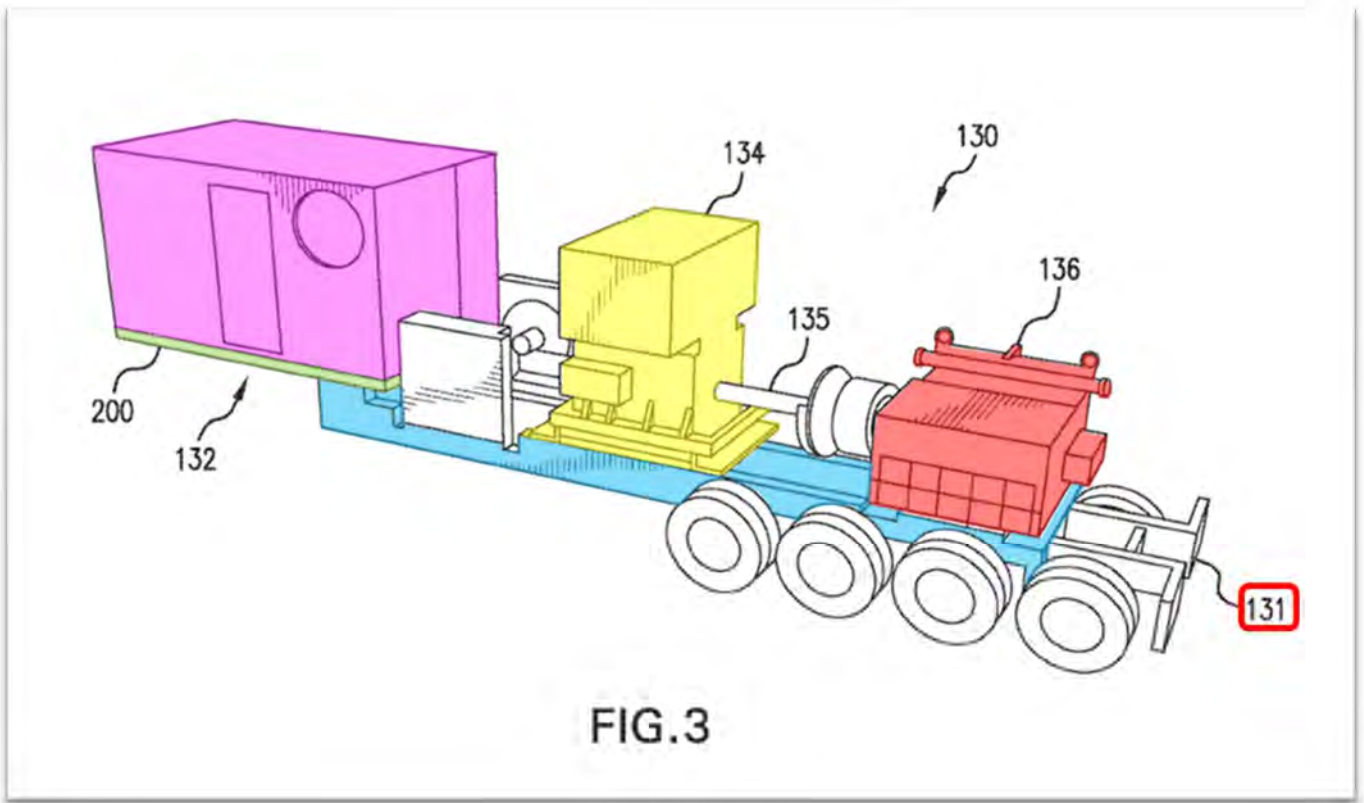
148. Accordingly, *Fischer* discloses a hydraulic fracturing system as claimed. As discussed below, *Fischer* discloses, or at the least renders obvious, each and every component of the claimed hydraulic fracturing system.

- b. **1[a]: “a support structure having a first area at a first height and a second area at a second height, the first and second areas adjacent one another;”**

149. *Fischer* discloses the claimed support structure arranged as claimed.

Fig. 3 of *Fischer* shows a support structure in the form of a pump trailer 131

(annotated in red). Pump trailer 131 contains a first area (highlighted in blue) at a first height and a second area (highlighted in green) at a second height.



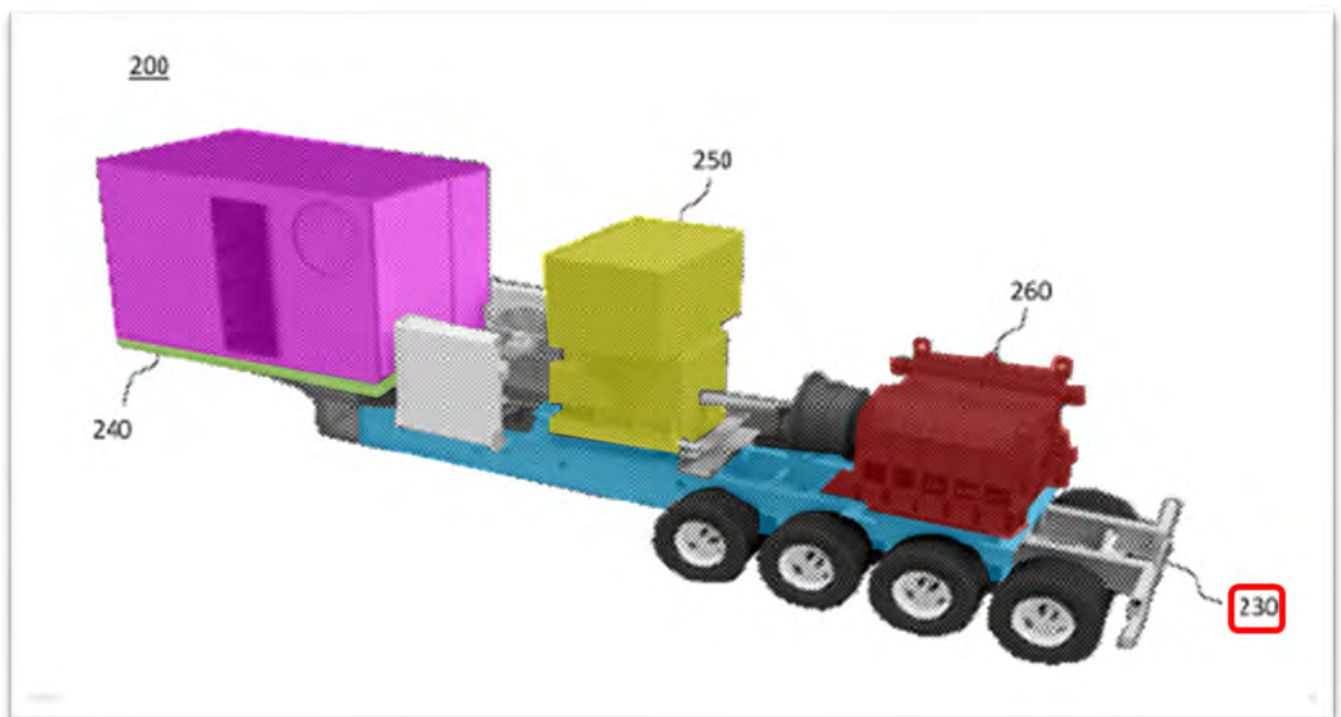
Ex. 1008 (*Fischer*) Fig. 3 (annotated)

150. *Fischer* discloses that the trailer “includes a medium-voltage VFD [variable frequency drive] 132 [annotated in magenta], a single, single-shaft electric motor 134 [annotated in yellow] and a single hydraulic pump 136 [annotated in maroon], each of which is mounted on a single pump trailer 131 [annotated in red].”¹¹¹ As can be seen in Fig. 3, the first area (annotated in blue) is at a first height,

¹¹¹ Ex. 1008 (*Fischer*) 12:3-8, Fig. 3; Ex. 1009 (*Fischer Provisional*) [0031], Fig. 2.

and the second area (annotated in green) is at a second, higher height. Further, the first and second areas are adjacent.

151. *Fischer Provisional* contains disclosure of a similar trailer 230 (annotated in red) with a first area (annotated in blue) at a first height containing an electric motor 250 (annotated in yellow) and a hydraulic pump 260 (annotated in maroon) and a second area (annotated in green) at a second height containing VFD 240 (annotated in magenta).¹¹²



Ex. 1009 (*Fischer Provisional*) Fig. 2 (annotated)

¹¹² Ex. 1009 (*Fischer Provisional*) [0031].

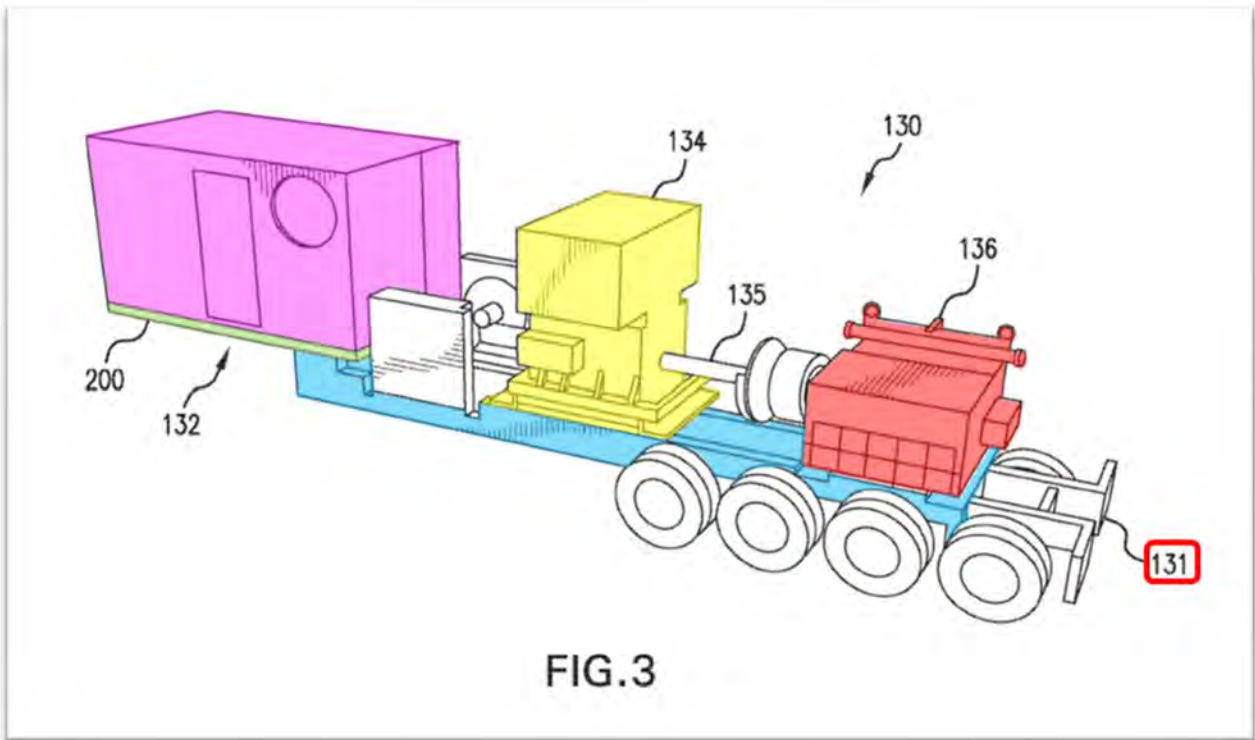
152. In *Fischer Provisional*, then, the first area (annotated in blue) is at a first height, and the second area (annotated in green) is at a second, higher height. Further, the first and second areas are adjacent. .

153. Accordingly, Fischer discloses a support structure (pump trailer) having a first area at a first height and a second area at a second height, the first and second areas adjacent to one another as claimed in limitation 1[a].

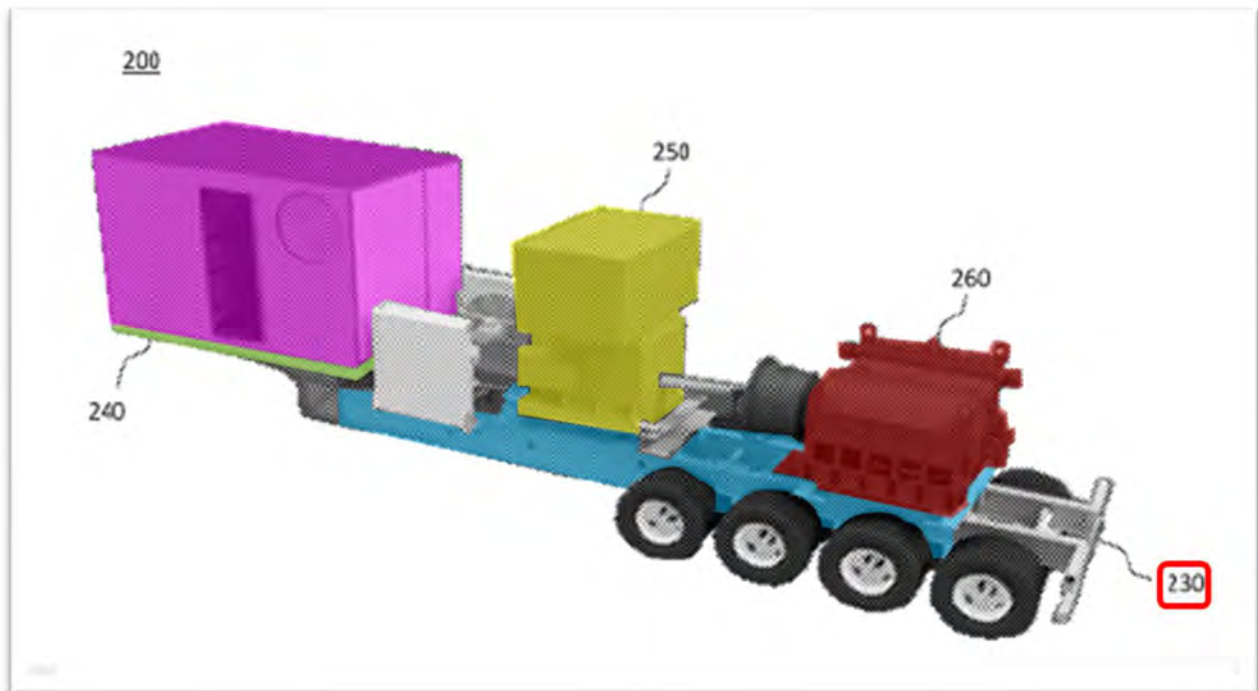
- c. **1[b]: “an electric powered, multi-plunger pump with an odd number of plungers, arranged in the first area, the electric powered pump coupled to a well, via outlet piping, and powered by at least one electric motor, also arranged in the first area;”**

154. As described above regarding limitation 1[a], *Fischer* discloses a first area containing both a hydraulic pump 136 (annotated in maroon) and an electric motor 134 (annotated in yellow), as seen in Fig. 3.¹¹³

¹¹³ Ex. 1008 (*Fischer*) 12:3 – 8; Ex. 1009 (*Fischer Provisional*) [0031], Fig. 2.

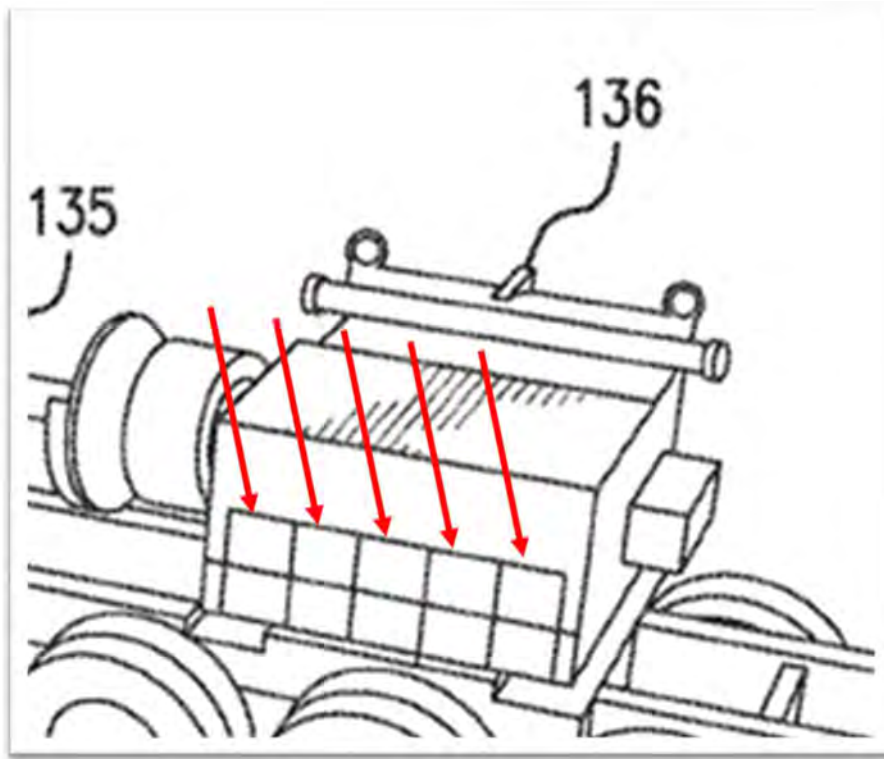


Ex. 1008 (*Fischer*) Fig. 3 (annotated)

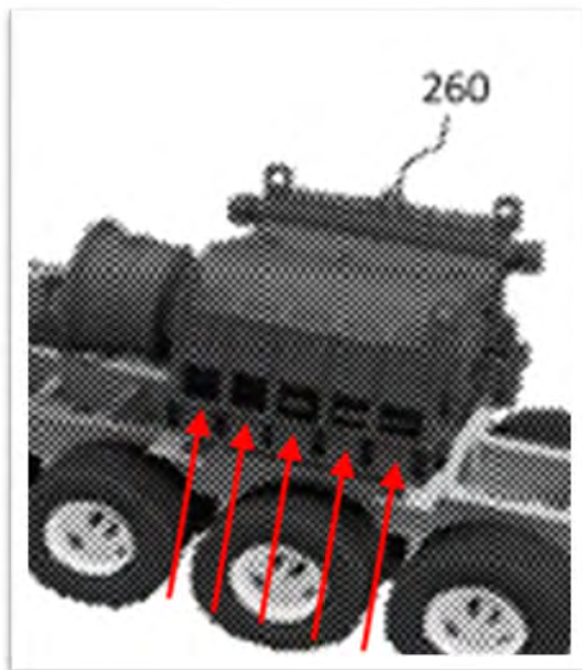


Ex. 1009 (*Fischer Provisional*) Fig. 2 (annotated)

155. Fig. 3 of *Fischer* and Fig. 2 of *Fischer Provisional*) shows what a POSITA would have recognized as a multi-plunger pump with 5 plungers (an odd number of plungers), as indicated by the five arrows depicting the five suction covers and/or valve covers in the annotated and excerpted Fig. 3 below.



Ex. 1008 (*Fischer*) Fig. 2 annotated and excerpted.



Ex. 1009 (Fischer Provisional) Fig. 3 annotated and excerpted.

156. *Fischer* further describes that the “hydraulic pump 136 may, for example, be provided as a Weir QEM5000 pump.”¹¹⁴ As would have been known to a POSITA, a Weir QEM 5000 pump is a 5,000 Hp quintuplex plunger pump.¹¹⁵ A quintuplex pump contains five plungers (an odd number of plungers), as would have been known to a POSITA.¹¹⁶

157. *Fischer* confirms, as would be evident to a POSITA by examining Fig. 3, that the electric motor powers the hydraulic pump. For example, *Fischer* teaches

¹¹⁴ Ex. 1008 (*Fischer*) 15:26 – 36; Ex. 1009 (*Fischer Provisional*) [0040].

¹¹⁵ Ex. 1017 (*Drilling Contractor Magazine*) (identifying the Weir “Quintuplex Extended Max (QEM)” 5000 pump).

¹¹⁶ See Section IX.L Above; see also Ex. 1013 (*Karassik*), 3.11 (Table 7 identifying “Quintuplex” as the industry term for a five-plunger pump)).

that “the single-shaft electric motor 134 *may be coupled to the single hydraulic pump 136 and drive the single hydraulic pump 136* such that the single hydraulic pump 136 continuously pumps the fracking media into the fracking well 109 to execute the fracking operation to extract the fluid from the fracking well 109. The single hydraulic pump 136 may operate on a continuous duty cycle such that the single hydraulic pump 136 continuously pumps the fracking media into the fracking well 109.”¹¹⁷ Accordingly, *Fischer* teaches an electric powered, multi-plunger pump with an odd number of plungers (five plungers) which is powered by at least one electric motor.

158. Further, *Fischer* discloses that the pump is coupled to a well via outlet piping. As discussed above, *Fischer* teaches that the hydraulic pump “continuously pumps the pumping fracking media into the fracking well 109 to execute the fracking operation to extract the fluid from the fracking well 109.”¹¹⁸ In order for the pump to pump fracking media into the fracking well, the pump would be connected to the well via outlet piping, which is a commonly-used and well-known mechanism for transporting the “fracking media,” a slurry substance, from a pump to a well.¹¹⁹

¹¹⁷ Ex. 1008 (*Fischer*) 14:52 – 66 *emphasis added*; see also 13:11 – 10, 14:46 – 51; Ex. 1009 (*Fischer Provisional*) [0035], see also [0034], [0038].

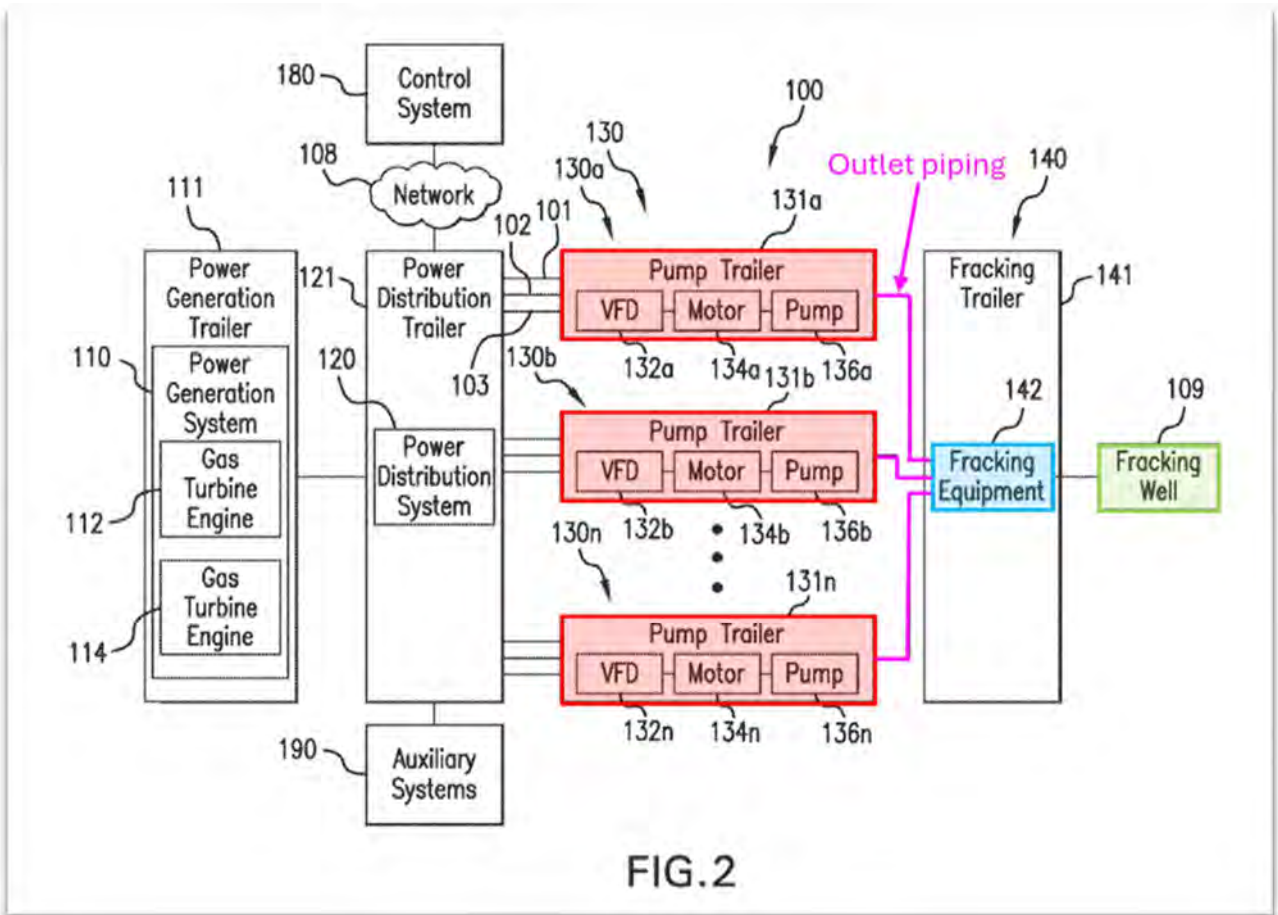
¹¹⁸ Ex. 1008 (*Fischer*) 15:26 – 36; Ex. 1009 (*Fischer Provisional*) [0035], Fig. 1.

¹¹⁹ See, e.g., Ex. 1012 (Oehring-I) Abstract, [0018], [0025] (describing “discharge piping” used to connect the discharge of a hydraulic pump with a wellhead

159. Further, *Fischer* shows outlet piping connecting the pump(s) and the fracking well 109 via outlet piping from the pump trailer 131a...n (annotated in red) to the fracking equipment 142 (missile, annotated in blue) to the fracking well 109 (annotated in green). The outlet piping is shown annotated in magenta. This is a common, well-understood configuration of fracturing equipment at a fracturing site, and would be necessary in order to perform the fracturing operations (i.e. pump the fracturing fluid down the well).¹²⁰

assembly to provide a “conduit for the slurry between the pump 136 and the wellhead assembly 141”), Figs. 1, 5.

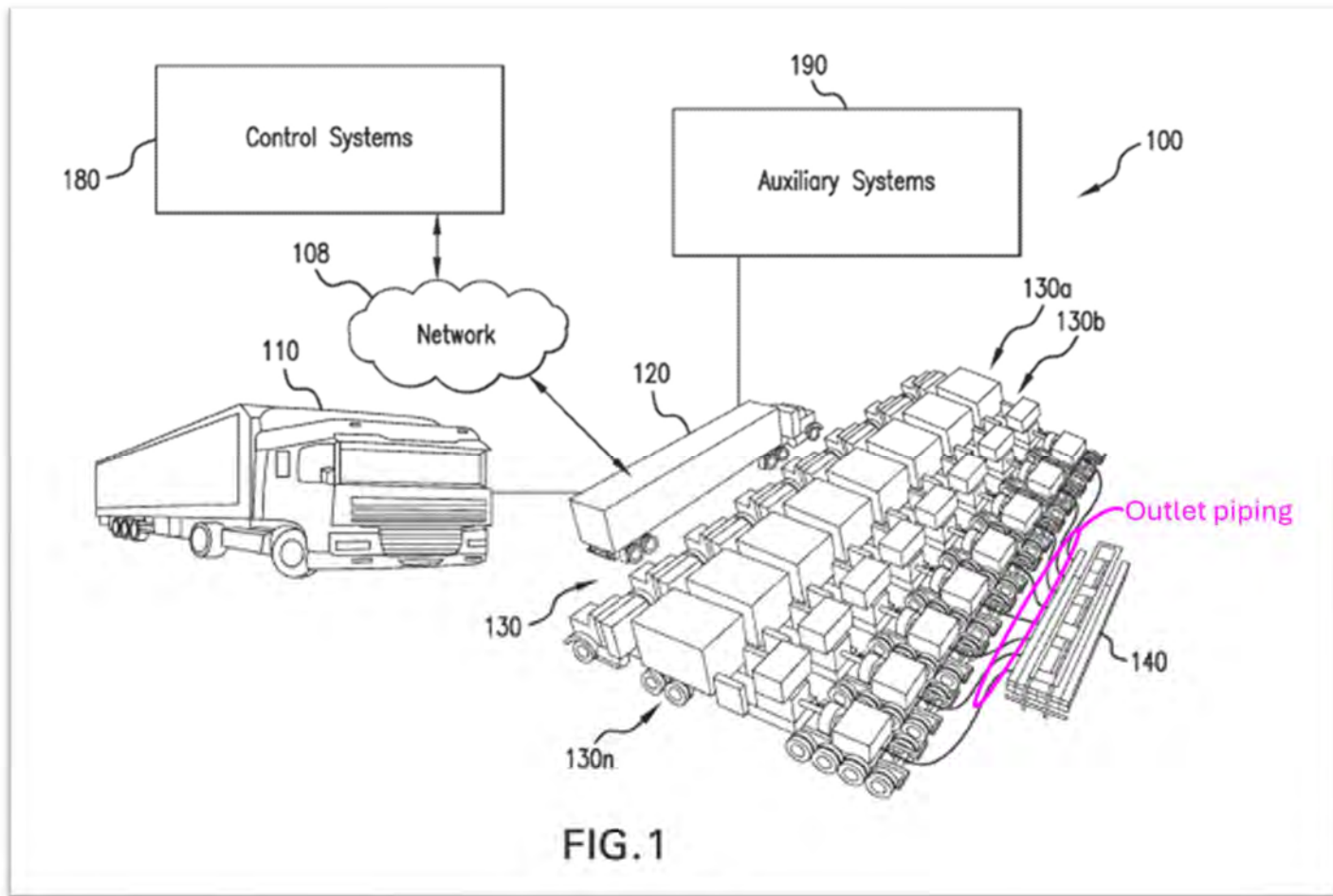
¹²⁰ Ex. 1008 (*Fischer*) 4:16 - 20; Ex. 1009 (*Fischer Provisional*) [0016] (“hydraulic pumps may pump a fracking mixture into a fracking well to execute a fracking operation [] the fracking trailer 170 may include the fracking equipment that implements the missile as well as the well heads”)



Ex. 1008 (*Fischer*) Fig. 2 annotated

160. Fig. 1 of *Fischer* also shows outlet piping coupling from the trailers delivering frack fluid to the missile and then to the well.¹²¹

¹²¹ See Ex. 1009 (*Fischer Provisional*) Fig. 1 which shows a similar configuration, just not converted into a line drawing.



Ex. 1008 (*Fischer*) Fig. 1 (annotated)

161. Accordingly, *Fischer* discloses an electric powered, multi-plunger pump with an odd number of plungers (5 plungers) arranged in the first area, the electric powered pump coupled to a well via outlet piping, and powered by at least one electric motor, also arranged in the first area as claimed in limitation 1[b].

162. To the extent that *Fischer* or *Fischer Provisional* does not explicitly use the term “outlet piping” to connect the pumps to the well, such a configuration would have been obvious to a POSITA as a means to allow the pumps to pump fluid

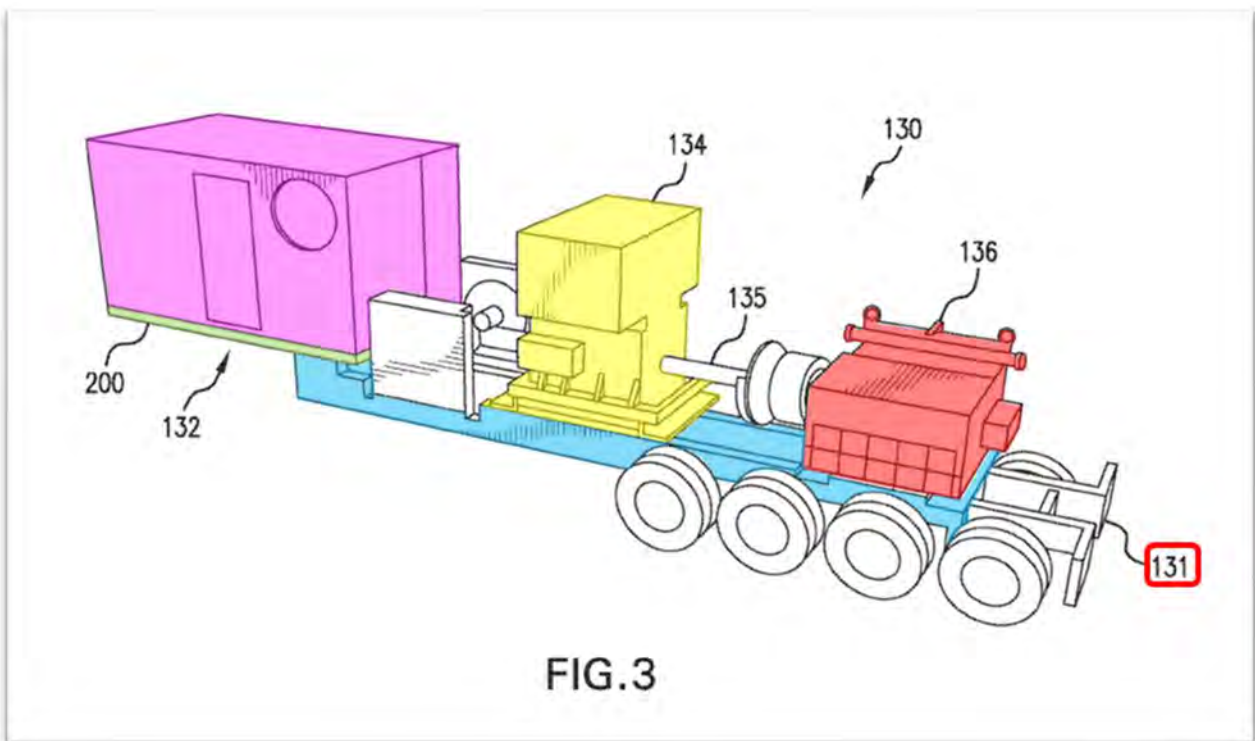
(e.g., fracking media) into the well. Indeed, a POSITA would have understood that there would some connection (such as piping or tubing) to connect the pumps to the well, and to contain the pressure of the fluid, and piping connected to the outlet pumps is an obvious way to connect the pumps and the well, as piping on the outlet of pumps was well known in fracturing or in any application where pumps are used to pump fluid to a location.¹²²

163. Accordingly, *Fischer* discloses an electric powered, multi-plunger pump with an odd number of plungers (5 plungers) arranged in the first area, the electric powered pump coupled to a well vial outlet piping, and powered by at least one electric motor, also arranged in the first area as claimed in limitation 1[b], or at least such a configuration would have been obvious to a POSITA based on the teachings of *Fischer* and the general knowledge of a POSITA regarding pumping and moving fluid using pumps and piping.

¹²² See, e.g., Ex. 1012 (Oehring-I) Abstract, [0019], [0025] (describing “discharge piping” used to connect the discharge of a hydraulic pump with a wellhead assembly to provide a “conduit for the slurry between the pump 136 and the wellhead assembly 141”), Figs. 1, 5.

- d. 1[c]: “a variable frequency drive (VFD), arranged in the second area, connected to the at least one electric motor, the VFD configured to control at least a speed of the at least one electric motor; and”

164. As discussed above regarding limitation 1[a], and incorporated herein by reference, *Fischer* discloses a second area (highlighted in green) containing a VFD (highlighted in magenta) as seen in Fig. 3.¹²³



Ex. 1008 (*Fischer*) Fig. 3 (annotated)

165. *Fischer* further discloses that the VFD is connected to the electric motor and configured to control the speed of the electric motor. *Fischer* teaches that “[t]he medium-voltage VFD 132 *may then drive the single, single-shaft electric motor*

¹²³ See also Ex. 1009 (*Fischer Provisional*) Fig. 2.

134 and the single hydraulic pump 136 as well as ***control the operation of the single, single-shaft electric motor 134*** and the single hydraulic pump 136 as the single-shaft electric motor 134 continuously drives the single hydraulic pump 136 to cause the single hydraulic pump 136 to continuously pump the fracking media.”¹²⁴ A POSITA would have understood that a VFD driving and controlling the operation of the electric motor would have to be connected to the motor, and would have controlled at least the speed of the electric motor, as it was well known that the function of a VFD is to control the speed and torque of an electric motor.¹²⁵ To the extent that the Board finds that *Fischer* does not explicitly disclose a VFD configured to control the speed of an electric motor, using a VFD to control the speed of an electric motor would have been an obvious choice for a POSITA based on *Fischer’s* teaching of using a VFD to “control the operation” of the electric motor, and the well-known function of a VFD to control the speed of an electric motor.

166. Accordingly, *Fischer* discloses a variable frequency drive (VFD) arranged in the second area, connected to the at least one electric motor, the VFD configured to control at least a speed of the at least one electric motor as claimed, or

¹²⁴ Ex. 1008 (*Fischer*) 12:18 – 25 *emphasis added*, see also 13:11 – 19; Ex. 1009 (*Fischer Provisional*) [0032].

¹²⁵ See Section IX.I above.

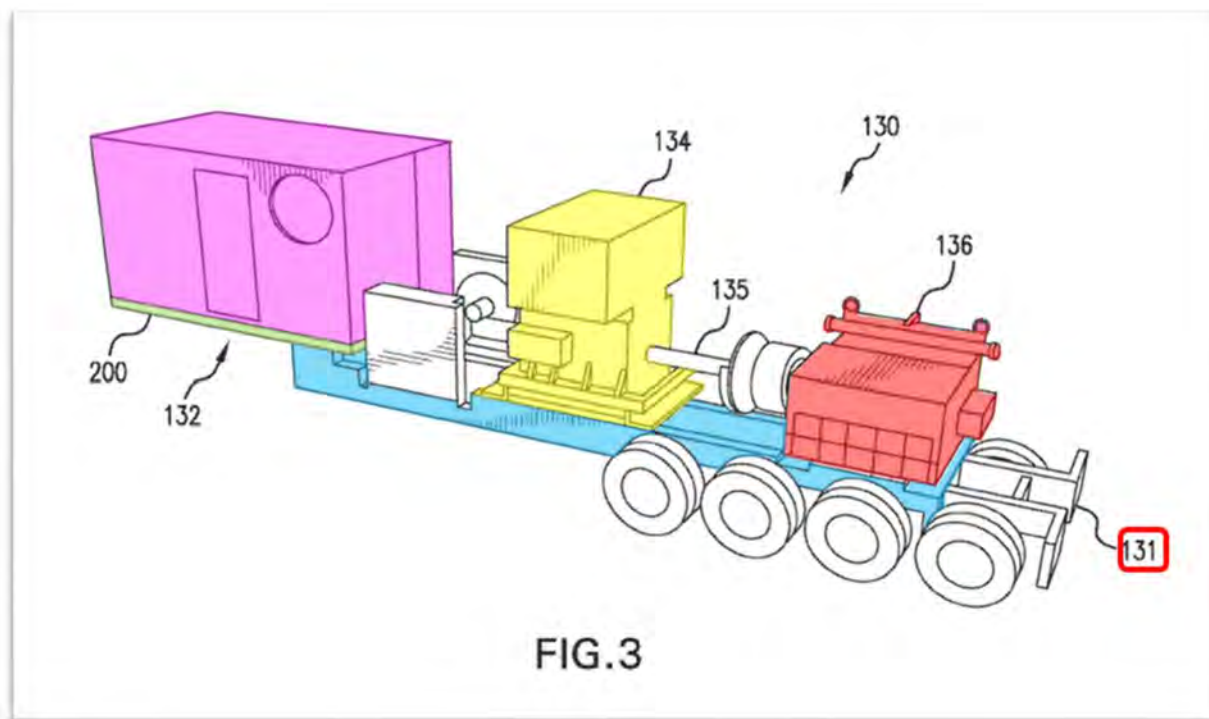
at least it would have been obvious to a POSITA based on the disclosure of *Fischer* and the knowledge of a POSITA regarding VFDs.

- e. **1[d]: “a transformer, arranged in the second area, the transformer positioned within an enclosure with the VFD, the transformer configured to distribute power for operation of the electric pump.”**

167. *Fischer* Fig. 3 discloses a “single-pump configuration 130 that includes a medium-voltage VFD [variable frequency drive] 132 [annotated in magenta], a single, single-shaft electric motor 134 [annotated in yellow] and a single hydraulic pump 136 [annotated in maroon], each of which is mounted on a single pump trailer 131 [annotated in red].”¹²⁶

¹²⁶ Ex. 1008 (*Fischer*) 12:12:3-8, Fig. 3; Ex. 1009 (*Fischer Provisional*) [0031], Fig. 2.

As can be seen, the VFD is arranged in the second area (annotated in green).



Ex. 1008 (*Fischer*) Fig. 3 (annotated)

168. *Fischer* further discloses that “the medium-voltage VFD 132 generally includes a transformer assembly 230 and a power cell assembly 240.”¹²⁷ As seen above in Fig. 3, and shown similarly in Fig. 2 of the *Fischer Provisional*, the VFD is depicted as an enclosure or room mounted in the second area. A POSITA would have understood that the transformer would have been inside the enclosure (i.e., the component marked as item 200 in Fig. 3 of *Fischer* and the component marked as

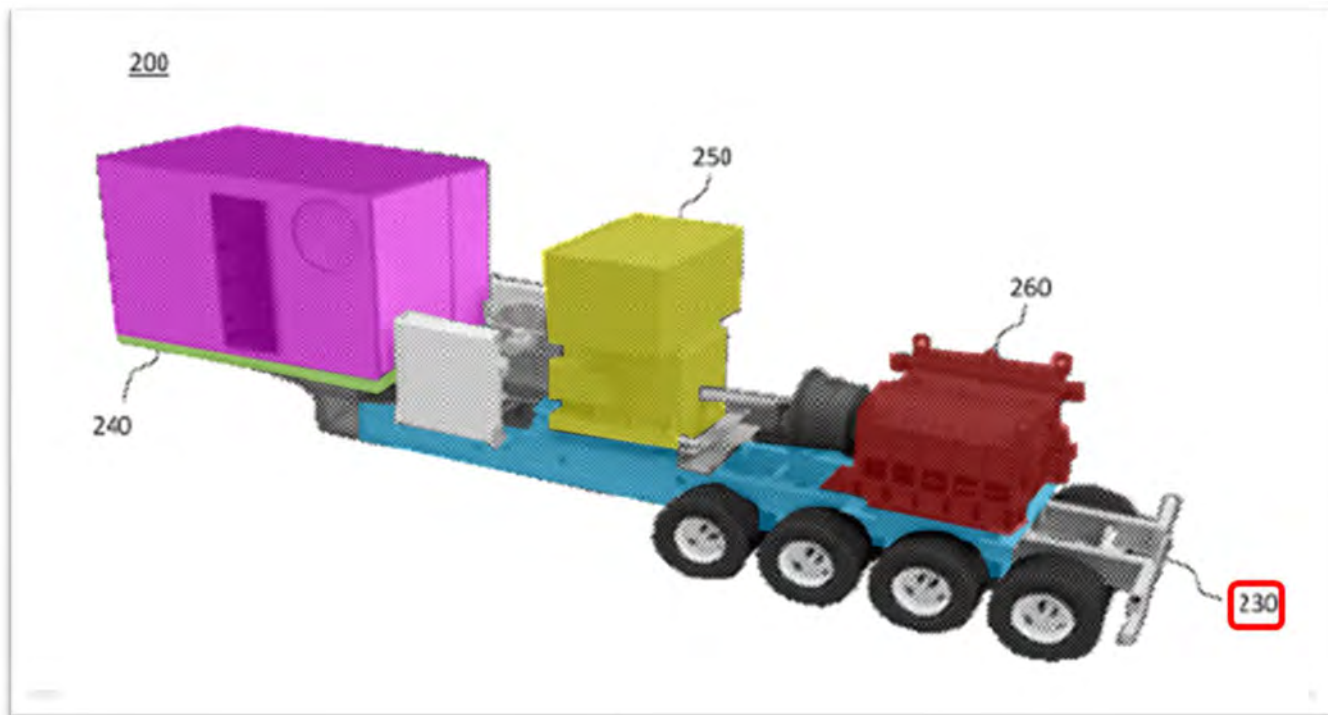
¹²⁷ Ex. 1008 (*Fischer*) 35: 32 – 34; see also 20:62 – 66; Ex. 1009 (*Fischer Provisional*) [0082] (“The transformer incorporated into the single VFDs 340(a-n) may then step-down the voltage level of 13.8kV for the AC voltage signal 360 to the voltage level of 4160V for the VFD voltage signal.”).

item 240 in Fig. 2 of *Fischer Provisional*) of the VFD, along with the power cell assembly, as the VFD 132 “includes” those components. If, as *Fischer* teaches, the VFD includes the transformer, then the transformer is clearly with the VFD.

169. *Fischer* further teaches that the transformer is configured to distribute power for operation of the electric [powered] pump. *Fischer* teaches “converting, by the transformer 232, the electric power at the initial voltage level to electric power at a transformer voltage level, and converting, by the plurality of power cells 242, the electric power at the transformer voltage level to electric power at the VFD voltage level.”¹²⁸ As discussed above regarding 1[c], and incorporated herein by reference, the VFD controls operation of the electric powered pump. Accordingly, by converting and distributing power to the VFD (which then distributes power to the electric motor), the transformer is distributing power for operation of the electric (powered) pump.

170. *Fischer Provisional* supports the disclosures of *Fischer* regarding the VFD containing a transformer arranged in the second area. Initially, as discussed above regarding limitation 1[a], *Fischer Provisional* shows VFD 240 (annotated in magenta) arranged in the second area (annotated in green) as shown in Fig. 2.

¹²⁸ Ex. 1008 (*Fischer*) 35:36–41; see also id., 7:51-8:7, 35:58-36:10; Ex. 1009 (*Fischer Provisional*) [0035], [0082].



Ex. 1009 (*Fischer Provisional*) Fig. 2 (annotated)

171. Further, *Fischer Provisional* teaches that “[t]he transformer incorporated into the single VFDs 340(a-n) may then step-down the voltage level of 13.8kV for the AC voltage signal 360 to the voltage level of 4160V for the VFD voltage signal.”¹²⁹ *Fischer Provisional* further teaches that the 4160V voltage signal is provided to the motor.¹³⁰ A POSITA would have understood this disclosure to include a transformer incorporated into the VFD enclosure depicted in Fig. 2 of *Fischer Provisional* (called VFD 240), so that the transformer is “with” the VFD, and that the transformer distributes power for operation of the electric pump.

¹²⁹ Ex. 1009 (*Fischer Provisional*) [0082].

¹³⁰ Ex. 1009 (*Fischer Provisional*) [0082].

172. To the extent that the Board finds that this disclosure is insufficient to support the disclosure of *Fischer* explicitly depicting the transformer located inside the same enclosure as a VFD, a POSITA would have found it obvious to incorporate the transformer into the VFD enclosure based on the knowledge of a POSITA that transformers are include in VFD packages, as shown by the NEMA ICS standards.¹³¹ Further, a POSITA would have found it obvious to include the transformer inside the enclosure with the VFD in order to protect the transformer and the electrical connections from the elements. As discussed above regarding limitation 1[c], and incorporated herein by reference, *Fischer* discloses that the VFD is configured to control the operation of the electric motor.

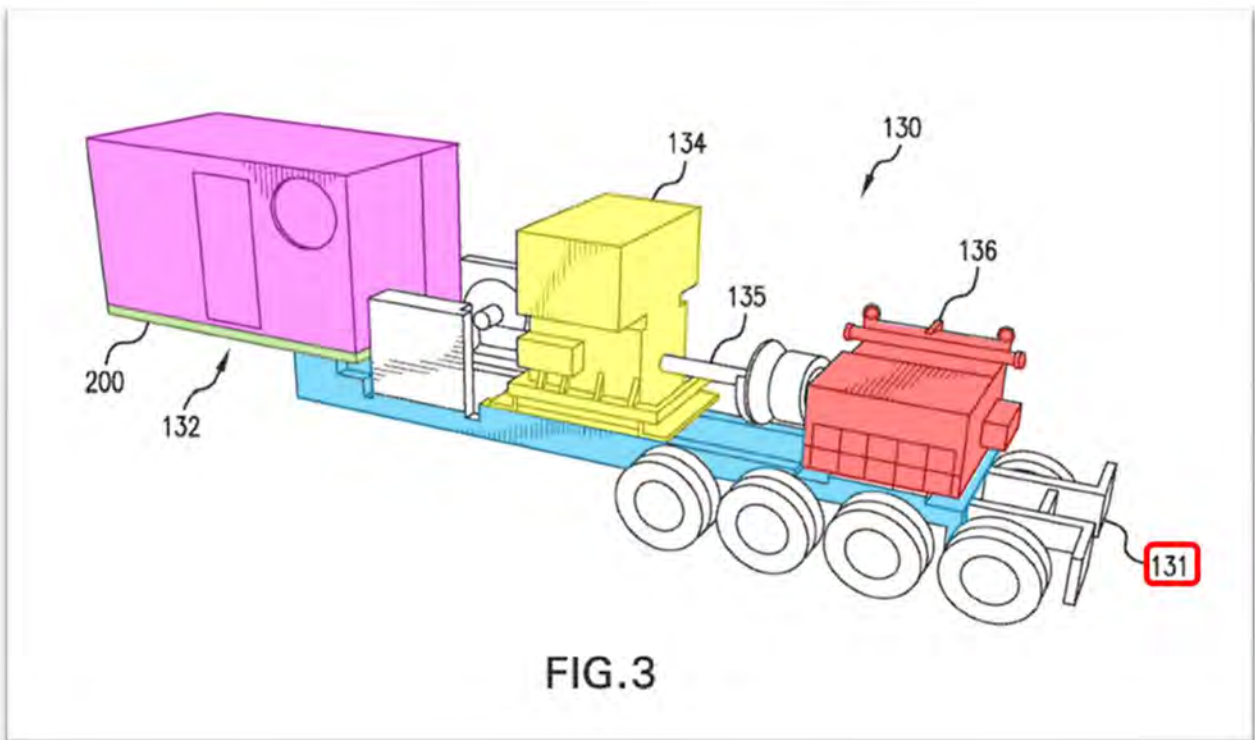
173. Accordingly, *Fischer* discloses a transformer, arranged in the second area, the transformer positioned within an enclosure with the VFD, the transformer configured to distribute power for operation of the electric pump. or at least it would have been obvious,

B. CLAIM 9

9. The hydraulic fracturing system of claim 1, wherein the first area is opposite the second area and the second area includes a hitch for coupling to a prime mover.

¹³¹ See section IX.J above.

174. Claim 9, would have been obvious to a POSITA based on the teachings of *Fischer*. As discussed above regarding Claim 1, and incorporated herein by reference, *Fischer* teaches a trailer mounted fracturing system with a first area (annotated in blue) and a second area (annotated in green) that are on opposite sides of the trailer.¹³²

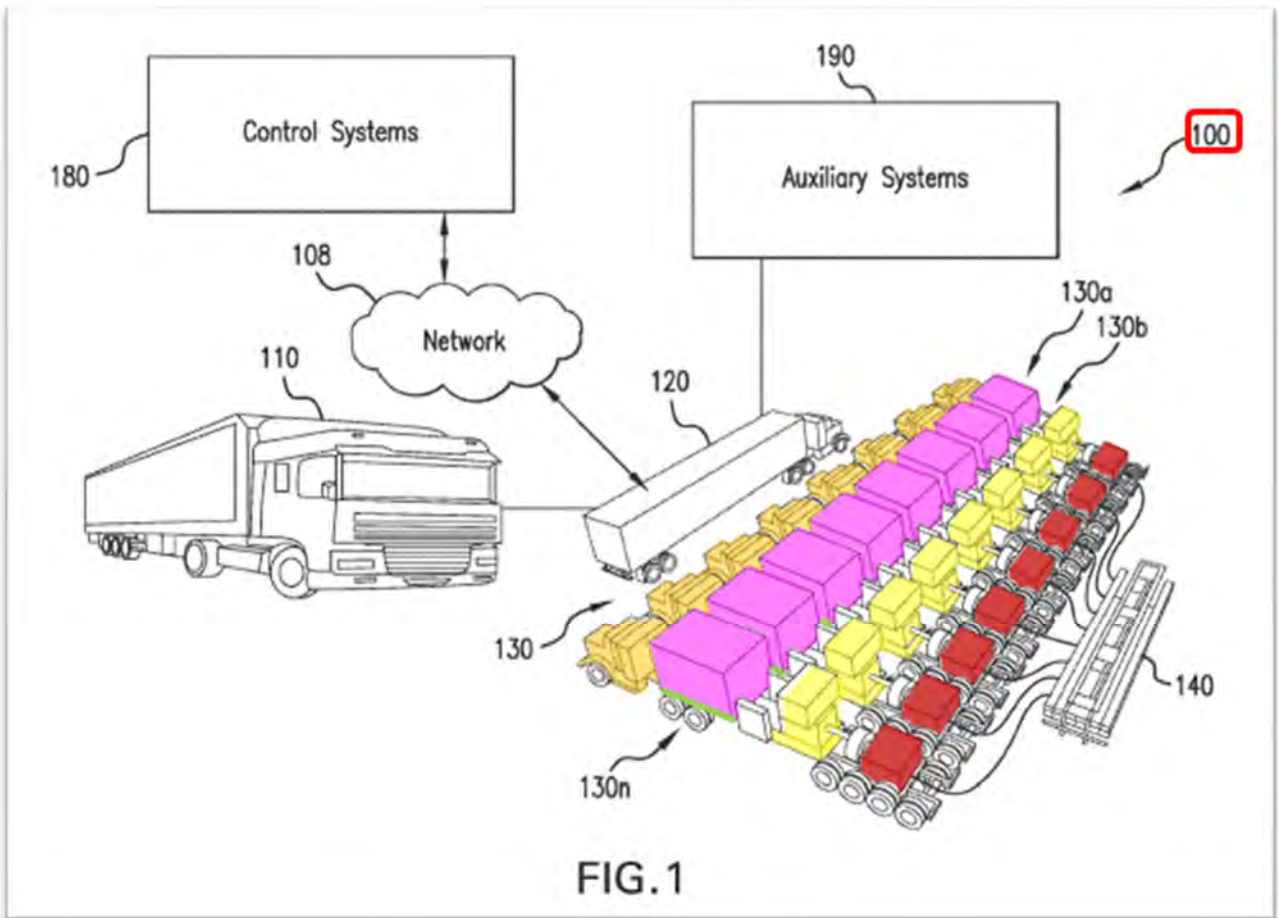


Ex. 1008 (*Fischer*) Fig. 3 (annotated)

175. *Fischer* also teaches that “hydraulic fracking operation 100 is oftentimes a mobile operation where each of the components is positioned on a

¹³² See also Ex. 1008 (*Fischer*) 6:29 – 49; see also Ex. 1009 (*Fischer Provisional*) Fig. 2.

corresponding trailer *that is then hauled to the fracking site via semi-trucks and/or tractors*. For example, the fracking system 140 includes a trailer 141 including fracking equipment 142 *that is hauled in via a semi-truck*¹³³ as shown in Fig. 1 of *Fischer*.



Ex. 1008 (*Fischer*) Fig. 1 (annotated)¹³⁴

¹³³ Ex. 1008 (*Fischer*) 6:41 – 46; Ex. 1009 (*Fischer Provisional*) [0017], Fig. 1.

¹³⁴ see also Ex. 1009 (*Fischer Provisional*) Fig. 1.

176. As can be seen, the trailers' second areas (highlighted in green, difficult to see), located beneath the VFDs (highlighted in magenta) are located at, and attached to, the semi-truck (highlighted in orange). In order for the trailer to be connected to the semi-truck to be transported from site to site, a POSITA would have understood that a hitch would have been a well-known and obvious component incorporated into the second area of the trailer for attachment to the truck.¹³⁵ To the extent that a hitch is not explicitly disclosed by *Fischer* having a hitch in the second area to connect the second area to the semi-truck, as shown in Fig. 1, would have been an obvious configuration to connect a trailer and a semi-truck.

177. Accordingly, the hydraulic fracturing system of claim 1, wherein the first area is opposite the second area and the second area includes a hitch for coupling to a prime mover as claimed in Claim 9 would have been obvious to a POSITA based on the teachings of *Fischer*.

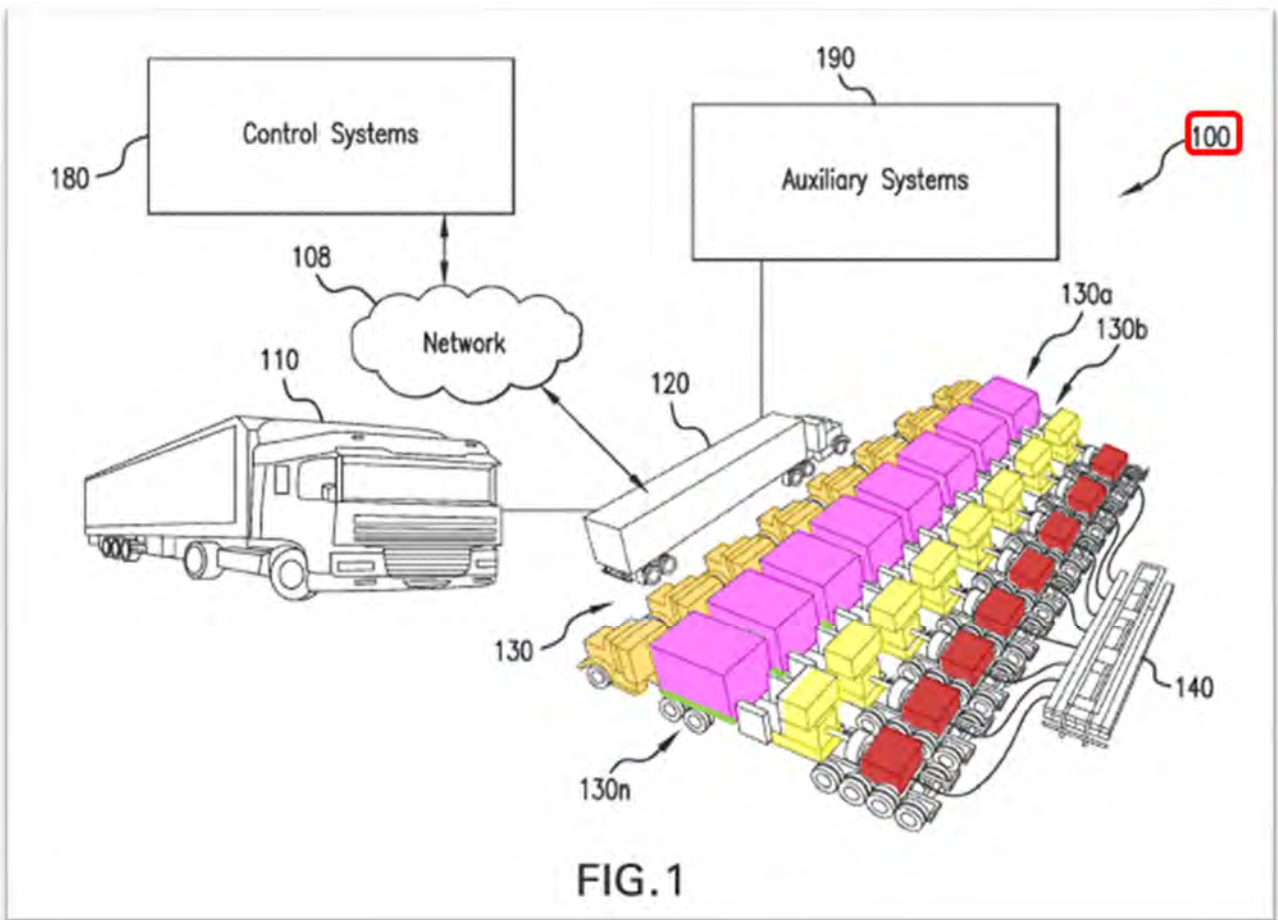
XIII. GROUND 2: OBVIOUS OVER FISCHER IN VIEW OF OEHRING-I

A. MOTIVATION TO COMBINE

178. A POSITA would have been motivated to combine the teachings of *Oehring-I* with those of *Fischer*. Initially, both *Fischer* and *Oehring-I* disclose

¹³⁵ See, e.g., Ex. 1012 (*Oehring-I*) Abstract (“The pump and motor are mounted on a trailer that is hitched to a tractor.”); EX1018, 2:65-70, Fig. 3 (depicting a trailer that is attached, via a hitch, “to the fifth wheel 18 on a prime mover”).

trailer-based fracturing systems. *Fischer* discloses in Figs. 1 and 2 “a hydraulic fracturing operation 100 [annotated in red] in which hydraulic pumps [annotated in orange] may pump a fracking media into a fracking well 109 [not shown] to execute a fracking operation in order to extract a fluid from the fracking well 109.”¹³⁶

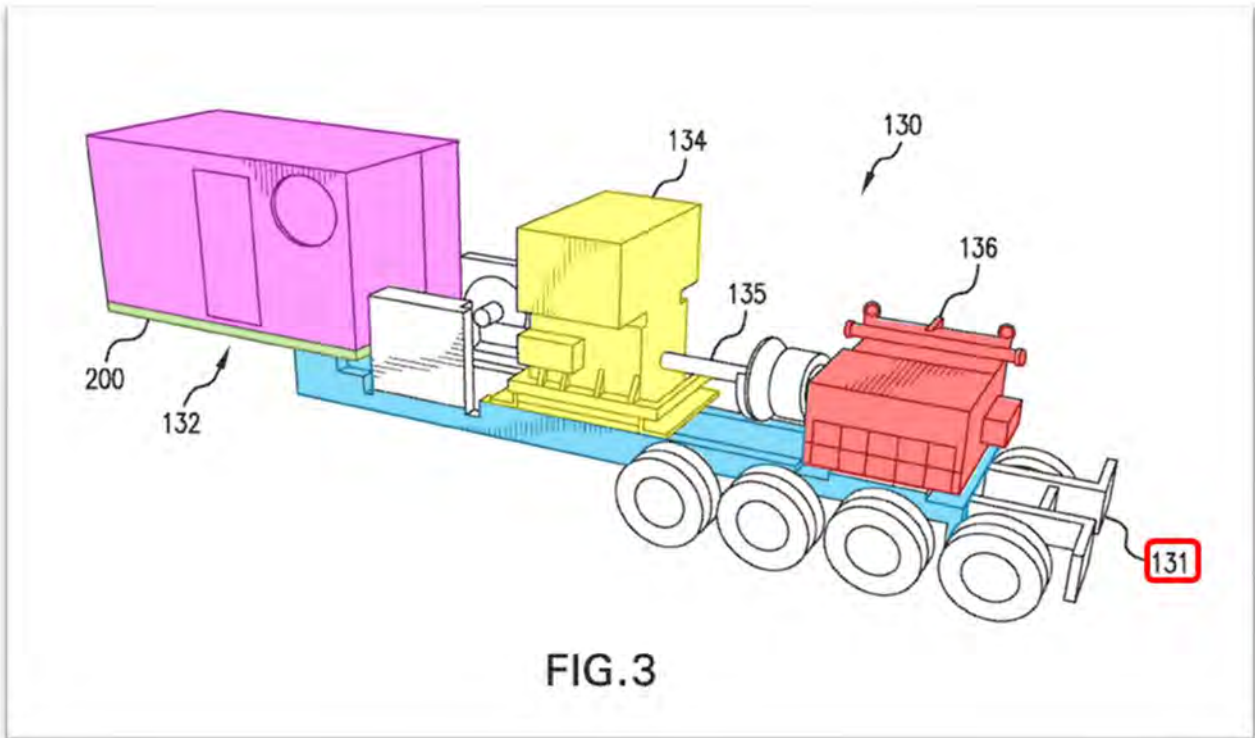


Ex. 1008 (*Fischer*) Fig. 1

¹³⁶ Ex. 1008 (*Fischer*) 4:16 – 20; Ex. 1009 (*Fischer Provisional*) [0016], Fig. 1, Fig. 2.

179. As seen in Fig. 1, the fracturing system comprises a variety of trailers.

Fischer teaches that these trailers contain fracturing equipment.



Ex. 1008 (*Fischer*) Fig. 3 (annotated)¹³⁷

180. *Fischer* discloses that the trailer “includes a medium-voltage VFD [variable frequency drive] 132 [annotated in magenta], a single, single-shaft electric motor 134 [annotated in yellow] and a single hydraulic pump 136 [annotated in maroon], each of which is mounted on a single pump trailer 131 [annotated in red]” as can be seen in Fig. 3, the first area (annotated in blue) is at a second, lower height

¹³⁷ See also Ex. 1009 (*Fischer* Provisional), Fig. 2.

than the second area (annotated in green), and the first and second areas are adjacent one another.¹³⁸

181. Similarly, *Oehring-I* discloses “[a] hydraulic fracturing system has a pump driven by an electrically powered motor,”¹³⁹ and shows the motor and pump mounted on a trailer. Fig. 1, annotated below, shows “pumps 12₁ , 12₂ [highlighted in maroon] mounted on a trailer 14 (annotated in red). Further, like *Fischer*, *Oehring-I* teaches “[a]lso mounted on trailer 14 are motors 18₁, 18₂ [annotated in yellow] which are used for driving pumps 12₁ , 12₂ and which are electrically powered.”¹⁴⁰ Finally, like *Fischer*, *Oehring-I* teaches that the motor is driven by a VFD.¹⁴¹ *Oehring-I* further teaches that its trailer has a first area (annotated in blue) and a second area (annotated in green) adjacent each other and at different heights, as *Fischer* does. Organized in the first area are the pumps and motors, and in the second area is an enclosed control room 26 (annotated in magenta), similar to the enclosure of *Fischer*. A POSITA, therefore, would have been motivated to combine the references at least because of their similarities and would have understood that

¹³⁸ Ex. 1008 (*Fischer*) 12:12:3-8, Fig. 3; Ex. 1009 (*Fischer Provisional*) [0031], Fig. 2.

¹³⁹ Ex 1012 (*Oehring-I*) at Abstract

¹⁴⁰ Ex. 1012 (*Oehring-I*) [0018].

¹⁴¹ Ex. 1012 (*Oehring-I*) [0025], see also [0027],

182. Further, *Oehring-I* contains an express motivation to combine. *Oehring-I* teaches “a platform assembly is mounted onto the trailer, and which is selectively moveable between deployed and stowed configurations. The platform assembly includes a platform, a lateral rail assembly mounted to the platform, and gates on the forward and aft ends of the platform. The rail assembly and gates define

a safety barrier to prevent operations personnel from falling off the platform. In the stowed configuration the platform assembly is anchored in place over wheels on the trailer. In the deployed configuration, *the platform assembly provides work surface so that operations personnel can readily access the pump on the trailer.*”¹⁴²

A teaching of a feature that would “prevent operations personnel from falling off the platform” would motivate a POSITA to incorporate such a feature. Further, a POSITA would recognize the benefits of deploying a platform so that operations personnel can readily access the pump on the trailer, such as for operations or maintenance of the pump. POSITA reading *Oehring-I* would have been motivated to include slide-out platforms with rails to prevent operations personnel from falling off the platform and increase the safety of the fracturing equipment, a goal at any fracturing site. Further, a POSITA would have been motivated to include the slide-out platforms for easy access to the pumps, such as maintenance of the pumps.

183. A POSITA would have a reasonable expectation of success in combining the teachings of *Fischer* and *Oehring-I*. Implementing *Oehring-I*’s platform with the trailer of *Fischer* would merely be using a known technique (incorporating *Oehring-I*’s safety and maintenance platforms) to improve similar devices (*Fischer*’s fracturing pump trailer) in the same way. The results of the

¹⁴² Ex. 1012 (*Oehring-I*), Abstract.

combination would be predictable: a pump trailer with a retractable platform assembly that provides maintenance operators access to *Fischer*'s pump mounted on the pump trailer. Indeed, a POSITA would have recognized that *Oehring-I*'s platform assembly would be implemented in *Fischer*'s pump trailer just as it is in *Oehring-I*, i.e., such that it is installed over the wheels on *Fischer*'s pump trailer to provide access to *Fischer*'s pump.

B. CLAIM 2

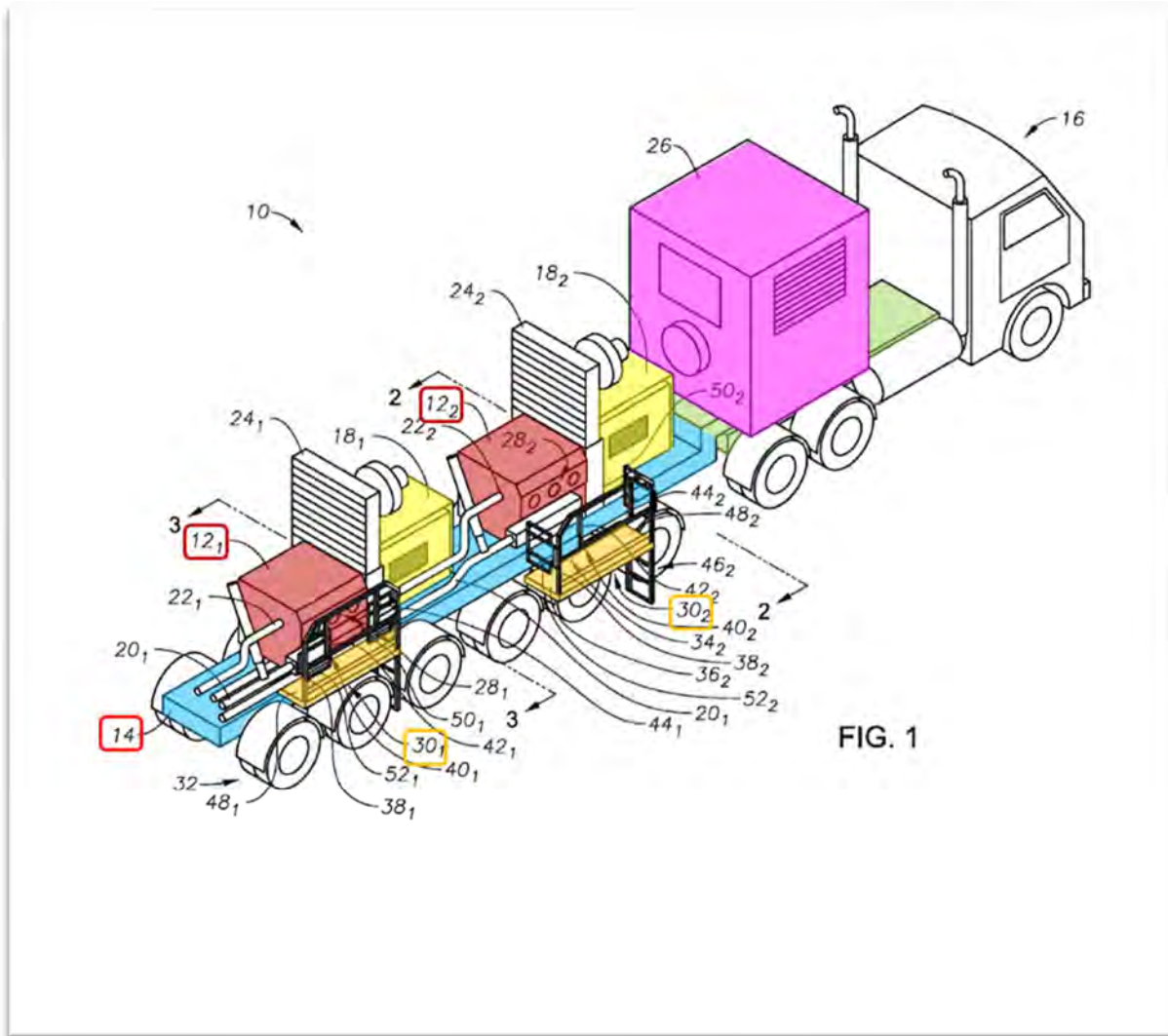
The hydraulic fracturing system of claim 1, further comprising: a slide out platform integrated into the first area, the slide out platform being driven between a retracted position and a deployed position, wherein the deployed position provides a work area proximate the electric powered, multi-plunger pump.

184. Claim 2 depends from Claim 1. In addition to the disclosures of *Fischer* discussed above regarding Claim 1, and incorporated herein by reference, *Oehring-I* discloses the additional limitations of Claim 2.

185. As discussed above regarding Ground 1, *Fischer* discloses, or at least renders obvious, the hydraulic fracturing system of Claim 1. *Oehring-I* further discloses a slide out platform as described and claimed in Claim 2. Like *Fischer*, Fig. 1 of *Oehring-I* shows a first area (annotated in blue) and a second area

(annotated in green) wherein the second area is at a different elevation than the first area. Further, *Oehring-I* shows “platform assemblies 30₁, 30₂ [annotated in orange] are shown provided with trailer 14 [annotated in red] and which can selectively be deployed so that operations personnel can access the pumps 12₁, 12₂, [] for repairing pumps 12₁ and 12₂ [annotated in maroon].”¹⁴³ As can be seen from Fig. 1, the platform assemblies 30₁, 30₂ are shown integrated into the first area. *Oehring* further explicitly discloses that the platforms are “deployed so that operations personnel can access the pumps 12₁, 12₂, for repairing pumps 12₁ and 12₂.” A POSITA would have understood that the platforms provide a work area for repair of the pumps.

¹⁴³ Ex. 1012 (*Oehring-I*) [0019].



Ex. 1010 (*Oehring-I*) Fig. 1 (annotated)

186. Further, *Oehring-I* teaches that a “platform assembly is mounted onto the trailer, and which is selectively moveable [i.e. driven] between deployed and stowed configurations. The platform assembly includes a platform, a lateral rail assembly mounted to the platform, and gates on the forward and aft ends of the platform. The rail assembly and gates define a safety barrier to prevent operations personnel from falling off the platform. In the stowed configuration the platform

assembly is anchored in place over wheels on the trailer. In the deployed configuration, the platform assembly provides work surface so that operations personnel can readily access the pump on the trailer.”¹⁴⁴ The platform assembly is coupled to support rails, which “slidingly engage” with mount assemblies on the trailer such that the platform can be “readily moved between the stowed and deployed configurations.”¹⁴⁵ Further, *Oehring-I* teaches a “platform assembly mounted to the trailer and from which at least a one of the pumps are accessible by operations personnel.”¹⁴⁶ Accordingly, *Oehring-I* teaches that the platforms provide a work area proximate the electric powered multi-plunger pump (i.e. for repairing the pumps) as claimed. This is even more evident in the Figures of *Oehring-I*. The platform assembly is a “slide out platform being driven between a retracted position and a deployed position” because the support rails with which it is coupled are “slidingly engaged” with mount assemblies on the trailer such that the platform can be “selectively moveable between deployed and stowed configurations.”

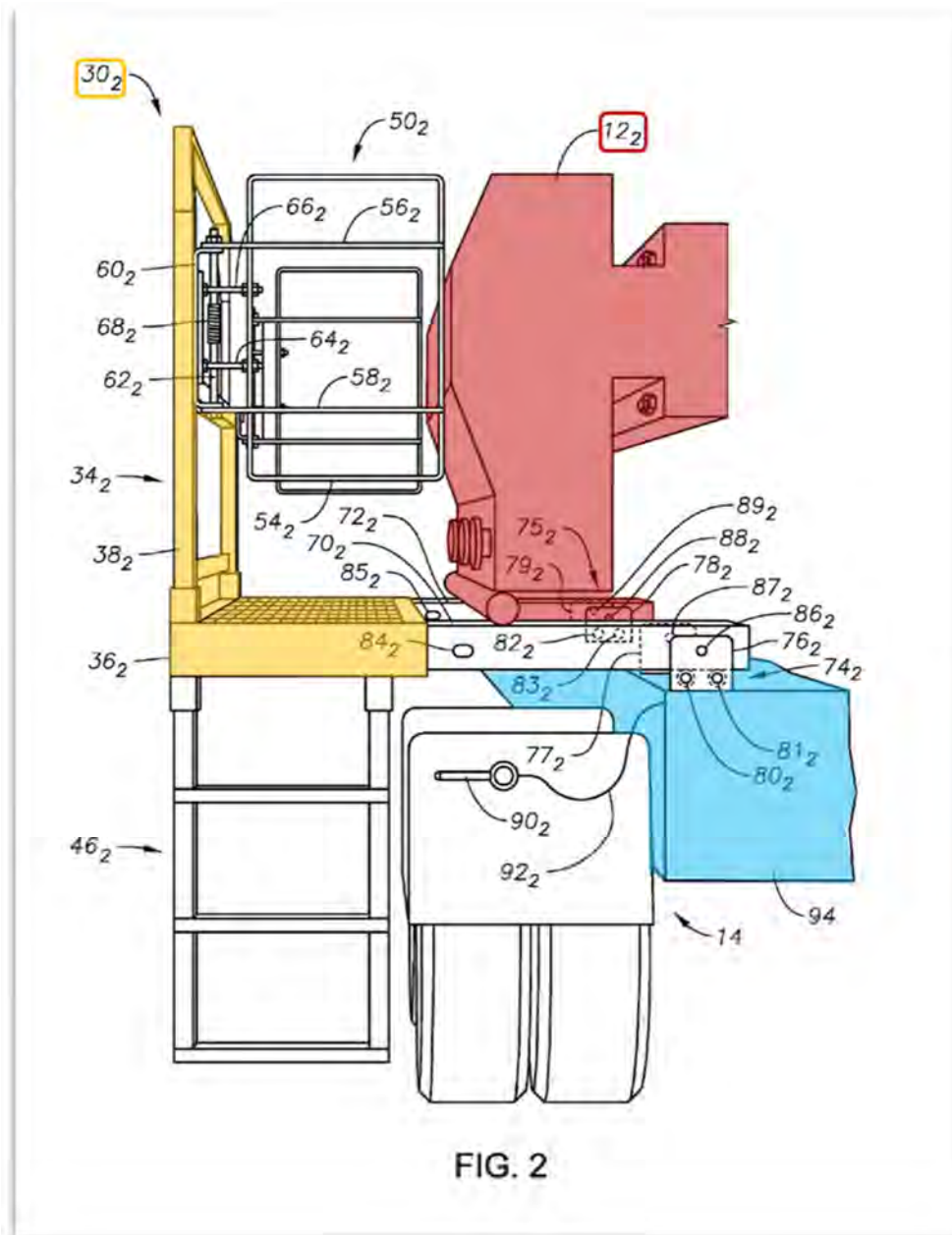
187. Fig. 2 of *Oehring-I* shows platforms 30₂ (highlighted in orange) in the “an end view of an example of a platform assembly for use with the trailerized pump

¹⁴⁴ Ex. 1012 (*Oehring-I*) at Abstract.

¹⁴⁵ Ex. 1012 (*Oehring-I*) [0022]-[0023].

¹⁴⁶ Ex. 1012 (*Oehring-I*) [0007], Claim 1, Claim 10,

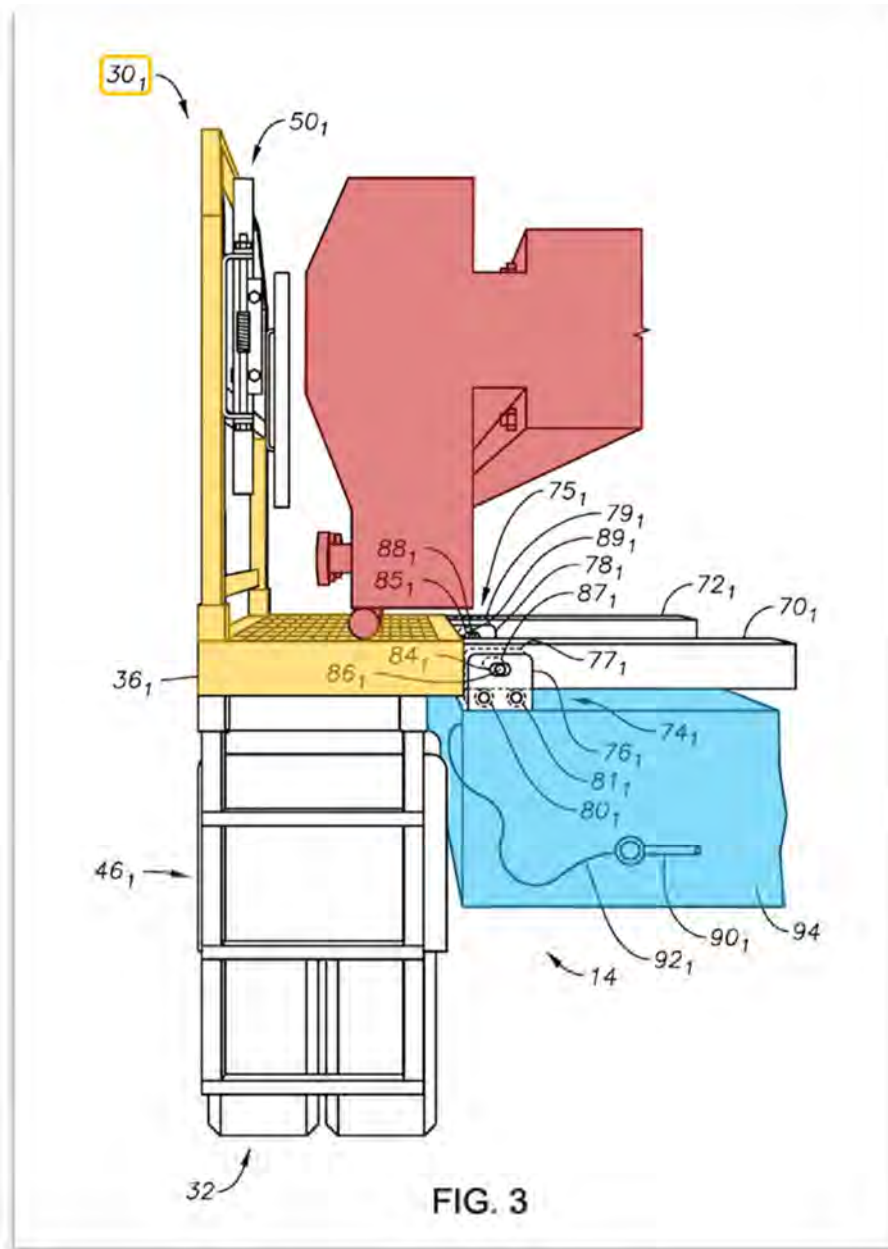
system of FIG. 1 and in a deployed configuration.”¹⁴⁷ The pump 12₂ is highlighted in maroon and the first area is highlighted in blue.



Ex. 1012 (*Oehring-I*) Fig. 2 (annotated)

¹⁴⁷ Ex. 1012 (*Oehring-I*) [0011].

188. Similarly, Fig. 3 of *Oehring-I* “is an end view of an example of a platform assembly (30₁ annotated in orange) for use with the trailerized pump system of FIG. 1 and in a stowed configuration.”¹⁴⁸



¹⁴⁸ Ex. 1012 (*Oehring-I*)

Ex. 1012 (*Oehring-I*) Fig. 3 (annotated)

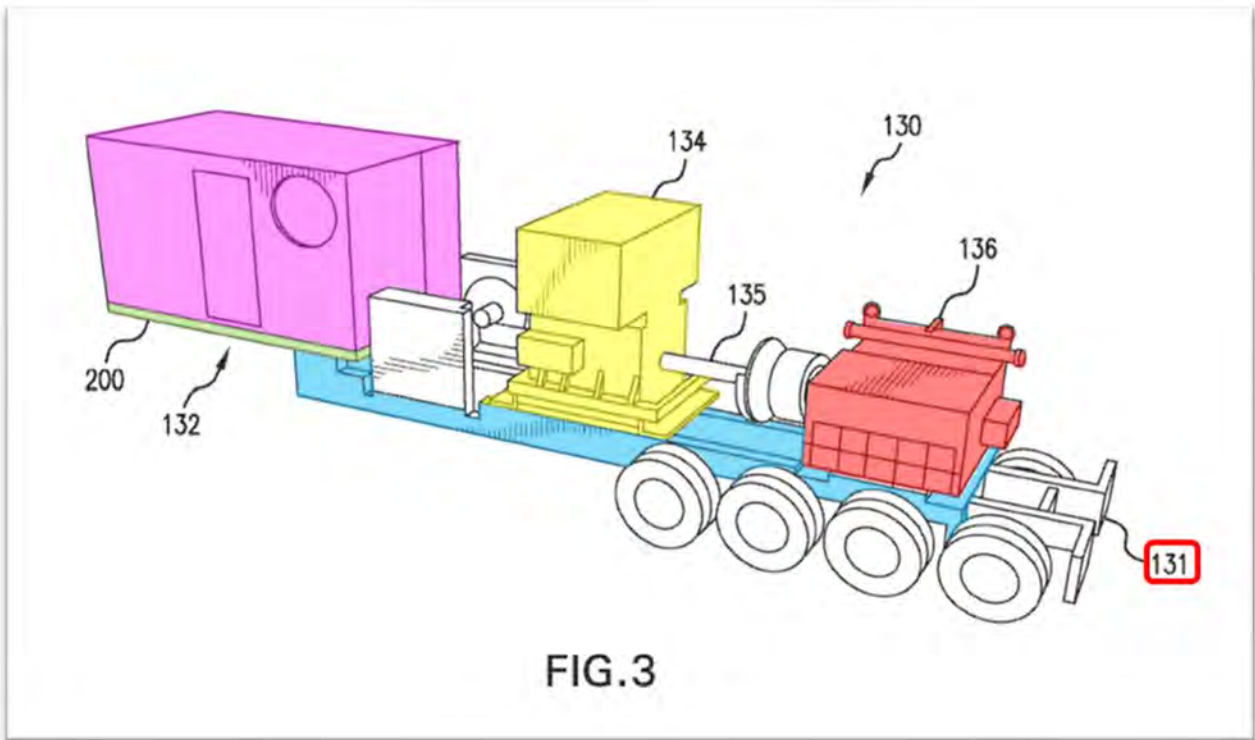
189. As discussed above, POSITA would have understood that in the combined *Fischer-Oehring-I* system, *Oehring-I*'s teachings of a platform assembly would have been incorporated into *Fischer*'s pump trailer to provide a “selectively movable” platform that gives operations personnel access to *Fischer*'s pump, as taught by *Oehring-I*. And because *Fischer*'s pump is located in the “*first area*” of *Fischer*'s pump trailer, a POSITA would have understood that *Oehring-I*'s platform assembly, which is proximate to and provides access to the pump, would be “integrated into the first area.” As a result, the combination of *Fischer* and *Oehring-I* renders Claim 2 obvious.

XIV. GROUND 3: OBVIOUS OVER *FISCHER* IN VIEW OF *OEHRING-II*

A. MOTIVATION TO COMBINE

190. *Fischer* describes a pump trailer that includes a first area in which an electric motor and a hydraulic pump are mounted and a second, elevated area that features an enclosure which houses a VFD.¹⁴⁹ Figure 3 of *Fischer*, depicting the pump trailer, is copied below:

¹⁴⁹ See § XII.A.(b)-(e) above.



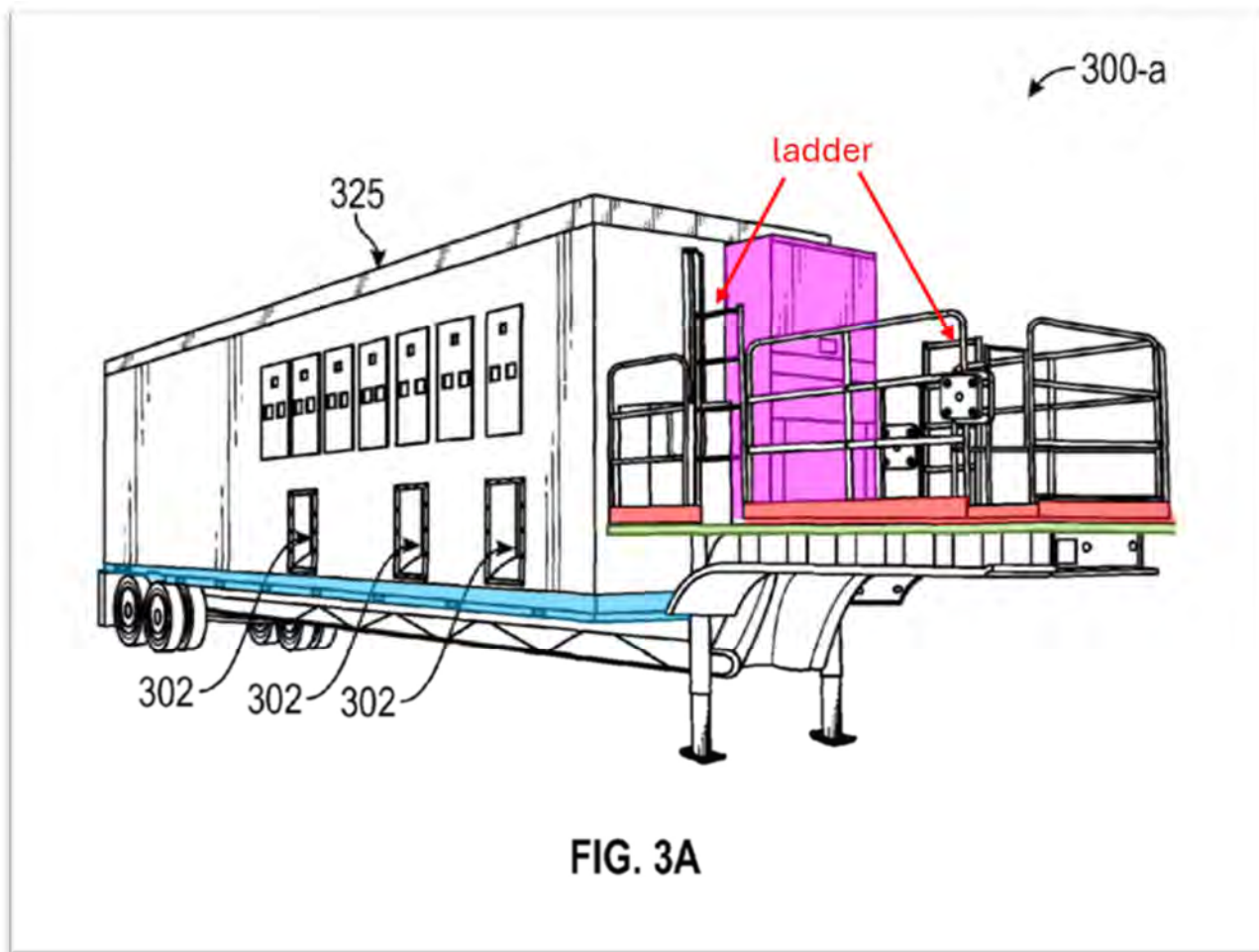
Ex. 1008 (Fischer), Fig. 3¹⁵⁰

191. Similarly, *Oehring-II* discloses a hydraulic fracturing system that uses electrical motors, powered by generators, to drive electric pumps.¹⁵¹ *Oehring-II* further describes a “switchgear trailer” that provides electric connections for various components of the fracturing system.¹⁵² Annotated Figure 3A of *Oehring-II*, provided below, depicts this trailer:

¹⁵⁰ See also Ex. 1009 (Fischer Provisional), Fig. 2/

¹⁵¹ Ex. 1016 (*Oehring-II*), Abstract.

¹⁵² Ex. 1016 (*Oehring-II*), 7:21-28.



Ex. 1016 (Oehring-II), Fig. 3A (annotated).

192. As depicted in Fig. 3A, the switchgear trailer further contains an enclosure (annotated in magenta above) accessible from an elevated platform (annotated in red above) that is located along the trailer's longitudinal axis.

193. A POSITA would have been motivated to incorporate *Oehring-II*'s elevated platform into *Fischer*'s pump trailer for multiple reasons. First, design incentives would have motivated a POSITA to make this combination. As depicted in Figure 3 of *Fischer*, the second area of *Fischer*'s pump trailer (including the VFD

enclosure) is elevated above the first area and the ground; however, *Fischer* does not describe how this area is actually accessed by an operator. A POSITA implementing *Fischer's* pump trailer therefore would have been motivated to look for and incorporate some sort of apparatus to access these components, such as the elevated platform and ladders depicted in *Oehring-II*. This would enable personnel to access the enclosure for operations or maintenance tasks.

194. Second, incorporating *Oehring-II's* platform to provide access to the second area of *Fischer's* pump trailer is applying a known technique (a platform coupled to a trailer as taught by *Oehring-II*) to improve similar devices (*Fischer's* pump trailer) in the same way. The results of the combination would be predictable: a pump trailer with a platform located along trailer's longitudinal axis at the front of the trailer that provides operators access to the elevated areas of *Fischer's* pump trailer. A POSITA, therefore, would have a reasonable expectation of success in applying the teachings of *Oehring-II* to *Fischer*. Accordingly, a POSITA would have been motivated to combine *Fischer* and *Oehring-II* and would have had a reasonable expectation of success in doing so.

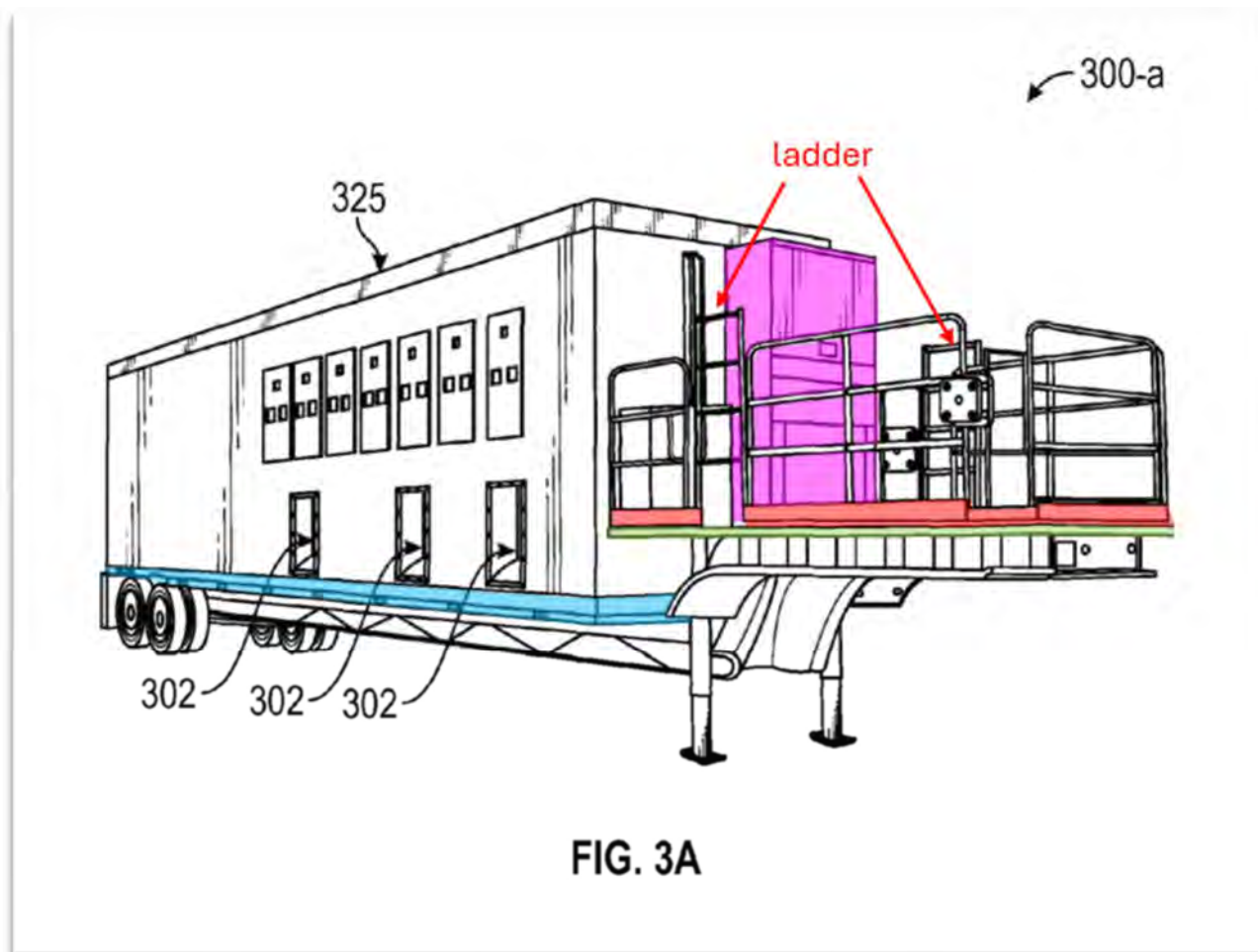
B. CLAIM 3

The hydraulic fracturing system of claim 1, further comprising:

a work platform proximate the enclosure in the second area, the work platform providing access to the enclosure, the work platform arranged such that the enclosure is between the work platform and the first area.

195. Claim 3 depends from Claim 1. In addition to the discussion of *Fischer* regarding Claim 1 above, and incorporated herein by reference, *Oehring-II* discloses the additional limitations of Claim 3.

196. *Oehring-II* discloses a trailer similar to that of *Fischer* (and *Oehring-I*) that has a first area (highlighted in blue) and a second area (highlighted in green). *Oehring-II* also shows an enclosure (highlighted in magenta) in the second area.



Ex. 1016 (Oehring-II) Fig. 3A (annotated)

197. *Oehring-II* also shows a work platform (highlighted in red) with rails (not highlighted) and access ladders (annotated with red arrows). A worker on this platform would have access to the enclosure (annotated in magenta). The enclosure is between the work platform and the first area (highlighted in blue)

198. In combination with *Fischer*, a POSITA would have understood to add a work platform similar to that of *Oehring-II* to the trailer of *Fischer* in the second area to give access to VFD 132 and its enclosure without having to stand on a ladder

while accessing the enclosure. It would be understood, based on the teachings of *Oehring-II* that the platform would be placed at the very front of the trailer, in the second area, with the enclosure between the platform and the first area, as depicted in *Oehring-II*, for example Fig. 3A as annotated above. A POSITA would have understood that in this combined system, *Oehring-II*'s elevated platform (annotated in red above) would be "proximate the enclosure in the second area, the work platform providing access to the enclosure," because *Fischer*'s "enclosure" is also located in the second area of the pump trailer, as discussed above with reference to Limitations 1[c] and 1[d].

199. The claims do not require a POSITA to be able to enter the enclosure (VFD 132). However, to the extent that *Fischer* depicts the "door" to the VFD enclosure on the side of the VFD enclosure, it would be a simple matter for a POSITA to rearrange the VFD enclosure to have the access door on the "front" (nearest the tractor) of the trailer in order to gain access to the interior of the VFD enclosure from the added platform based on the teachings of *Oehring-II*. Such a configuration would merely be a modification or adaptation of the embodiments of *Fischer* and would not require undue experimentation.

200. Accordingly, *Oehring-II* discloses a work platform proximate the enclosure in the second area, the work platform providing access to the enclosure, the work platform arranged such that the enclosure is between the work platform and

the first area and Claim 3 would have been obvious to a POSITA based on the combined teachings of *Fischer* and *Oehring-II*.

XV. GROUND 4: OBVIOUS OVER FISCHER IN VIEW OF ORBAN

A. MOTIVATION TO COMBINE

201. A POSITA would have been motivated to combine the teachings of *Fischer* with those of *Orban* to take advantage of *Orban*'s cooling mechanism to remove heat from the power electronics (e.g. IGBTs) associated with *Fischer*'s VFD. *Fischer* already teaches an air-based cooling (ventilation) system for cooling the VFD cabin and electronic components of the VFD. *Fischer* discloses that "the medium-voltage VFD 132 may be housed in a VFD cabin, which may further include a ventilation system that operates using low-voltage power to cool the medium-voltage VFD 132."¹⁵³ Further, *Fischer* discloses that "each power cell 242" which is a part of the VFD 132, "has a dedicated temperature sensor 249 and a dedicated cooling fan 258, with the cooling fans 258 comprising a portion of the ventilation system 250."¹⁵⁴

202. *Orban* teaches "[a]n integrated power and electronics unit (IPEU) operable for providing output power for driving an electric motor of a drilling rig

¹⁵³ Ex. 1008 (*Fischer*) 6:2-5, see also 25:33-48. Ex. 1009 (*Fischer Provisional*) [0058], [0069].

¹⁵⁴ Ex. 1008 (*Fischer*) 7 – 10. Ex. 1009 (*Fischer Provisional*), [0069], [0073].

machine.”¹⁵⁵ The IPEU comprises a housing, a radiator, and a VFD. The radiator is mounted within the housing and comprises radiating members each extending through an opening in the housing. The VFD comprises insulated-gate bipolar transistor devices (IGBTs) operable to convert input power to the output power.”¹⁵⁶ *Orban* specifically teaches that the IPEU may be for fracturing pumping systems, such as may comprise one or more electrically driven triplex pumps.”¹⁵⁷ A POSITA would have understood that for larger pumps (for example, quintuplex or larger with higher horsepower), the corresponding electronic components would handle more heat than for smaller pumps, requiring more heat dissipation from those electronics, making the teachings of *Orban* even more germane to the problem of protecting electronics from heat related damage. Accordingly, *Orban* contains an express motivation to combine its teachings with those of other references dealing with fracturing pumps, such as *Fischer*. Further, *Orban* teaches that “[t]he IPEU includes a housing, a radiator, and a VFD.”¹⁵⁸ Additionally, “[t]he VFD includes IGBTs operable to convert input power to the output power. The IGBTs are coupled to the radiator within the housing such that heat generated by the IGBTs is transferred out of the housing via the radiator.”¹⁵⁹ A POSITA would have immediately recognized

¹⁵⁵ Ex. 1010 (*Orban*) at Abstract.

¹⁵⁶ Ex. 1011 (*Orban*) at Abstract.

¹⁵⁷ Ex. 1011 (*Orban*) [0042].

¹⁵⁸ Ex. 1011 (*Orban*) [0006].

¹⁵⁹ Ex. 1011 (*Orban*) [0006].

the benefits of removing heat from the electronics (IGBTs) so that the IGBTs are operated at the appropriate temperature and do not overheat. For example, *Orban* teaches the use of radiators “may avoid overheating of some IGBTs 135, while ensuring that their "speed" response is similar for proper sharing of current during PWM switching.”¹⁶⁰ A POSITA would have recognized *Orban*’s radiator, whose design allows a VFD to “operate at substantially the same temperature,” would achieve such goals.¹⁶¹

203. Further, a POSITA would have been motivated to combine *Orban*’s liquid based cooling system based on the general knowledge that such systems have been employed in protecting power electronics since at least the 1970s.¹⁶² A POSITA would have been motivated to supplement the air-based ventilation system described by *Fischer* with the liquid based cooling system taught by *Orban* to allow for additional cooling of the electronics (and the enclosure), as liquid cooling systems were known to dissipate more heat than air based systems.¹⁶³

204. A POSITA would have a reasonable expectation of success in combining the teachings of *Fischer* and *Orban* as *Orban* explicitly discloses that its liquid cooling system was applicable to fracturing pumps. Further, a POSITA would

¹⁶⁰ Ex. 1011 (*Orban*) [0066].

¹⁶¹ Ex. 1011 (*Orban*), [0065].

¹⁶² See §IX.K above.

¹⁶³ See §IX.K above.

have had a reasonable expectation of success in the combination as liquid-based cooling systems for power electronics have been known for over 50 years. Further, a POSITA would have had a reasonable expectation of success in combining the teachings as commercially available VFD systems with liquid cooling were known. Further still, incorporating *Orban's* teachings of a water-based radiator to cool *Fischer's* VFD is applying a known technique (a water-based VFD cooling system) to improve similar devices (*Fischer's* VFD) in the same way. The results of the combination would be predictable: a VFD coupled to a water-based radiator for cooling the VFD and, by extension, the enclosure in which the VFD is located. Accordingly, a POSITA would have been motivated to combine *Fischer* and *Orban* and would have had a reasonable expectation of success in doing so.

B. CLAIM 4

The hydraulic fracturing system of claim 1, further comprising:

a cooling system for the enclosure, the cooling system being a liquid cooling system thermally coupled to at least one of the VFD or the transformer.

205. Claim 4 depends from Claim 1. As discussed above regarding Ground 1, and incorporated herein by reference, *Fischer* discloses or at least renders obvious

each and every limitation of Claim 1. *Orban* discloses the additional limitations of Claim 4.

206. *Orban* discloses an “IPEU” (Integrated Power and Electronics Unit) which comprises “a housing, a radiator and a VFD”.¹⁶⁴ A POSITA would have recognized the “housing” as containing the VFD (and other components), in a similar way that the VFD enclosure of *Fischer*. Further, *Orban* teaches that the “VFD includes insulated-gate bipolar transistor (IGBT) devices operable to convert input power to the output power.”¹⁶⁵ Further, *Orban* explains that the “IGBTs are coupled to the radiator within the housing [for the VFD] such that heat generated by the IGBTs is transferred out of the housing via the radiator.”¹⁶⁶

207. Further, *Orban* teaches that “the IGBTs 135 may be cooled as a conventional water-cooled VFD. The cooling fluid (water) for these multiple VFDs may be cooled by a conventional radiator”¹⁶⁷ as shown in Fig. 13 annotated below. *Orban* teaches that the “IGBT devices 135 are secured to the plate 126 [] in a manner permitting heat transfer [] from the IGBTs 135 to the radiating members 127.”¹⁶⁸ *Orban* further discloses that “the IGBTs 135 [highlighted in yellow] may be cooled

¹⁶⁴ Ex. 1011 (*Orban*) [0005].

¹⁶⁵ Ex. 1011 (*Orban*) [0005].

¹⁶⁶ Ex. 1011 (*Orban*) [0005].

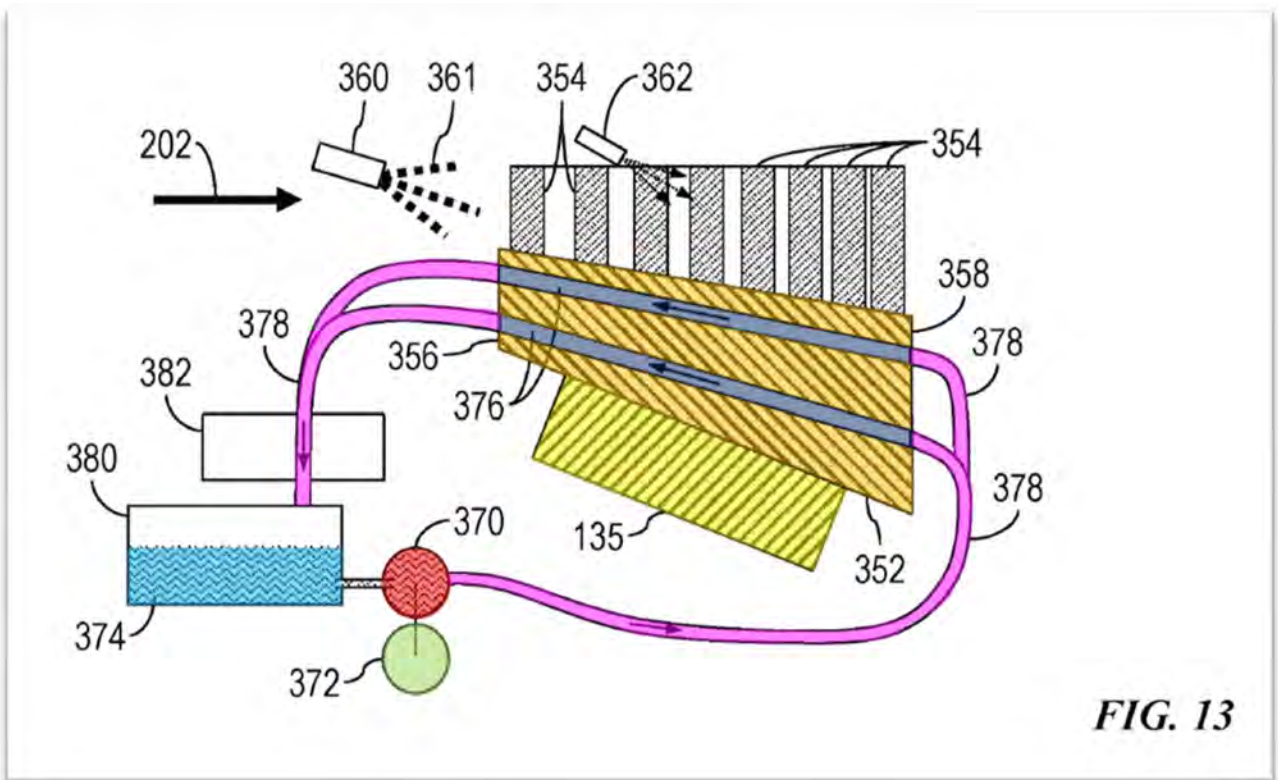
¹⁶⁷ Ex. 1011 (*Orban*) [0070]

¹⁶⁸ Ex. 1011 (*Orban*) [0045].

as a conventional water-cooled VFD.”¹⁶⁹ Further, “a pump 70 [*sic.*, 370, highlighted in red] (e.g., driven by a motor 372 [highlighted in green]) pumps cooling fluid (e.g., water) 374 [highlighted in blue] through channels 376 [highlighted in dark blue] in the base plate 356 [i.e. radiator, highlighted in orange] via various tubing and/or other conduits 378 [highlighted in magenta].”¹⁷⁰ The figure shows IGBTs 135 (highlighted in yellow) connected to and cooled by the liquid cooled heat sink. Accordingly, *Orban* discloses that the liquid cooling system is thermally coupled to the VFD.

¹⁶⁹ Ex. 1011 (*Orban*) [0070].

¹⁷⁰ Ex. 1011 (*Orban*) [0070], Fig. 13. It is clear from Fig. 13, for example, that the pump is 370 and not 70. Further, *Orban* teaches that the number for the “baseplate” in Fig. 13 is 352 and the number for the “leading edge” of the baseplate is 356. See, for example, [0064] (“The base plate 352 and the radiating members 354 are substantially the same as the base plate 126 and the radiating members 127 shown in FIG. 3, except that the radiating members 354 get progressively longer from the leading edge 356 to the trailing edge 358 of the base plate 352, and the base plate 352 gets progressively thicker from the leading edge 356 to the trailing edge 358.”



Ex. 1011 (*Orban*) Fig. 13 (annotated)

208. Under the *Fischer-Orban* combination, a POSITA would have understood that *Orban*'s teachings of a water-based radiator would have been incorporated into *Fischer*'s VFD to cool the VFD as described in *Orban*. Under such an implementation, *Orban*'s water-based radiator teaches a "liquid cooling system thermally coupled to . . . the VFD," because the radiator baseplate is thermally coupled to *Fischer*'s VFD electronics as taught by *Orban*. Further, a POSITA would have understood *Orban*'s water-based radiator to be a "cooling system for the enclosure" because it cools the VFD, thereby cooling "the enclosure"

in which the VFD is located (as discussed above with reference to Limitation 1[d]) by limiting the amount of heat radiated by the VFD into the enclosure.

209. Thus, *Orban* discloses a cooling system for the enclosure (housing) a cooling system for the enclosure, the cooling system being a liquid cooling system thermally coupled to at least one of the VFD or the transformer. Accordingly, Claim 5 would have been obvious to a POSITA based on the combination of *Fischer* and *Orban*.

C. CLAIM 5

The hydraulic fracturing system of claim 4, wherein the liquid cooling system includes water or glycol.

210. Claim 5 depends from Claim 4. In addition to the teachings regarding Claim 1 and Claim 4 discussed above, and incorporated herein by reference, *Orban* discloses the additional limitations of Claim 5.

211. *Orban* discloses the use of water in its liquid cooling system. For example, as discussed above, *Orban* teaches “the IGBTs 135 may be cooled as a conventional water-cooled VFD. The cooling fluid (water) for these multiple VFDs may be cooled by a conventional radiator.”¹⁷¹ Further, *Orban* also teaches “pumps cooling fluid (e.g., water) 374 through channels 376 in the base plate 356 via various

¹⁷¹ Ex. 1011 (*Orban*) [0070]

tubing and/or other conduits 378. The heat carried from the base plate 356 by the cooling fluid 374 may dissipate in a collection tank 380 and/or via a radiator.”¹⁷²

212. Thus, *Orban* discloses that the liquid cooling system includes water or glycol. Accordingly, Claim 5 would have been obvious to a POSITA based on the combination of *Fischer* and *Orban*.

XVI. GROUND 5: OBVIOUS OVER FISCHER IN VIEW OF KARASSIK

A. MOTIVATION TO COMBINE

213. *Fischer* already discloses a quintuplex (five-plunger) fracturing pump.¹⁷³ A POSITA would have searched for other references to better understand details of multi-plunger pumps that are not described in *Fischer*. One such reference is *Karassik*, which is a publication that describes fundamental pump theory and operations, including the use of one-, two-, three-, four-, five- six-, seven-, and nine-plunger pumps.¹⁷⁴ As discussed above in section IX.L, and confirmed by *Karassik*, “[u]nlike a centrifugal pump, a power pump [including a plunger pump] does not develop pressure; it only produces a flow of fluid. The downstream process or piping system produces a resistance to this flow, thereby generating pressure in the piping system and discharge portion of the pump.”¹⁷⁵ Additionally, as discussed above in

¹⁷² Ex. 1011 (*Orban*) [0070]

¹⁷³ See Ground 1, Limitation 1[b] above.

¹⁷⁴ Ex. 1013 (*Karassik*), pg. 3.11. (Table 7).

¹⁷⁵ Ex. 1013 (*Karassik*), pg. 3.3.

Section IX.L, and also taught by *Karassik*, the flowrate of a plunger pump (at a given speed) is directly proportional to the number of plungers of the pump, the pump's speed, the pump's stroke length, and the cross-sectional area of the pump's plungers. For example, *Karassik* teaches that the ideal flowrate of a plunger pump is governed by

$$D = A \times m \times n \times s \times 6 \times 10^{-5}$$

Where

D = Displacement (volume flow rate, m³/h)

A = cross-sectional area of plunger or piston (mm²)

m = number of plungers or pistons

n = rpm of pump

s = stroke of pump (mm) (half the distance the plunger moves in on rev.)¹⁷⁶

214. *Karassik* further teaches the use of plunger pumps with up to 9 cylinders.

¹⁷⁶ Ex. 1013 (*Karassik*), 3.4.

TABLE 8 The effect of the number of plungers on variations in capacity from the mean (C is approx. 6:1)

Type	Number of Plungers	% Above Mean	% Below Mean	Total %	Plunger Phase
Duplex	2	24	22	46	180 deg.
Triplex	3	6	17	23	120 deg.
Quadruplex	4	11	22	33	90 deg.
Quintaplex	5	2	5	7	72 deg.
Sextuplex	6	5	9	14	60 deg.
Septuplex	7	1	3	4	51.5 deg.
Nonuplex	9	1	2	3	40 deg.

Ex. 1013 (*Karassik*) Table 8

Based on the equation above at a given speed (RPM) a nonuplex (9 plunger) pump would have 9 times the flow of a simplex (1 plunger) pump with the same plunger size, stroke length and speed, 3 times the flow of a triplex pump and 1.8 times the flow of a quintuplex pump.

215. Further, *Karassik* teaches that as the cylinder (plunger) count goes up, the variations in pressure are reduced. *Karassik* teaches that “the pulsating characteristics of the fluid flowing into and out of power pumps are significantly influenced by the number of plungers or pistons. Discharge flow pulsations are the most critical because of the high energy potential generated when the system resistance reacts with the flow to create pressure. Since the magnitude of the discharge pulsation is mostly affected by the number of cylinders, increasing the

number of cylinders will reduce the flow pulsations.”¹⁷⁷ As seen above, the pulse variations (variations in flow) for a duplex pump, for example, range between -22% and +24% (46% total), and variations from a triplex pump range from -17% to +6% (23% total). In comparison, pulse variations for a nonuplex pump are only -2% to +1% (3% total). A POSITA would have known, based on the characteristics of a plunger pump described by *Karassik*, that variations in flow lead to variations in pressure. Further, a POSITA would have known that pressure variations lead to noise, vibration and potential damage to the piping, valves and other equipment downstream of the pumps.

216. Accordingly, a POSITA implementing *Fischer*’s pump would have been motivated to look to references like *Karassik* and its description of the ideal flowrate produced by plunger pumps and their pulse variation characteristics, which would aid a POSITA’s selection of plunger count, pump speed, and stroke length when implementing *Fischer*’s pumping system to achieve a desired flowrate and/or a desired pressure variation profile. As such, combining *Fischer* with *Karassik* would simply be combining prior art elements (fundamentals of a plunger pump, as taught by *Karassik*, and *Fischer*’s plunger pump) according to known methods (operating the pump) to yield predictable results (a desired output flow).

¹⁷⁷ Ex. 1013 pg. 3.10.

217. Further, a POSITA would have been motivated to combine the teachings of *Karassik* with those of *Fischer* to gain the additional flowrates from higher count plunger pumps, as well as reduced pulsations in the fluid, available from the odd and higher count plunger fluid pumps. A POSITA would further have recognized that modifying *Fischer* to use seven plungers or nine plungers, as taught by *Karassik*, rather than five plungers would involve the simple substitution of one known element (a seven- or nine-plunger pump, as taught by *Karassik*) for another (*Fischer's* five-plunger pump) to obtain the predictable result of performing fracturing operations with a seven-plunger or nine-plunger pump, and the associated increased flowrates and reduced pressure variations that come from using the higher plunger count pumps. Accordingly, a POSITA would have been motivated to combine *Fischer* with *Karassik* and would have a reasonable expectation of success when doing so.

B. CLAIM 6

The hydraulic fracturing system of claim 1, wherein the electric powered, multi-plunger pump is a septuplex pump having seven plungers.

218. Claim 6 depends from Claim 1. In addition to the teachings regarding Claim 1 discussed above, and incorporated herein by reference, *Karassik* discloses the additional limitations of Claim 6. In addition to “quintuplex” pumps, *Karassik*

discloses “septuplex” (seven-plunger) pumps.¹⁷⁸ For example, *Karassik’s* Table 5 is duplicated below showing such pumps.

TABLE 5 The pulses per revolution and pulse amplitude for various pump types			
Pump Type	No. of Cylinders	Pulses per Rev.	Pulse Amplitude
Duplex, double-acting	4	8	+24% – 22%
Triplex, single-acting	3	6	+ 6% – 17%
Quintuplex, single-acting	5	10	+ 2% – 5%
Septuplex, single-acting	7	14	+1.2% – 2.6%
Nonoplex, single-acting	9	18	+0.6% – 1.5%

Ex. 1013 (Karassik) Table 5

219. A POSITA would have understood that *Fischer’s* quintuplex pump would have been substituted for a septuplex pump to gain the increased flowrates and reduced pressure variations, as these types and their characteristics were well-known alternatives for each other, as indicated by *Karassik*. Accordingly, Claim 6 would have been obvious to a POSITA based on the combination of *Fischer* and *Karassik*.

C. CLAIM 7

The hydraulic fracturing system of claim 1, wherein the electric powered, multi-plunger pump includes at least one of 9 plungers or 11 plungers.

¹⁷⁸ See, e.g., Ex. 1013 (Karassik), 3.12 (Table 8, identifying “Septuplex” as the industry term for a seven-plunger pump).

220. Claim 7 depends from Claim 1. In addition to the teachings regarding Claim 1 above, and incorporated herein by reference, *Karassik* discloses the additional limitations of Claim 7. In addition to “quintuplex” pumps, *Karassik* discloses “Nonuplex” (nine-plunger) pumps.¹⁷⁹ For example, *Karassik’s* Table 8 is duplicated below showing such pumps.

TABLE 5 The pulses per revolution and pulse amplitude for various pump types

Pump Type	No. of Cylinders	Pulses per Rev.	Pulse Amplitude
Duplex, double-acting	4	8	+24% – 22%
Triplex, single-acting	3	6	+ 6% – 17%
Quintuplex, single-acting	5	10	+ 2% – 5%
Septuplex, single-acting	7	14	+1.2% – 2.6%
Nonoplex, single-acting	9	18	+0.6% – 1.5%

Ex. 1013 (Karassik) Table 5

221. A POSITA would have understood that *Fischer’s* quintuplex pump would have been substituted for a nonuplex pump to gain the increased flowrates and reduced pressure variations, as these types and their characteristics were well-known alternatives for each other, as indicated by *Karassik*. Accordingly, Claim 7 would have been obvious to a POSITA based on the combination of *Fischer* and *Karassik*.

¹⁷⁹ See, e.g., Ex. 1013 (Karassik), 3.12 (Table 8, identifying “Septuplex” as the industry term for a seven-plunger pump).

D. CLAIM 8

The hydraulic fracturing system of claim 1, wherein the electric powered, multi-plunger pump includes more than 5 plungers.

222. Claim 8 is disclosed by *Karassik* and would have been obvious to a POSITA over the combination of *Fischer* and *Karassik* for the same reasons as those discussed in Section XVI.B and XVI.C above, as both septuplex and nonuplex pumps contain more than 5 plungers.

XVII. GROUND 6: OBVIOUS OVER FISCHER IN VIEW OF THE KNOWLEDGE OF A POSITA AND, IN THE ALTERNATIVE, KARASSIK

A. MOTIVATION TO COMBINE

223. A POSITA would have been motivated to combine *Fischer* with *Karassik* for the same reasons provided above in Ground 5 (Section XVI.A), which is incorporated herein by reference.

B. CLAIM 10

The hydraulic fracturing system of claim 1, wherein the electric powered, multi-plunger pump is a single pump and a first pump output meets or exceeds a second pump output associated with two quintuplex pumps.

224. As discussed above with reference to Limitation 1[b], *Fischer* discloses that its hydraulic pump is a five-plunger pump powered by an electric motor. It was

well known in the art that the ideal flow rate of a reciprocating pump is given by the following equation (“Equation 1”):

$$D = A \times m \times n \times s \times 6 \times 10^{-5},$$

where D = displacement (volume flow rate, m³/h), A = cross-sectional area of plunger or piston (mm²), m = number of plungers or pistons, n = rpm of pump, s = stroke of pump (mm) (half the distance the plunger moves in one rev).¹⁸⁰ As can be seen from Equation 1, there is a direct relationship between a pump’s flowrate (D) (i.e., its “*pump output*”) and the pump’s stroke length (s), pump speed (n), number of plungers (m), and cross-sectional area of the plungers (A). This is an inherent characteristic of plunger pumps.

225. The ’863 Patent uses this known relationship in explaining the purported invention. The ’863 Patent states “8 septuplex (7 plungers) pumps with 5" plungers and 10" stroke length can do the same work as 16 quintuplex pumps with 4.5" plungers and 8" stroke length.”¹⁸¹ Assuming a fixed speed (RPM) for each set of pumps of 100 RPM, the 8 septuplex pumps would output ~180,185 m³/hr (~18,889 bbl/min) while the 8 quintuplex pumps would output ~166,800 m³/hr (~17,486 bbl/min). Claim 10 is simply claiming what was well known to a POSITA,

¹⁸⁰ Ex. 1013 (*Karassik*), 3.4.

¹⁸¹ ’863 Patent 3:6 – 8.

pumps can be configured in a variety of ways and sizes and a pump that has twice the capacity will output twice the volume of fluid.¹⁸²

226. Accordingly, it would have been obvious to a POSITA that operating *Fischer*'s hydraulic pump at a first speed with a first stroke length and a first cross-sectional area of the plungers would result in a first flowrate ("*first pump output*") that is equal to a second flowrate ("*meets . . . a second pump output*") achieved by two quintuplex (five-plunger) pumps each operating at either half of the first speed, with half of the first stroke length, or with half of the cross-sectional area for each plunger. In the alternative, *Karassik* renders obvious Claim 10 for the same reasons.

227. Accordingly, Claim 10 is rendered obvious by *Fischer* in view of the knowledge of a POSITA and, in the alternative, by *Fischer* in view of *Karassik*.

C. INDEPENDENT CLAIM 11

228. It is my opinion that the combination of *Fischer* and *Karassik* renders Claim 11 obvious to a POSITA. *Fischer* and/or *Karassik* disclose each and every limitation of Claim 11 as discussed in the subsections below.

¹⁸² I note that the claim does not require any particular number of plungers for the "first pump output". The effect would even be greater if a quintuplex pump was compared to a nonuplex pump, which was also known.

a. **11[p]: “A hydraulic fracturing system, comprising:”**

229. Limitation 11[p] is disclosed by *Fischer* for the same reasons as those discussed above regarding limitation 1[p] in Section XII.A.a.¹⁸³

b. **11[a]: “an electric powered, multi-plunger pump, arranged on a support structure, the electric powered multi-plunger pump powered by at least one electric motor;”**

230. Limitation 11[a] is disclosed by *Fischer* for the same reasons as those discussed above regarding limitation 1[a] in Section XII.A.b.

c. **11[b]: “a variable frequency drive (VFD), arranged on the support structure, connected to the at least one electric motor to control a speed of the at least one electric motor, the VFD positioned separate from the electric powered, multi-plunger pump and within an enclosure; and”**

231. Limitation 11[b] is disclosed by *Fischer* for the same reasons as those discussed above regarding limitation 1[c] in Section XII.A.d.

d. **11[c]: “a transformer, arranged on the support structure, configured to distribute power for operation of the electric powered, multi-plunger pump, the power being received from at least one generator at a voltage higher than an operating voltage of the electric powered pump , the transformer positioned within the enclosure;”**

232. As discussed above regarding limitation 1[d] in Section XIII.A.e, and incorporated herein by reference, *Fischer* discloses a transformer, arranged on the

¹⁸³ I understand that the preamble may not be limiting. I include a discussion of the preamble to Claim 11 out of an abundance of caution.

support structure, configured to distribute power for operation of the electric powered, multi-plunger pump. *Fischer* also discloses the additional limitations of 11[c].

233. Fischer further discloses the use of a conventional step-down transformer to convert voltage received from the generator at a higher voltage than an operating voltage of the electric powered pump. For example, *Fischer* discloses that a “power generation system 110 may include at least one power source (e.g., a gas turbine engine and/or generator), and the power source may operate using one or more fuels (e.g., unleaded gasoline) and generate electric power that is then provided to each component of the hydraulic fracking operation 100.”¹⁸⁴

234. Further, Fischer discloses that “the power generation system 110 may generate the electric power at the power generation voltage level of 13.8 kV, which is a typical voltage level for electric power generated by gas turbine engines.”¹⁸⁵ Further, Fischer discloses “the power distribution system 120 may distribute the electric power to the medium-voltage VFD 132 at an initial voltage level of about 13.8 kV. The medium-voltage VFD 132 [including the transformer as discussed above regarding 1[d]] may then convert the electric power at the voltage level of about 13.8 kV to the VFD voltage level of about 4160V to adequately drive the

¹⁸⁴ Ex. 1008 (*Fischer*) 7:28 – 33; Ex. 1009 (*Fischer Provisional*), [0019].

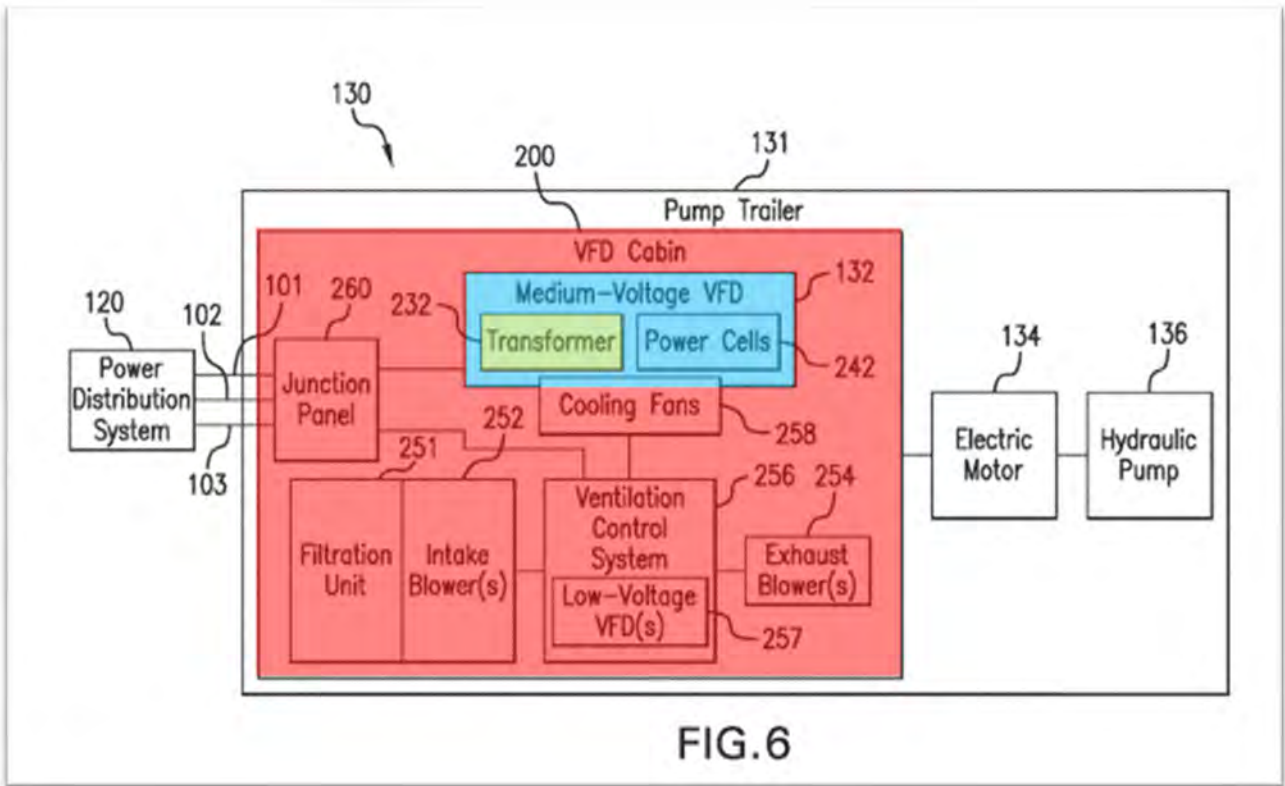
¹⁸⁵ Ex. 1008 (*Fischer*) 5:2 – 5. Ex. 1009 (*Fischer Provisional*) [0077]

single, single-shaft electric motor 134.”¹⁸⁶ Accordingly, the transformer (as part of the VFD) receives the voltage at a higher voltage level (e.g., 13.8kV) than the operating voltage of the electric powered pump (e.g. 4160V). This is a conventional use of a step-down transformer.¹⁸⁷ This stepping down is provided because, as just discussed, “the initial voltage level of the electric power distributed by the power distribution system 120 as generated by the power generation system 110 may be at a voltage level that is significantly higher than a voltage level that is appropriate to drive the single-shaft electric motor 134.”¹⁸⁸ *Fischer* depicts this arrangement, supported by the *Fischer Provisional* as discussed above, showing the transformer 232 (highlighted in green) is positioned within the enclosure 200 (highlighted in red) and within Medium-Voltage VFD 132 (highlighted in blue) as shown, for example, in Fig. 6.

¹⁸⁶ Ex. 1008 (*Fischer*) 13:64 – 14:3; *see also* 35:32-57 (“In certain embodiments, block 532 involves converting, by the transformer 232, the electric power at the initial voltage level to electric power at a transformer voltage level, and converting, by the plurality of power cells 242, the electric power at the transformer voltage level to electric power at the VFD voltage level.”), 7:51-8:7 (describing that the “initial voltage level” may be 13.8 kV), 35:58-36:10; Ex. 1009 (*Fischer Provisional*), [0035], [0082] (“The transformer incorporated into the single VFDs 340(a-n) may then step-down the voltage level of 13.8kV for the AC voltage signal 360 to the voltage level of 4160V for the VFD voltage signal”); [0084].

¹⁸⁷ See Section IX.F above.

¹⁸⁸ Ex. 1008 (*Fischer*), 12:30-34, 13:64-14:3; Ex. (*Fischer Provisional*), 1009, [0032]-[0033].



Ex. 1008 (*Fischer*) Fig. 6 (annotated)

235. Thus, *Fischer* discloses, or at least it would have been obvious to a POSITA based on the teachings of *Fischer*, a transformer, arranged on the support structure, configured to distribute power for operation of the electric powered, multi-plunger pump, the power being received from at least one generator at a voltage higher than an operating voltage of the electric powered pump, the transformer positioned within the enclosure as claimed in limitation 11[c].

- e. **11[d]: “wherein the electric powered, multi-plunger pump includes an odd number of plungers configured to reduce kinematic flow ripple.”**

236. As discussed above regarding Limitation 11[a], *Fischer* discloses a quintuplex (five-plunger) pump powered by an electric motor. A POSITA would have further understood that *Fischer*’s pump is “configured to reduce kinematic flow ripple.” It was well-known in the art that kinematic flow ripple, as indicated by flow variation/pulsations, is reduced by (1) using an odd number of cylinders/plungers and (2) increasing the number of cylinders/plungers of a displacement pump (such as a plunger pump). For example, as discussed above regarding Claims 6 – 8, *Karassik* discloses the use of an odd number of plungers (3,5,7,9), as shown in Table 5 of *Karassik*.

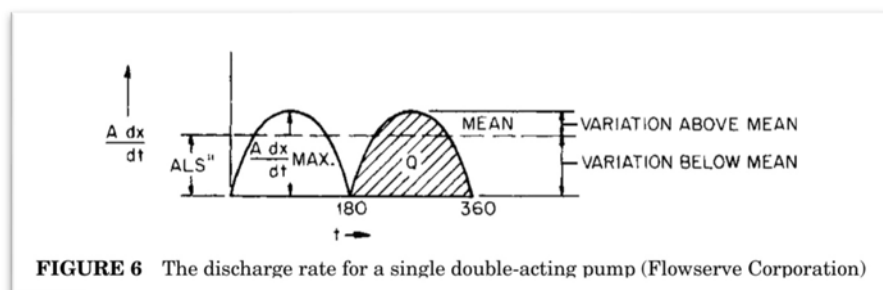
TABLE 5 The pulses per revolution and pulse amplitude for various pump types			
Pump Type	No. of Cylinders	Pulses per Rev.	Pulse Amplitude
Duplex, double-acting	4	8	+24% – 22%
Triplex, single-acting	3	6	+ 6% – 17%
Quintuplex, single-acting	5	10	+ 2% – 5%
Septuplex, single-acting	7	14	+1.2% – 2.6%
Nonoplex, single-acting	9	18	+0.6% – 1.5%

Ex. 1013 (*Karassik*) Table 5

237. *Karassik* also teaches that “[t]he pulsating characteristics of the fluid flowing into and out of power pumps are significantly influenced by the number of plungers or pistons. Discharge flow pulsations are the most critical because of the

high energy potential generated when the system resistance reacts with the flow to create pressure. Since the magnitude of the discharge pulsation is mostly affected by the number of cylinders, increasing the number of cylinders (i.e. plungers) will reduce the flow pulsations” as would have been noted by a POSITA when viewing Table 5.¹⁸⁹

238. *Karassik* further teaches that “Figures 6 and 7 show discharge rates for two types of pumps. Tables 8 and 9 show how variations from the mean are related to the change in the number of plungers with a C [discharge capacity] of approximately 6:1. **This shows that pumps with an even number of cylinders have a higher flow variation than pumps with an odd number of cylinders.**”¹⁹⁰



Ex. 1013 (*Karassik*) Figure 6

¹⁸⁹ Ex. 1013 (*Karassik*) pg. 3.10

¹⁹⁰ Ex. 1013 (*Karassik*) pg. 3.11 – 3.12 emphasis added.

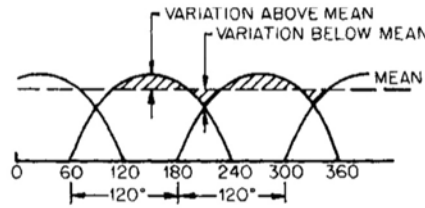


FIGURE 7 The discharge rate for a triplex single acting pump (Flowserve Corporation)

Ex. 1013 (*Karassik*) Figure 7

TABLE 8 The effect of the number of plungers on variations in capacity from the mean (*C* is approx. 6:1)

Type	Number of Plungers	% Above Mean	% Below Mean	Total %	Plunger Phase
Duplex	2	24	22	46	180 deg.
Triplex	3	6	17	23	120 deg.
Quadruplex	4	11	22	33	90 deg.
Quintaplex	5	2	5	7	72 deg.
Sextuplex	6	5	9	14	60 deg.
Septuplex	7	1	3	4	51.5 deg.
Nonuplex	9	1	2	3	40 deg.

Ex. 1013 (*Karassik*) Table 8

239. Thus, it was known in the art, as indicated by *Karassik*, that a multi-plunger pump that includes an odd number of plungers is configured to reduce kinematic flow ripple (pulse variations) when compared to pump containing fewer plungers, especially those with an even number of plungers (e.g., 2 or 4 plungers).

240. Accordingly, it would have been obvious to a POSITA that *Fischer's* five-plunger pump is “*configured to reduce kinematic flow ripple*” when compared to pumps with a lower number of plungers, or an even number of plungers. Thus, *Fischer* renders obvious Limitation 11[d] in view of the knowledge of a POSITA.

In the alternative, *Fischer* renders obvious Limitation 11[d] in view of *Karassik* for the same reasons.

241. This understanding is consistent with the '863 Patent, which explains that a “septuplex pump may produce less kinematic flow ripple than the standard quintuplex, which is the most common pump in the oil service industry.”¹⁹¹

D. CLAIM 19

The hydraulic fracturing system of claim 11, wherein the motor is powered by at least one of a turbine generator, a diesel generator, a natural gas generator, grid power, or a combination thereof.

242. Claim 19 depends from Claim 11. The discussion regarding Claim 11 above is incorporated herein by reference. *Fischer* discloses the use of a conventional step-down transformer to convert voltage received from the generator at a higher voltage than an operating voltage of the electric powered pump. For example, *Fischer* discloses that a “power generation system 110 may include at least one power source (e.g., a gas turbine engine and/or generator), and the power source may operate using one or more fuels (e.g., unleaded gasoline) and generate electric power that is then provided to each component of the hydraulic fracking operation 100.”¹⁹² *Fischer* further teaches that “the power generation system 110 may include

¹⁹¹ Ex. 1001 ('863 Patent), 2:65-3:2.

¹⁹² Ex. 1008 (*Fischer*) 7:28 – 33; Ex. 1009 (*Fischer Provisional*) [0019].

one or more power sources (e.g., gas turbine engines 112, 114) configured to generate electric power.”¹⁹³

243. As discussed above regarding Claim 11 and Claim 1, the generator provides power to the motor through the VFD (and transformer). Thus, *Fischer* discloses wherein the motor is powered by at least one of a turbine generator, a diesel generator, a natural gas generator, grid power, or a combination thereof. Accordingly, Claim 19 would have been obvious to a POSITA based on the combined teachings of *Fischer* and *Karassik*.

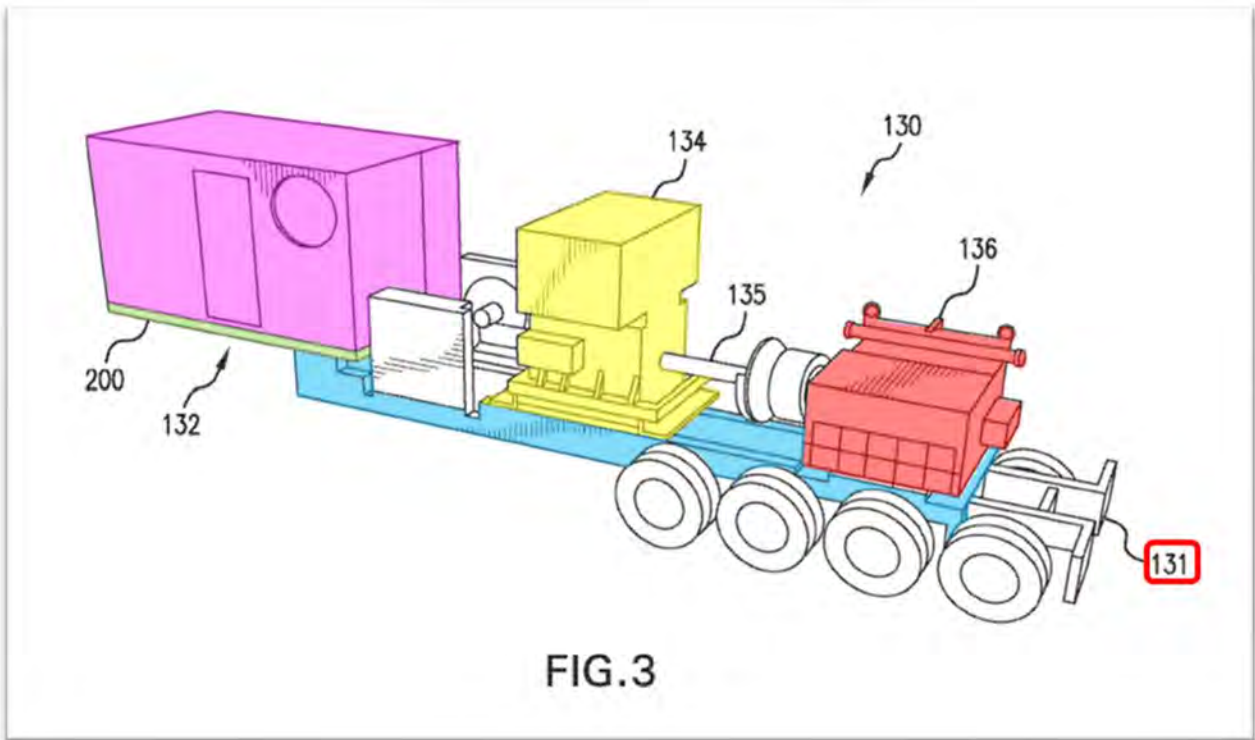
E. CLAIM 20

The hydraulic fracturing system of claim 11, wherein a first length of the support structure is less than or equal to a second length of a second support structure associated with two quintuplex pumps.

244. Claim 20 depends from Claim 11. The discussion regarding Claim 11 above is incorporated herein by reference. *Fischer* discloses that its support structure (i.e. trailer 131) contains one quintuplex pump 134 (annotated in maroon below), as discussed above regarding Claim 1 in Section XII.A. Fig. 3 shows the single pump 134 mounted on the trailer 131 (support structure).¹⁹⁴

¹⁹³ Ex. 1008 (*Fischer*) 4:43 – 61; Ex. 1009 (*Fischer Provisional*) [0019].

¹⁹⁴ See also Ex. 1009 (*Fischer Provisional*) Fig. 2 showing a single pump 250.



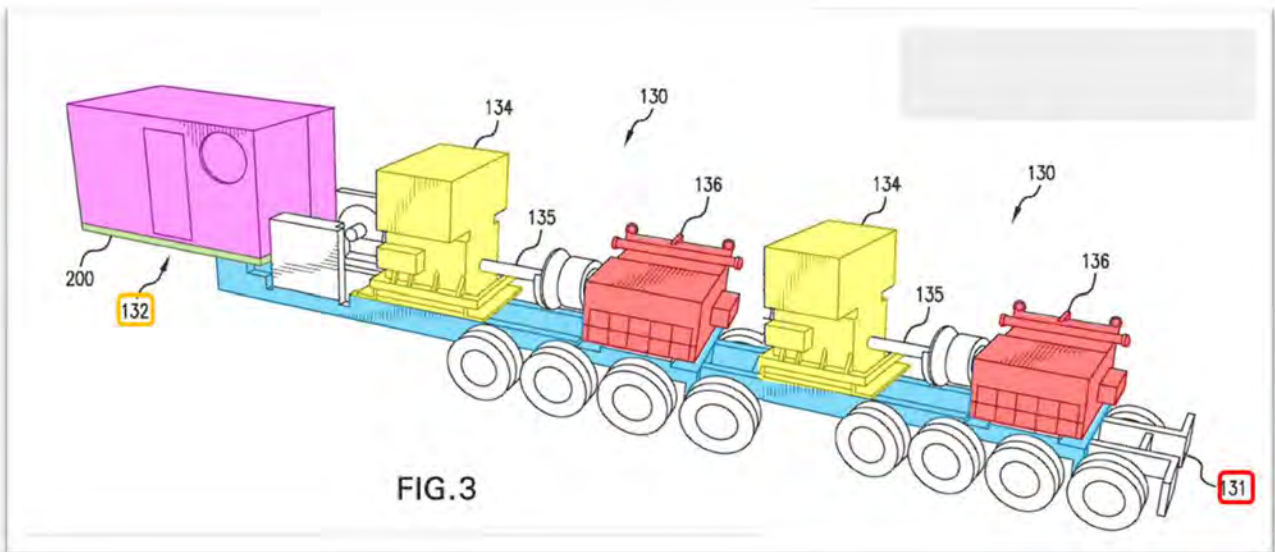
Ex. 1008 (Fischer), Fig. 3¹⁹⁵

245. Fischer’s Fig. 3 shows that the components mounted to the trailer take up nearly the entire “first length” of trailer 131.

246. Claim 20 appears to compare the “*first length*” of “*the support structure*” (i.e., Fischer’s pump trailer) to the length of a different “*second*” support structure that is “*associated with two quintuplex pumps.*” A POSITA would have readily understood that adding a second pump to the trailer would at least require the same length trailer, and more likely than not would require adding additional length to the trailer. For example, annotated Figure 3 of Fischer shows an elongated version

¹⁹⁵ see also Ex. 1009 (*Fischer Provisional*) Fig. 2.

of *Fischer's* pump trailer that fits an additional electric motor and an additional hydraulic pump along the longitudinal axis of the pump trailer:



Ex. 1008 (Fischer) Fig. 3 (annotated)

247. Thus, it would have been obvious to a POSITA that *Fischer's* one pump trailer would have a first length less than or equal to a second length of a theoretical second support structure (trailer) associated with two quintuplex pumps, as depicted, for example, by annotated Figure 3 above. Accordingly, a POSITA would have understood that the “*first length*” of *Fischer's* pump trailer is “*less than or equal to a second length of a second support structure associated with two quintuplex pumps,*” and that *Fischer* discloses Claim 20.

**XVIII. GROUND 7: OBVIOUS OVER FISCHER IN VIEW OF
OEHRING-I, THE KNOWLEDGE OF A POSITA AND, IN THE
ALTERNATIVE, KARASSIK**

A. MOTIVATION TO COMBINE

248. The motivation to combine Fischer and Karassik is the same as that discussed above in Section XVI.A. The motivation to combine *Fischer* and *Oehring-I* is the same as that discussed above in Section XIII.A. Nothing in *Oehring-I* or *Karassik* teaches away from the combination. Accordingly, a POSITA would have had a motivation to combine the teachings of *Oehring-I* with those of *Fischer* and *Karassik* and would have a reasonable expectation of success in combining those teachings for the same reasons as those disclosed in Section XIII.A and XVI.A.

B. CLAIM 12

The hydraulic fracturing system of claim 11, further comprising:

**a slide out platform proximate the electric powered, multi-plunger pump
being driven between a retracted position and a deployed position,
wherein the deployed position provides a work area proximate the
electric powered, multi-plunger pump.**

249. Claim 12 depends from Claim 11. As discussed above in Ground 2 with reference to Claim 2, the *Fischer-Oehring-I* combination renders obvious “a slide out platform integrated into the first area, the slide out platform being driven between a retracted position and a deployed position, wherein the deployed position

provides a work area proximate the electric powered, multi-plunger pump.”¹⁹⁶ A POSITA would have further understood that because *Oehring-I*’s platform assembly “provides access to the pump” (and “*provides a work area proximate the electric powered, multi-plunger pump*” as recited in Claim 2) the platform assembly (“*slide out platform*”) itself would be “*proximate the electric powered, multi-plunger pump*” when incorporated in *Fischer*’s pump trailer. Accordingly, *Oehring-I* discloses the limitations of Claim 12 and Claim 12 would have been obvious to a POSITA over the combined teachings of *Fischer*, *Oehring-I*, the knowledge of a POSITA and, in the alternative, *Karassik*.

XIX. GROUND 8: OBVIOUS OF *FISCHER* IN VIEW OF *OEHRING-II*, THE KNOWLEDGE OF A POSITA AND, IN THE ALTERNATIVE, *KARASSIK*

A. MOTIVATION TO COMBINE

250. The motivation to combine *Fischer* and *Karassik* is the same as that discussed above in Section XVI.A. The motivation to combine *Fischer* and *Oehring-II* is the same as that discussed above in Section XIV.A. Nothing in *Oehring-II* or *Karassik* teaches away from the combination. Accordingly, a POSITA would have had a motivation to combine the teachings of *Oehring-II* with those of *Fischer* and

¹⁹⁶ See XIII.B.

Karassik, and would have a reasonable expectation of success in combining those teachings for the same reasons as those disclosed in Section XIV.A and XVI.A

B. CLAIM 13

The hydraulic fracturing system of claim 11, further comprising: a work platform proximate and external to the enclosure, the work platform providing access to the enclosure, wherein the work platform is positioned at an elevation greater than the electric powered, multi-plunger pump.

251. Claim 13 depends from Claim 11. As discussed above in Ground 3 with reference to Claim 3, the *Fischer-Oehring-II* combination renders obvious incorporating *Oehring-II*'s elevated platform such that the platform is located “proximate and external to the enclosure, the work platform providing access to the enclosure.”¹⁹⁷ As discussed above with reference to Claim 3, the elevated platform of the combined *Fischer-Oehring-II* system would be placed at the floor level of *Fischer*'s VFD enclosure to provide operators access to the enclosure.¹⁹⁸ Because the VFD enclosure, which is located in the “second area” of *Fischer*'s pump trailer, is located at an elevation greater than the elevation of the first area on which *Fischer*'s “electric powered, multi-plunger pump” is mounted, a POSITA would

¹⁹⁷ See XIV.B.

¹⁹⁸ See XIV.B.

have understood that *Oehring-II*'s elevated platform is also “*positioned at an elevation greater than the electric powered, multi-plunger pump.*” Accordingly, *Oehring-II* discloses the limitations of Claim 13 and Claim 13 would have been obvious to a POSITA over the combined teachings of teachings of *Fischer*, *Oehring-II*, the knowledge of a POSITA and, in the alternative, *Karassik*.

XX. GROUND 9: OBVIOUS OVER *FISCHER* IN VIEW OF ORBAN, THE KNOWLEDGE OF A POSITA AND, IN THE ALTERNATIVE, *KARASSIK*

A. MOTIVATION TO COMBINE

252. The motivation to combine *Fischer* and *Karassik* is the same as that discussed above in Section XVI.A. The motivation to combine *Fischer* and *Orban* is the same as that discussed above in Section XV.A. Nothing in *Orban* or *Karassik* teaches away from the combination. Accordingly, a POSITA would have had a motivation to combine the teachings of *Orban* with those of *Fischer* and *Karassik*, and would have a reasonable expectation of success in combining those teachings for the same reasons as those disclosed in Section XV.A and XVI.A

B. CLAIM 14

The hydraulic fracturing system of claim 11, further comprising:

a cooling system for the enclosure, the cooling system being a liquid cooling system thermally coupled to at least one of the VFD or the transformer.

253. Claim 14 depends from Claim 11. Except for depending from Claim 11, the limitations of Claim 14 are identical to those of Claim 4, and are disclosed by *Orban* for the same reasons as those described above in Section XV.B, and incorporated herein by reference. Accordingly, *Orban* discloses the limitations of Claim 14 and Claim 14 would have been obvious to a POSITA over the combined teachings of *Fischer* and *Orban* in view of the knowledge of a POSITA and, in the alternative, *Karassik*.

C. CLAIM 15

The hydraulic fracturing system of claim 14, wherein the liquid cooling system includes water or glycol.

254. Claim 15 depends from Claim 11. Except for depending from Claim 11, the limitations of Claim 15 are identical to those of Claim 5, and are disclosed by *Orban* for the same reasons as those described above in Section XV.C, and incorporated herein by reference. Accordingly, *Orban* discloses the limitations of Claim 15 and Claim 15 would have been obvious to a POSITA over the combined teachings of *Fischer* and *Orban* in view of the knowledge of a POSITA and, in the alternative, *Karassik*.

XXI. GROUND 10: OBVIOUS OVER FISCHER, KARASSIK, THE KNOWLEDGE OF A POSITA AND, IN THE ALTERNATIVE, KARASSIK

255. As discussed below, *Karassik* renders obvious the subject matter of Claims 16-18. Because Claim 11, from which Claims 16-18 depend, is challenged based on *Fischer* in view of the knowledge of a POSITA and, in the alternative, *Karassik*, Ground 10 is based on *Fischer* in view of *Karassik*, the knowledge of a POSITA and, in the alternative, *Karassik*.

A. MOTIVATION TO COMBINE

256. A POSITA would have been motivated to combine *Fischer* with *Karassik* for the same reasons provided above in Ground 5 (Section XVI.A), which is incorporated herein by reference.

B. CLAIM 16

The hydraulic fracturing system of claim 11, wherein the electric powered, multi-plunger pump is a septuplex pump having seven plungers.

257. Other than depending from Claim 11, the limitations of Claim 16 are identical to those of Claim 6 and are disclosed by *Karassik* for the same reasons as those discussed above in Section XVI.B, and incorporated herein by reference. Accordingly, the combination of *Karassik* and *Fischer* render Claim 16 obvious in view of the knowledge of a POSITA and, in the alternative, *Karassik*.

C. CLAIM 17

The hydraulic fracturing system of claim 11, wherein the electric powered, multi-plunger pump includes at least one of 9 plungers or 11 plungers.

258. Other than depending from Claim 11, the limitations of Claim 17 are identical to those of Claim 7 and are disclosed by *Karassik* for the same reasons as those discussed above in Section XVI.C, and incorporated herein by reference. Accordingly, the combination of *Karassik* and *Fischer* render Claim 17 obvious in view of the knowledge of a POSITA and, in the alternative, *Karassik*.

D. CLAIM 18

The hydraulic fracturing system of claim 11, wherein the electric powered, multi-plunger pump includes more than 5 plungers.

259. Other than depending from Claim 11, the limitations of Claim 18 are identical to those of Claim 8 and are disclosed by *Karassik* for the same reasons as those discussed above in Section XVI.D, and incorporated herein by reference. Accordingly, the combination of *Karassik* and *Fischer* render Claim 18 obvious in view of the knowledge of a POSITA and, in the alternative, *Karassik*.

XXII. GROUND 11: OBVIOUS OVER MORRIS

A. INDEPENDENT CLAIM 1

260. It is my opinion that *Morris* renders Claim 1 obvious. obvious. As discussed below, *Morris* discloses or at least renders obvious each and every limitation of Claim 1.

a. 1[p]: “1. A hydraulic fracturing system, comprising:”

261. *Morris* discloses a hydraulic fracturing system.¹⁹⁹ *Morris* discloses “a system and method for producing fracturing fluid.”²⁰⁰ Further, *Morris* teaches that fracturing systems were known and “commonly used” prior to *Morris*.

Hydraulic fracturing has been commonly used by the oil and gas industry to stimulate production of hydrocarbon producing wells, such as oil and/or gas wells. Hydraulic fracturing, sometimes called “fracing” or “fracking” is the process of injecting fracturing fluid into a wellbore to fracture the subsurface geological formations and release hydrocarbons. The fracturing fluid is pumped into a wellbore at a pressure sufficient to cause fissures within the underground geological formations. Once inside the wellbore, the fracturing fluid fractures the underground formation. The fracturing fluid may include water, various chemical additives, and proppants that promote the extraction of the hydrocarbon reserves, such as oil and/or gas. Proppants, such as fracturing sand, prevent fissures and fractures in the underground formation from closing; thereby,

¹⁹⁹ I understand that the preamble may not be limiting. I include a discussion of the preamble to Claim 1 out of an abundance of caution.

²⁰⁰ Ex. 1010 (*Morris*) at Abstract.

allowing the formation to remain open so that hydrocarbons flow through the hydrocarbon wells.²⁰¹

262. Morris further discloses “a fracturing transport comprises: a prime mover, a first pump, a first gear box, a first gear shaft, and a first coupling. The prime mover has a motor shaft and is operable to transmit drive to the motor shaft. The first pump is disposed adjacent the prime mover, and the first gear box (connected to the first pump) and the first gear shaft (disposed on the first gear box) are used to transmit the drive from the prime mover to the pump.”²⁰² Morris further describes a method “for pumping fracture fluid with a pump,” wherein “the pump has a fluid end assembly powered by a power end assembly driven by a prime mover.”²⁰³

263. Accordingly, *Morris* discloses a well-known hydraulic fracturing system.

b. 1[a]: “a support structure having a first area at a first height and a second area at a second height, the first and second areas adjacent one another;”

264. As discussed above regarding the preamble, *Morris* discloses “a fracturing transport comprises: a prime mover, a first pump, a first gear box, a first gear shaft, and a first coupling. The prime mover has a motor shaft and is operable to transmit drive to the motor shaft. The first pump is disposed adjacent the prime

²⁰¹ Ex. 1010 (*Morris*) [0002].

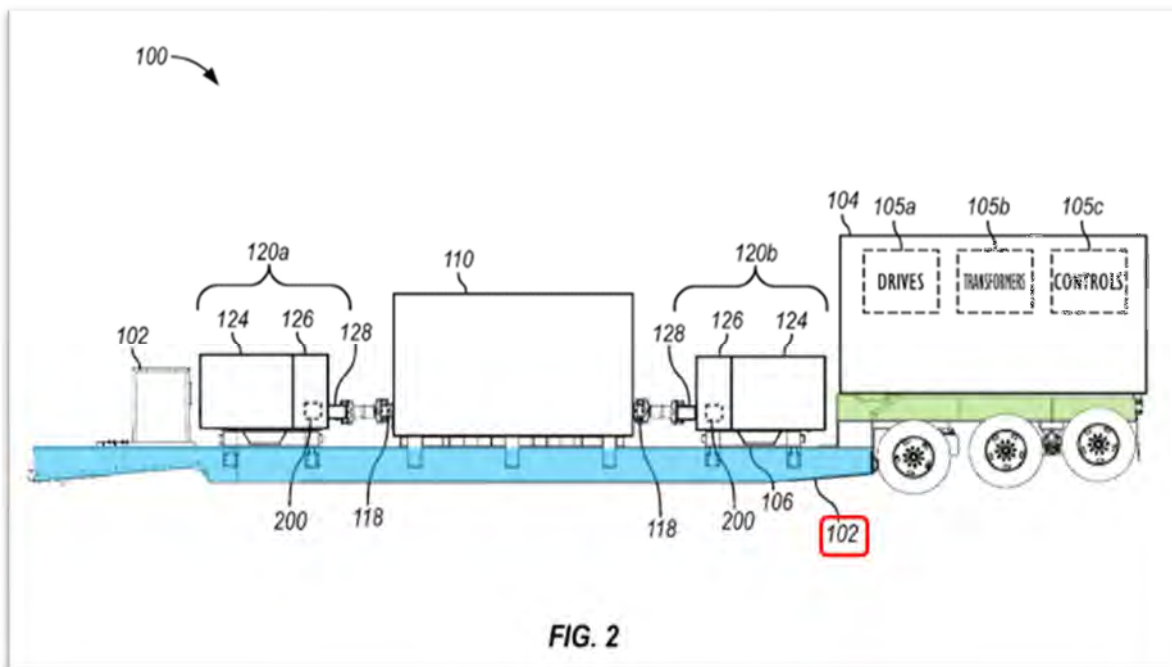
²⁰² Ex. 1010 (*Morris*) [0017].

²⁰³ Ex. 1010 (*Morris*) [0031].

mover, and the first gear box (connected to the first pump) and the first gear shaft (disposed on the first gear box) are used to transmit the drive from the prime mover to the pump.”²⁰⁴ *Morris*’ Fig 2 illustrates the fracturing transport 100 and teaches that “the fracturing pump transport 100 utilizes a lay-down trailer 102 [annotated in red] to enhance mobility, improved safety, and enhance ergonomics for crew members when performing routine maintenance and operations of the pumps 120 a-b. The lay-down trailer 120 positions the pumps 120 a-b lower to the ground as the main trailer beams are resting on the ground in operational mode. [i.e. a first area annotated in blue] With the lay-down trailer design, the fracturing pump transport 100 has an upper section above the trailer axles that may hold or have mounted the power and control systems 104. [i.e. second area, annotated in green]”²⁰⁵

²⁰⁴ Ex. 1010 (*Morris*) [0017].

²⁰⁵ Ex. 1010 (*Morris*) [0047].



Ex. 1010 (*Morris*) Fig. 2 (annotated)

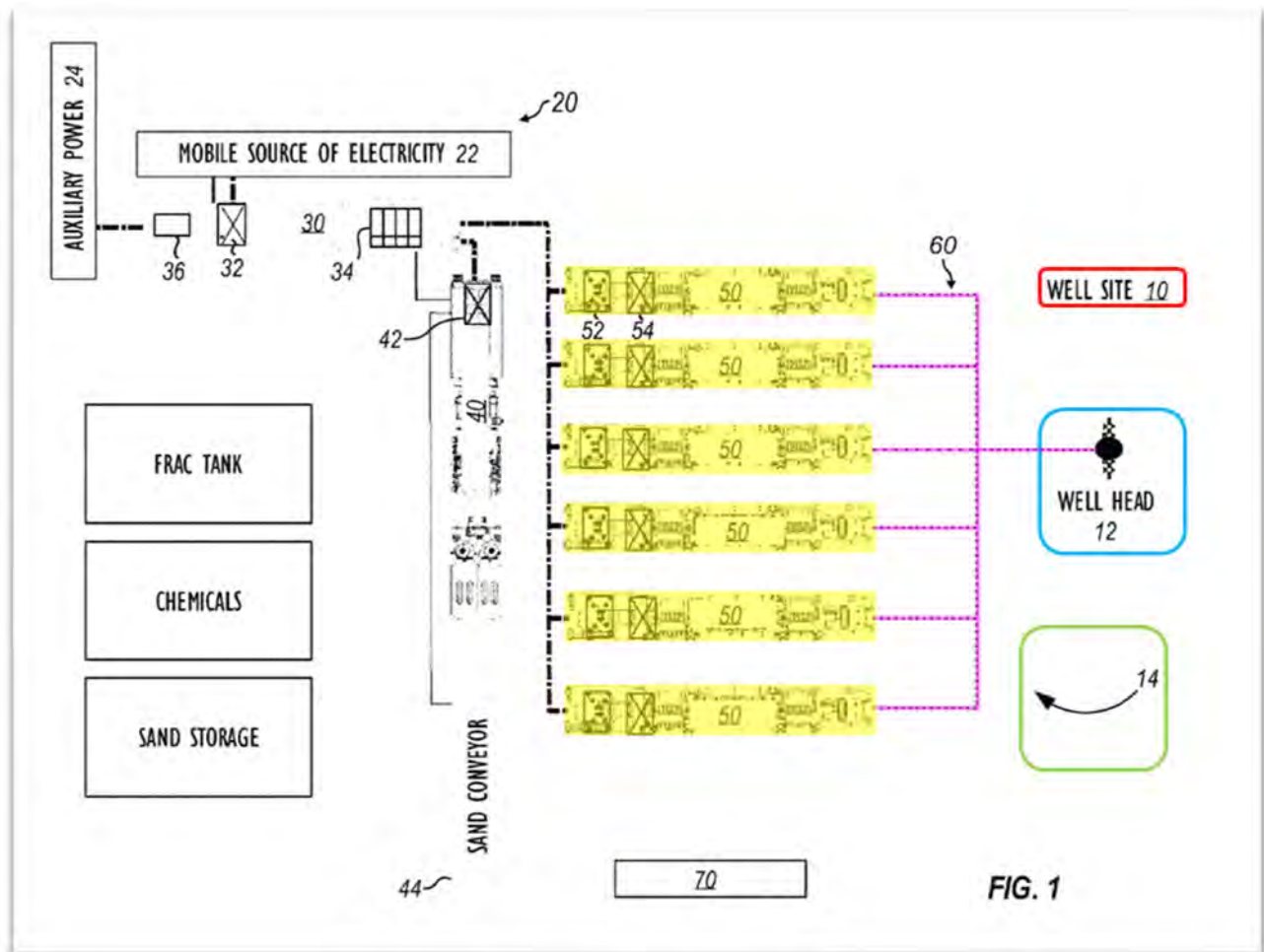
265. As seen in Fig 2, the first area (blue) is at a first (lower) height and the second area (green) is at a second (higher) height. Further, the first area and the second area are adjacent.

266. Accordingly, *Morris* discloses limitation 1[a].

- c. 1[b]: “an electric powered, multi-plunger pump with an odd number of plungers, arranged in the first area, the electric powered pump coupled to a well, via outlet piping, and powered by at least one electric motor, also arranged in the first area;”

267. *Morris* discloses the limitations of 1[b]. *Morris* discloses, when discussing Fig. 1 “is a schematic diagram of a fracturing fleet 14 [annotated in magenta] located at a well site 10 [annotated in red] having one or more wellheads

112 [annotated in blue].”²⁰⁶ Fig. 1 also depicts “one or more fracturing pump transports 50 [annotated in yellow].”²⁰⁷



Ex. 1010 (*Morris*) Fig. 1 (annotated)

268. *Morris* further teaches that “the fracturing pump transport 50 receives the electric power to power a prime mover (not shown). The prime mover converts electric power to mechanical power for driving one or more pumps (not shown [i.e.,

²⁰⁶ Ex. 1010 (*Morris*) [0033].

²⁰⁷ Ex. 1010 (*Morris*) [0033].

an electric motor]). The pumps on the fracturing pump transports 50 pump the fracturing fluid to a hydraulic fracturing manifold at the wellhead 12. The pressurized fracturing fluid can be delivered using piping and manifolds [60, annotated in magenta] to the wellhead 12 in any suitable arrangement known in the art.”

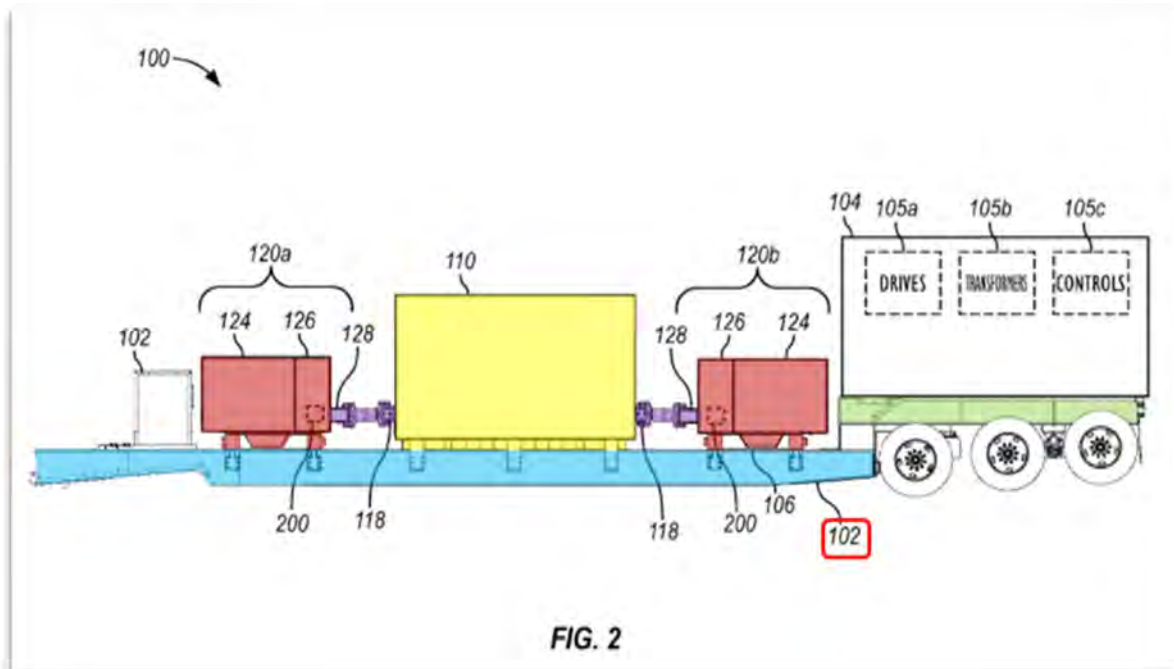
269. *Morris* further discloses that “FIG. 2 is a schematic diagram of an embodiment of a fracturing pump transport that can engage and disengage one or more pumps from a prime mover.”²⁰⁸ Fig. 2 also discloses “details of how a prime mover connects to pumps.”²⁰⁹ A POSITA would have understood that Fig. 2 is a more detailed representation of fracturing pump transports 50 shown in Fig. 1, and would have understood that the two embodiments shown in Fig. 1 and Fig. 2 were compatible.

270. With regard to Fig. 2, *Morris* teaches that the fracturing transport 100 (annotated in red) of Figure 2 contains “a prime mover 110” (annotated in yellow) and “pumps 12_{a-b}” (annotated in maroon) on the transport 100.²¹⁰

²⁰⁸ Ex. 1010 (*Morris*) [0011].

²⁰⁹ Ex. 1010 (*Morris*) [0043].

²¹⁰ Ex. 1010 (*Morris*) [0043].



Ex. 1010 (Morris) Fig. 2 (annotated)

271. *Morris* further teaches that “the prime mover 110 may be a dual shaft electric motor that has a motor shaft 118 [annotated in purple] that protrudes on opposite sides of the electric motor.”²¹¹ *Morris* further discloses that “the prime mover 110 may include other electric motors that are configured to provide about 5,000 HP or more.”²¹² As seen in Fig. 2 above, shafts 118 connect the prime mover 110 to pumps 120_{a-b}.

272. *Morris* further describes that pumps 120_{a-b} are multi-plunger pumps. *Morris* teaches that “each of the pumps 120 a-b may be a quintuplex pump [5

²¹¹ Ex. 1010 (*Morris*) [0049].

²¹² Ex. 1010 (*Morris*) [0049].

plungers] located on the same transport 100. Other embodiments may include other types of plunger style pumps 120 a-b, such as triplex pumps [3 plungers].”²¹³ Both quintuplex (five-plunger) and triplex (three-plunger) pumps have an odd number of plungers.²¹⁴

273. Accordingly, *Morris* discloses an electric powered, multi-plunger pump with an odd number of plungers, arranged in the first area, the electric powered pump coupled to a well, via outlet piping, and powered by at least one electric motor, also arranged in the first area as claimed in 1[b].

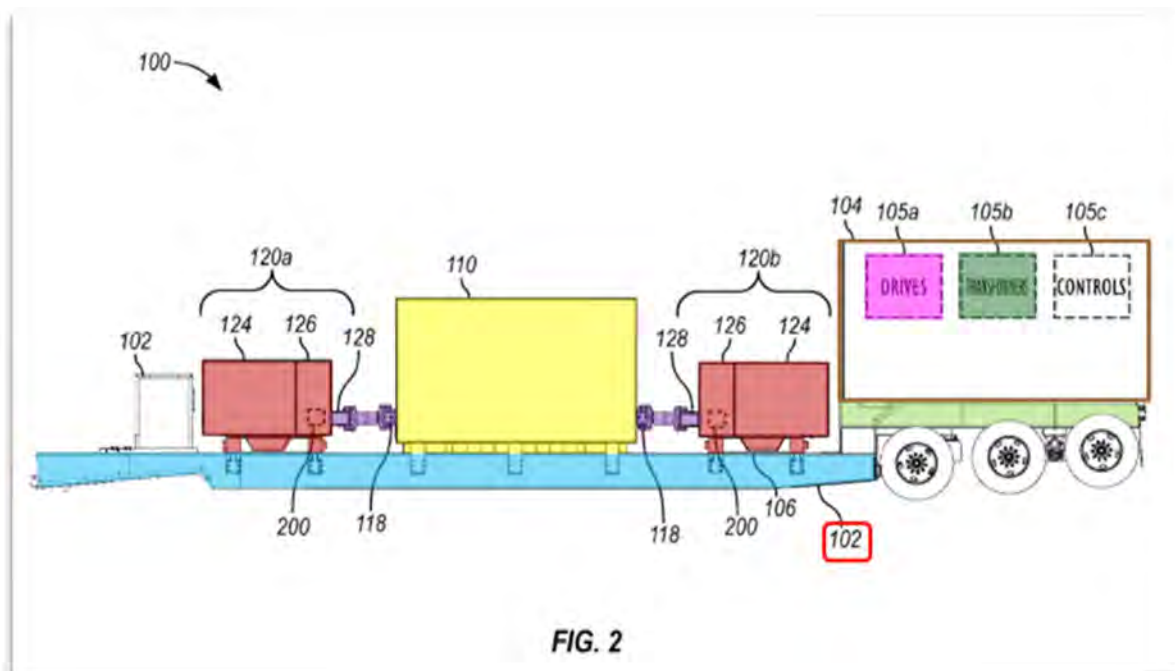
- d. **1[c]: “a variable frequency drive (VFD), arranged in the second area, connected to the at least one electric motor, the VFD configured to control at least a speed of the at least one electric motor; and”**

274. As discussed above regarding limitation 1[a], *Morris* teaches a second area, which is annotated in green in the annotated Fig. 2 below. Further, *Morris* discloses that “[t]he power and control system 104 (outlined in brown) may include one or more electric drives 105a (e.g., variable frequency drives (VFD)) [highlighted in magenta], transformers 105b [highlighted in dark green], controls 105c (e.g., a programmable logic controller (PLC) located on the fracturing pump transport 100), and cable connections (not shown) to other transports (e.g., switch gear transport).

²¹³ Ex. 1010 (*Morris*) [0051]

²¹⁴ See Ex. 1013 (Karassik), 3.11 (Table 7).

The electric drives 105a may provide control, monitoring, and reliability functionality, such as preventing damage to a grounded or shorted prime mover 110 and/or preventing overheating of components (e.g., semiconductor chips) within the electric drives.”²¹⁵ The VFDs (105a) are arranged in the second area (highlighted in green).



Ex. 1010 (*Morris*) Fig 2 (annotated)

275. Morris further discloses that “[t]he prime mover 110 may be driven by at least one variable frequency drive 105a that is rated to a maximum of about 5,000 HP and may receive electric power generated from the mobile source of electric

²¹⁵ Ex. 1010 (*Morris*) [0048].

power.”²¹⁶ A POSITA would understand that the motor being driven by the VFD means at least that the motor speed is controlled by the VFD, as this was one known function of VFDs for decades prior to the ’863 Patent.²¹⁷ Further, a POSITA would understand that a VFD which drives an electric motor, and provides control and monitoring of the prime mover 110 (i.e. electric motor) would have been connected, at least electrically to the motor.

276. To the extent that *Morris* does not explicitly state that the VFDs control the speed of the motors, or that the VFD is connected to the motor, it would have been obvious to a POSITA that VFDs driving electric motors control the speed of the electric motors and are connected to the electric motors. VFDs have been well-known power electronic devices used to control the speed of an electric motor (and hydraulic fracturing pump motors in particular) long before the ’863 Patent.²¹⁸ Further, in order to provide power to and control the speed of the electric motor (and perform diagnostics on the electric motor), it was well known to connect VFDs to an electric motor.²¹⁹

277. Accordingly, *Morris* discloses, or at least it would have been obvious to a POSITA based on the teachings of *Morris* combined with the general knowledge

²¹⁶ Ex. 1010 (*Morris*) [0050].

²¹⁷ See §IX.I.

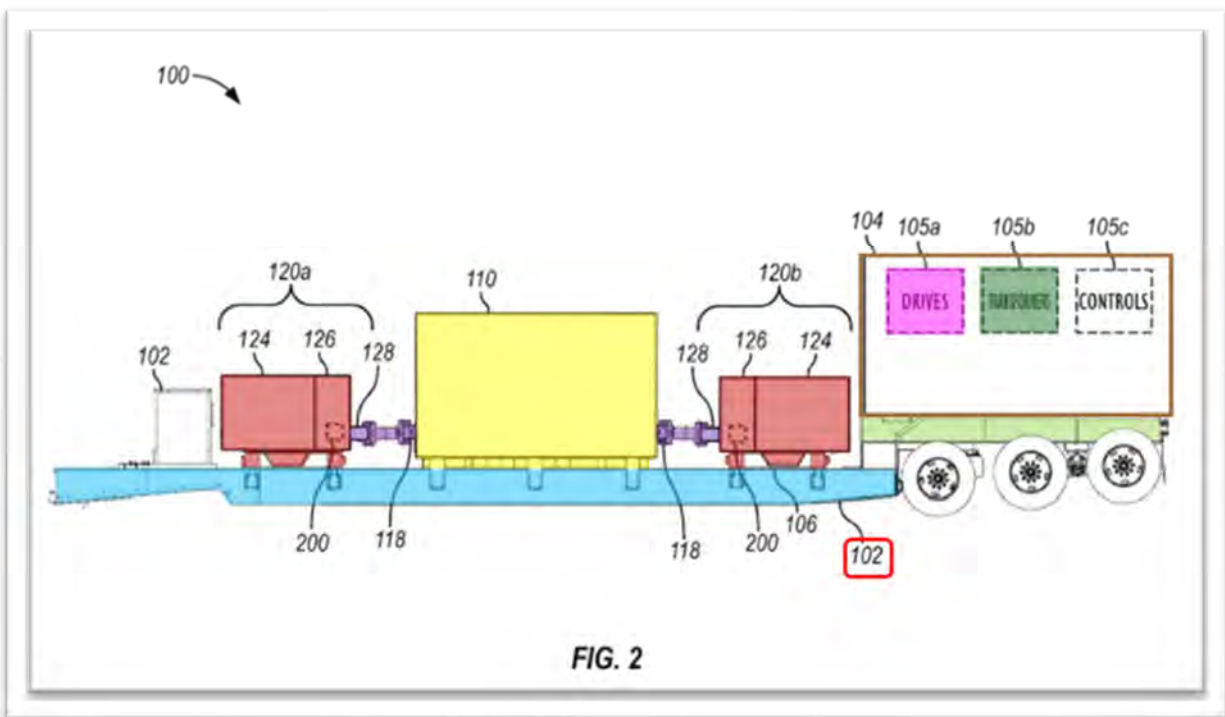
²¹⁸ See §IX.H – IX.I.

²¹⁹ See §IX.H – IX.I.

of a POSITA regarding VFDs and electric motors, a variable frequency drive (VFD), arranged in the second area, connected to the at least one electric motor, the VFD configured to control at least a speed of the at least one electric motor.

- e. **1[d]: “a transformer, arranged in the second area, the transformer positioned within an enclosure with the VFD, the transformer configured to distribute power for operation of the electric pump.”**

278. As discussed above regarding limitation 1[c], *Morris* discloses transformers 105b (highlighted in dark green) arranged in the second area (highlighted in green). These transformers are contained within [t]he power and control system 104 (outlined in brown), which also contains the VFD 105a (highlighted in magenta).



Ex. 1010 (*Morris*) Fig 2 (annotated)

279. It would have been obvious to POSTIA that power and control system 104 comprises an enclosure, such as to protect the electric and electronic components from the weather. Further, *Morris* teaches that “the fracturing pump transport 100 has an upper section above the trailer axles that ***may hold or have mounted the power and control systems 104.***”²²⁰ Further, *Morris* discloses that “[t]he transformers 105 b ***within the power and control systems 104*** can step one or more input voltages (e.g., 13.8 kilovolts (kV)) to one or more lower voltages (e.g., 4.2 kV, 2.1 kV, 600 and 480 volts (V)).”²²¹ Power and control systems 104 is discussed as, and shown in Fig. 2 as a single structure, and *Morris* teaches that transformers 105b are within the power and control systems 104, which a POSITA would have understood to be, or at least it would have been obvious to be, an enclosure which is mounted to the upper section (second area), for example.

280. *Morris* teaches that transformers 105b have the function of a stepdown transformer. As discussed above, *Morris*’ transformers 105b step one or more input voltage (e.g. 13.8 kV) down to one or more lower voltages (e.g. 4.2 kV, 2.1 kV, 600 and 480 volts). Further, *Morris* teaches that this lower voltage level is used at least for the electric motors (prime movers). *Morris* discloses that “each of the transports

²²⁰ Ex. 1010 (*Morris*) [0047], emphasis added.

²²¹ Ex. 1010 (*Morris*) [0047].

40, 50 can include one or more transformers 42, 52, and 54 that step down the target output voltage level (e.g., 13.8 kV) to one or more lower voltage levels that equipment (e.g., electric prime movers) mounted on the transports 40, 50 may utilize.”²²²

281. Accordingly, *Morris* discloses, or at least it would have been obvious to a POSITA based on the teachings of *Morris*, a transformer, arranged in the second area, the transformer positioned within an enclosure with the VFD, the transformer configured to distribute power for operation of the electric pump as claimed in limitation 1[d].

XXIII. GROUND 12: OBVIOUS OVER *MORRIS* IN VIEW OF *OEHRING-I*

A. MOTIVATION TO COMBINE

282. A POSITA would have been motivated to combine the teachings of *Oehring-I* with those of *Morris* in order to take advantage of *Oehring-I*'s disclosure of safety devices (platforms with rails), trailer hitch teachings and working space created by slide-out platforms with rails to enhance mobility, safety and ergonomics of the system of *Morris*, a stated goal of *Morris*.

283. Initially, both *Morris* and *Oehring-I* teach a hydraulic fracturing system comprising motors and pumps located on trailers. *Morris* discloses a “system and a

²²² Ex. 1010 (*Morris*) [0036].

method for distributing electric power from a power source of electricity to power fracturing operations.”²²³ Further, *Morris* discloses a fracturing pump transport 104 comprises “fracturing equipment (e.g., electric prime movers) mounted on the transport[.]”²²⁴ *Morris* teaches that the pumps, powered by electric prime movers (i.e. motors) are part of “a fracturing fleet 103 located at well site.”²²⁵ Similarly, *Oehring-I* discloses “[a] hydraulic fracturing system has a pump driven by an electrically powered motor. The pump pressurizes fluid which is piped into a wellbore to fracture a subterranean formation. The pump and motor are mounted on a trailer that is hitched to a tractor.”²²⁶ Accordingly, both *Morris* and *Oehring-I* are similar to each other, and the ’863 Patent, and are in the same field of endeavor – electrically powered, trailer mounted fracturing fleets. Thus, a POSITA would have been motivated to combine the teachings of *Morris* and *Oehring-I* at least because of their similarities

284. *Morris* already anticipates configurations of trailers to “enhance mobility, improve[] safety and enhance ergonomics for crew members when performing routine maintenance and operations of the pumps.”²²⁷ *Oehring-I*’s

²²³ Ex. 1010 (*Morris*) at Abstract.

²²⁴ Ex. 1010 (*Morris*) [0022].

²²⁵ Ex. 1010 (*Morris*) [0020].

²²⁶ Ex. 1010 (*Morris*) Abstract

²²⁷ Ex. 1010 (*Morris*)

teachings regarding platforms and rails assist in furthering *Morris*' goal of enhanced safety and ergonomics while performing maintenance on the pumps. *Oehring-I* teaches "a platform assembly is mounted onto the trailer, and which is selectively moveable between deployed and stowed configurations. The platform assembly includes a platform, a lateral rail assembly mounted to the platform, and gates on the forward and aft ends of the platform. The rail assembly and gates define a safety barrier to prevent operations personnel from falling off the platform. In the stowed configuration the platform assembly is anchored in place over wheels on the trailer. In the deployed configuration, the platform assembly provides work surface so that operations personnel can readily access the pump on the trailer."²²⁸ These benefits would accrue to the laydown trailer of *Morris* as the pumps are still elevated above the ground even when in a laydown position.

285. A POSITA would have understood that *Oehring-I*'s teachings of a platform and rail assembly attached to the pumping trailer would enhance *Fischer*'s goals of improving safety and ergonomics while performing maintenance on the pumps by allowing easier access to the pumps. Further, a POSITA would have understood that *Oehring-I*'s teachings of a platform that can be stowed, for example

²²⁸ Ex. 1012 (*Oehring-I*)

when moving from location to location, would assist in reaching *Fischer's* goal of enhancing mobility.

286. Further, incorporating *Oehring-I's* retractable platform assembly to provide access to *Morris's* trailer-mounter pump is applying a known technique (a retractable, trailer-mounter platform assembly) to improve similar devices (*Morris's* pump trailer) in the same way. The results of the combination would be predictable: a pump trailer with a retractable platform assembly that provides maintenance operators access to *Morris's* pump mounted on the lay-down trailer.

287. Accordingly, a POSITA would have been motivated to combine *Fischer* and *Oehring-I* and would have had a reasonable expectation of success in doing so.

B. CLAIM 2

The hydraulic fracturing system of claim 1, further comprising: a slide out platform integrated into the first area, the slide out platform being driven between a retracted position and a deployed position, wherein the deployed position provides a work area proximate the electric powered, multi-plunger pump.

288. The additional limitations of Claim 2 are disclosed by *Oehring-I* for the same reasons as those discussed above in Ground 2, section XIII.B. Namely, a

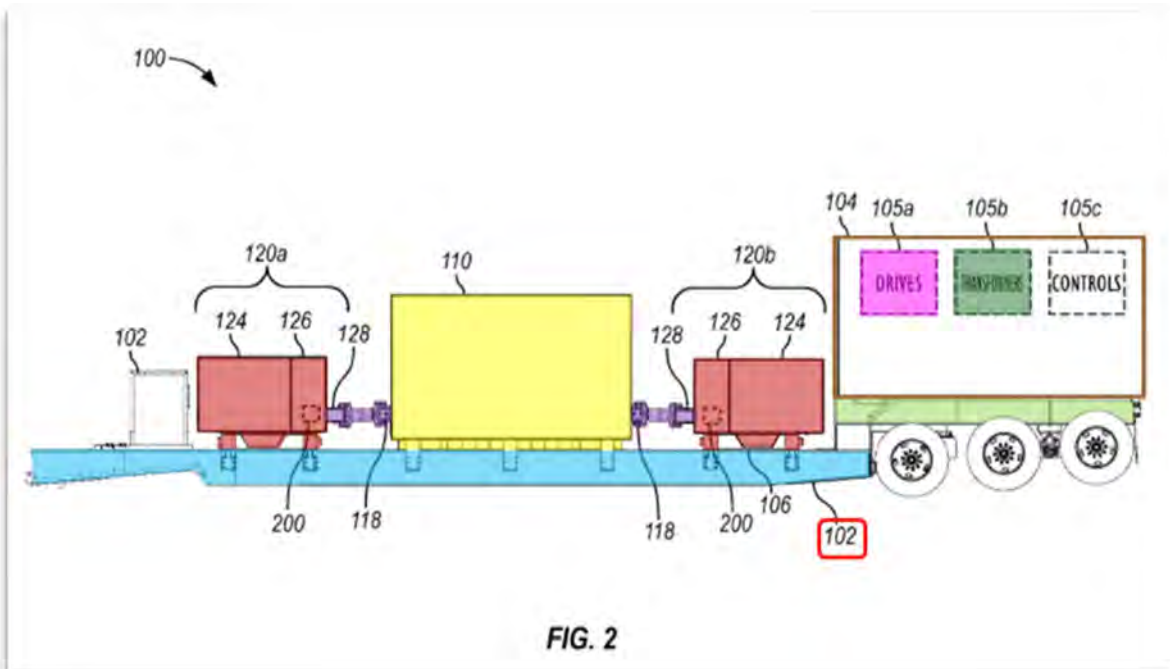
POSITA would have understood that in the combined *Morris-Oehring-I* system, *Oehring-I*'s teachings of a platform assembly would have been incorporated into *Morris*'s pump trailer to provide a "selectively movable" platform that gives operations personnel access to *Morris*'s pump, as taught by *Oehring-I*.²²⁹ And because *Morris*'s pump is located in the "*first area*" of *Morris*'s lay-down trailer, a POSITA would have understood that *Oehring-I*'s platform assembly, which is proximate to and provides access to the pump, would be "*integrated into the first area*." Accordingly, Claim 2 is rendered obvious by the combination of *Morris* and *Oehring-I*.

XXIV. GROUND 13: OBVIOUS OVER MORRIS IN VIEW OF
OEHRING-II

A. MOTIVATION TO COMBINE

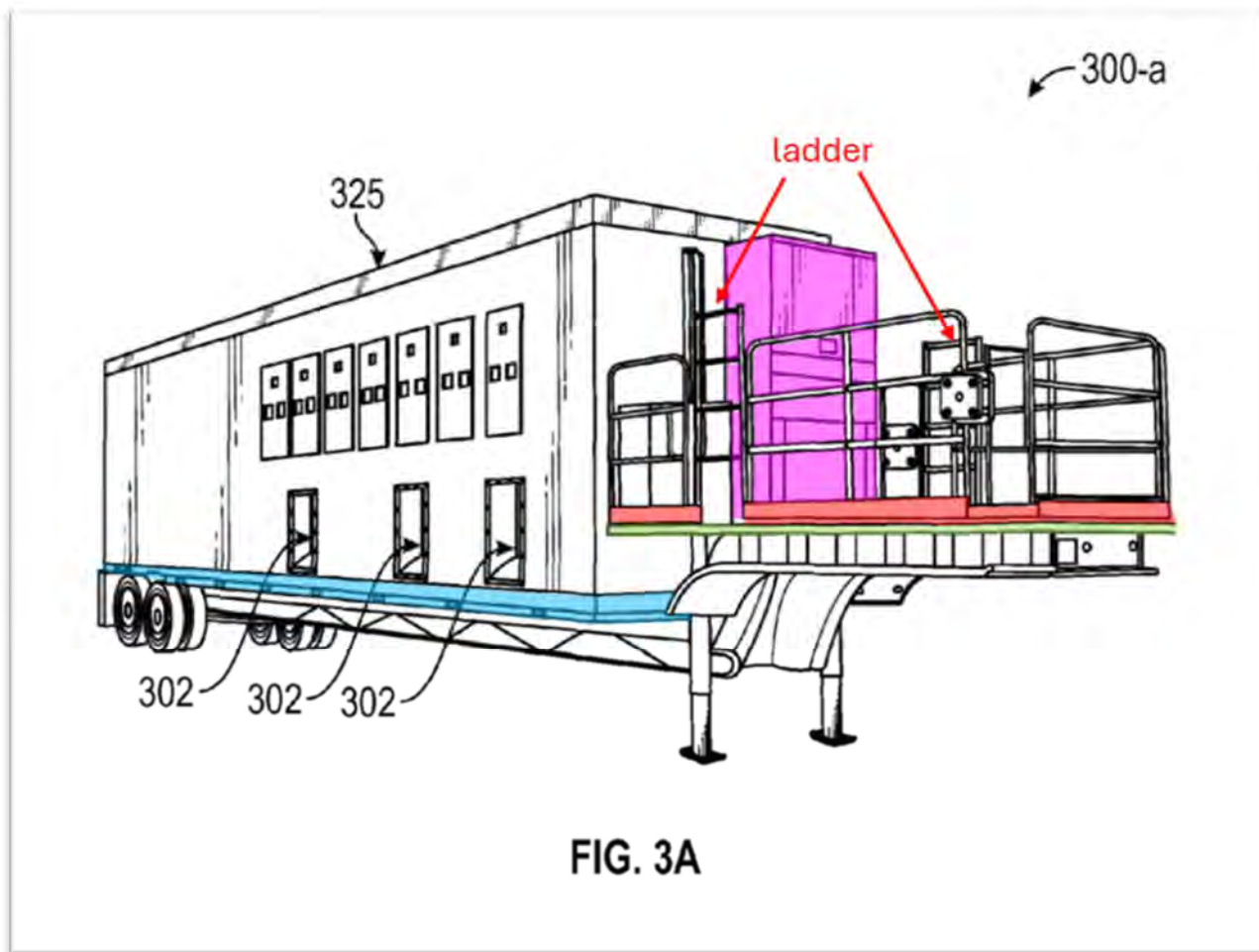
289. As discussed above in Ground 11, *Morris* describes a lay-down trailer that includes a first area (highlighted in blue) in which an electric motor (highlighted in yellow) and pumps (highlighted in maroon) are mounted and a second, elevated area (highlighted in green) that features an enclosure (outlined in brown) wherein a VFD (highlighted in magenta) and a transformer (highlighted in dark green) is housed. Figure 2 of *Morris*, depicting the lay-down trailer, is copied below:

²²⁹ See XIII.B.



Ex. 1010, Fig. 2.

290. Further, as discussed above with reference to Ground 4, *Oehring-II* discloses an elevated platform that is located along the trailer's longitudinal axis and provides access to the switchgear trailer as well as an enclosure adjacent to the trailer, depicted in Figure 3A of *Oehring-II* below:



Ex. 1016 (*Oehring-II*), Fig. 3A.

291. A POSITA would have been motivated to incorporate *Oehring-II*'s teachings elevated platform into *Morris*'s lay-down trailer for multiple reasons. First, design incentives would have motivated a POSITA to make this combination. As depicted in Figure 2 of *Morris*, the second area of *Morris*'s lay-down trailer (wherein the VFD enclosure is located) is elevated above the ground; however, *Morris* does not describe how this area is actually accessed by an operator. Accordingly, a POSITA implementing *Morris*'s lay-down trailer would have been

motivated to incorporate some sort of assembly to access these components, such as the elevated platform and rails depicted in *Oehring-II*.

292. Second, incorporating *Oehring-II*'s teachings of a platform to provide access to the second area of *Morris*'s lay-down trailer is applying a known technique (a platform coupled to a trailer as taught by *Oehring-II*) to improve similar devices (*Morris*'s lay-down trailer) in the same way. The results of the combination would be predictable: a lay-down trailer with an elevated platform located along the trailer's longitudinal axis at the back of the trailer that provides operators access to the elevated areas of *Morris*'s lay-down trailer. Accordingly, a POSITA would have been motivated to combine *Morris* and *Oehring-II* and would have had a reasonable expectation of success in doing so.

B. CLAIM 3

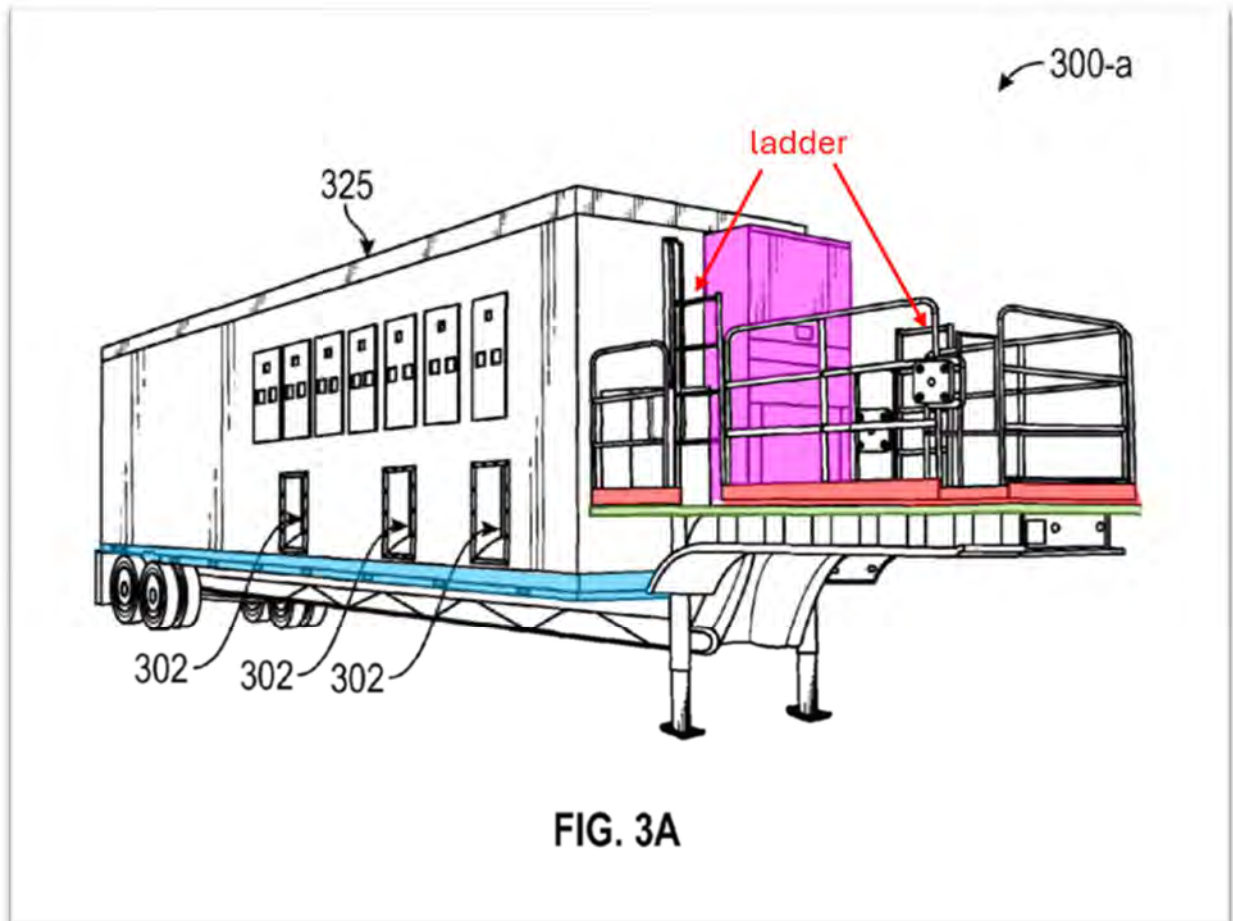
The hydraulic fracturing system of claim 1, further comprising:

a work platform proximate the enclosure in the second area, the work platform providing access to the enclosure, the work platform arranged such that the enclosure is between the work platform and the first area.

293. Claim 3 depends from Claim 1. In addition to the discussion of *Fischer* regarding Claim 1 above, and incorporated herein by reference, *Oehring-II* discloses the additional limitations of Claim 3. *Oehring-II* describes a "switchgear trailer" that

provides electric connections for various components of a fracturing system.²³⁰

Annotated Figure 3A of *Oehring-II*, provided below, depicts the switchgear trailer:



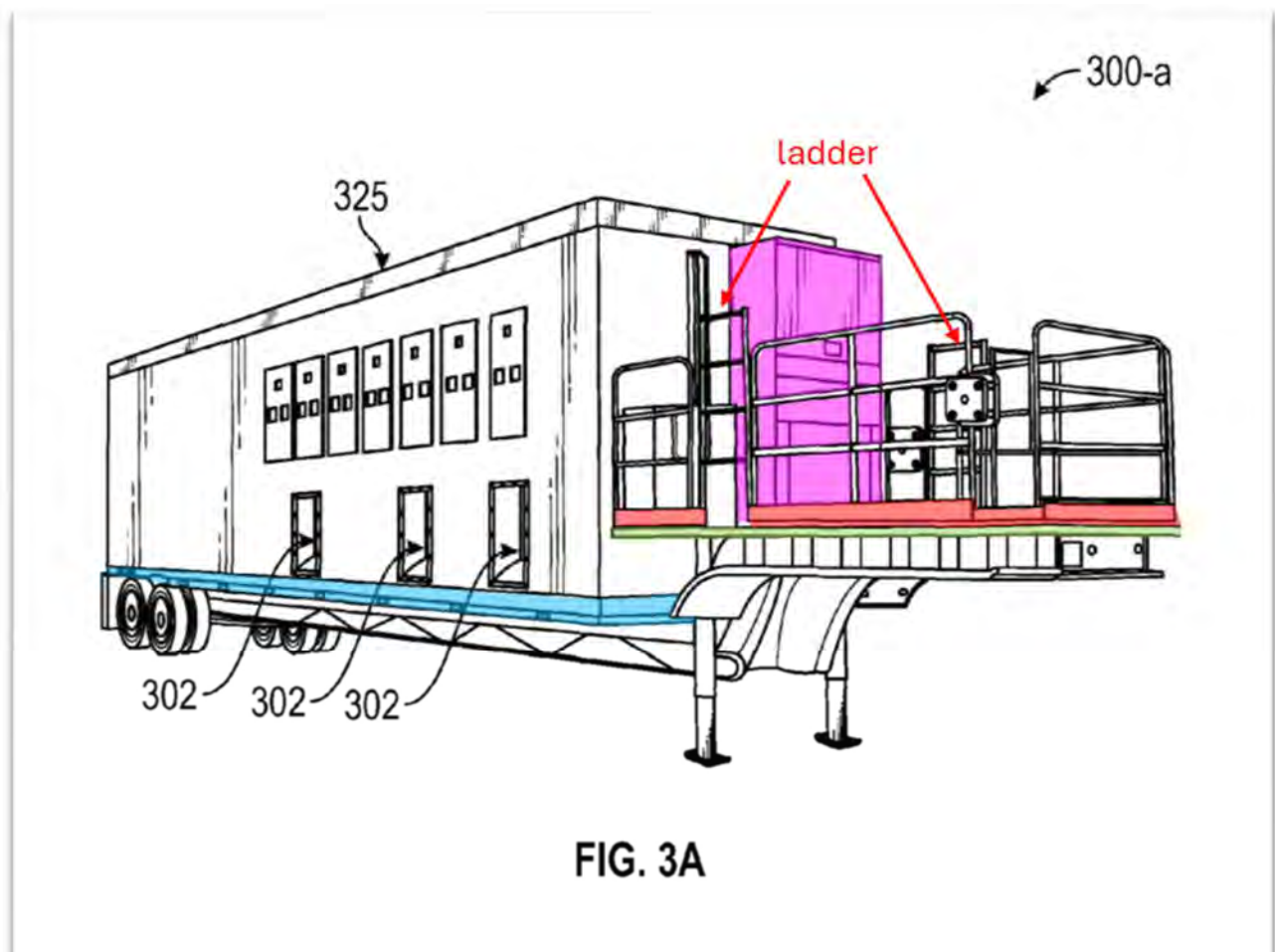
Ex. 1016 (*Oehring-II*), Fig. 3A (annotated).

294. As depicted, the switchgear trailer further comprises an enclosure (annotated in magenta) accessible from an elevated platform (annotated in red) that is located along the trailer's longitudinal axis and provides access to the enclosure, as well as being mounted in the second, elevated area (annotated in green).

²³⁰ Ex. 1016 (*Oehring-II*) 7:21-28.

295. Further, as discussed above with reference to Ground 10, *Morris* describes a pump trailer that includes a second, elevated area that features an enclosure housing a VFD.

296. *Oehring-II* discloses a trailer similar to that of *Morris* (and *Oehring-I*) that has a first area (highlighted in blue) and a second area (highlighted in green). *Oehring-II* also shows an enclosure (highlighted in magenta) in the second area.



Ex. 1016 (*Oehring-II*) Fig. 3A (annotated).

297. *Oehring-II* also shows a work platform (highlighted in red) with rails (not highlighted) and access ladders (annotated with red arrows). A worker on this platform would have access to the enclosure (annotated in magenta). The enclosure is between the work platform and the first area (highlighted in blue)

298. In combination with *Morris*, a POSITA would have understood to add a work platform similar to that of *Oehring-II* to the trailer of *Morris* in the second area to give access to VFD 132 and its enclosure, for example without having to stand on a ladder while accessing the enclosure. It would be understood, based on the teachings of *Oehring-II* that the platform would be placed along the trailer's longitudinal axis at the rear of *Morris*'s trailer, in *Morris*' elevated second area, with the enclosure between the platform and the first area, as suggested in *Oehring-II*, for example Fig. 3A as annotated above. Further, a POSITA would have understood that *Oehring-II*'s elevated platform would be placed at the floor height of the second, elevated area of *Morris*'s lay-down trailer to provide access to this area.

299. A POSITA would have understood that in this combined system, *Oehring-II*'s elevated platform (annotated in green above) would be “*proximate the enclosure in the second area, the work platform providing access to the enclosure,*” because *Morris*'s “*enclosure*” is located in the second area of the pump trailer, as discussed above with reference to Limitations 1[c] and 1[d]. Further, elevated

platform being configured in this manner is also “*arranged such that the enclosure is between the work platform and the first area,*” as depicted in the annotation above.

300. Accordingly, the *Morris-Oehring-II* combination renders obvious Claim 3

XXV. GROUND 14: OBVIOUS OVER MORRIS IN VIEW OF ORBAN

A. MOTIVATION TO COMBINE

301. A POSITA would have been motivated to combine the teachings of *Morris* with those of *Orban* to take advantage of *Orban*’s cooling mechanism to remove heat from the power electronics (e.g. IGBTs) associated with *Morris*’s VFD. *Morris* describes a lay-down trailer that includes “an upper section above the trailer axles that may hold or have mounted the power and control systems 104, ” *which* “may include one or more electric drives 105a (e.g., variable frequency drives (VFD))” that “provide control, monitoring, and reliability functionality, such as preventing damage to a grounded or shorted prime mover 110” and drive the prime mover.²³¹ As discussed above with reference to Limitation 1[d], a POSITA would have understood that the VFD is located within an enclosure located in the “*second area*” of *Morris*’s lay-down trailer.

²³¹ Ex. 1010 (*Morris*), [0047]-[0048], [0050].

302. *Orban* teaches “[a]n integrated power and electronics unit (IPEU) operable for providing output power for driving an electric motor of a drilling rig machine.”²³² The IPEU comprises a housing, a radiator, and a VFD. The radiator is mounted within the housing and comprises radiating members each extending through an opening in the housing. The VFD comprises insulated-gate bipolar transistor devices (IGBTs) operable to convert input power to the output power.”²³³ *Orban* specifically teaches that the IPEU may be used “for fracturing pumping systems, such as may comprise one or more electrically driven triplex pumps.”²³⁴ A POSITA would have understood that for larger pumps (for example, quintuplex or larger, higher horsepower), the corresponding electronic components would handle more heat than for smaller pumps, requiring more heat dissipation from those electronics, making the teachings of *Orban* even more germane to the problem of protecting electronics from heat-related damage. Accordingly, *Orban* contains an express motivation to combine its teachings with those of other references dealing with fracturing pumps, such as *Morris*. Further, *Orban* teaches that “[t]he IPEU includes a housing, a radiator, and a VFD.”²³⁵ Additionally, “[t]he VFD includes IGBTs operable to convert input power to the output power. The IGBTs are coupled

²³² Ex. 1011 (*Orban*) at Abstract.

²³³ Ex. 1011 (*Orban*) at Abstract.

²³⁴ Ex. 1011 (*Orban*) [0042].

²³⁵ Ex. 1011 (*Orban*) [0006].

to the radiator within the housing such that heat generated by the IGBTs is transferred out of the housing via the radiator.”²³⁶ A POSITA would have immediately recognized the benefits of removing heat from the electronics (IGBTs) so that the electronics are operated at the appropriate temperature and do not overheat. For example, *Orban* teaches the use of radiators “may avoid overheating of some IGBTs 135, while ensuring that their "speed" response is similar for proper sharing of current during PWM switching.”²³⁷ A POSITA would have recognized *Orban*’s radiator, whose design allows a VFD to “operate at substantially the same temperature,” would achieve such goals.²³⁸ Further, a POSITA would have been motivated to combine *Orban*’s liquid based cooling system based on the general knowledge that such systems have been employed in protecting power electronics since at least the 1970s.²³⁹ Further, incorporating *Orban*’s teachings would further *Morris*’ goal of providing “reliability functionality” by removing heat from the system that could damage electronics.

303. A POSITA would have a reasonable expectation of success in combining the teachings of *Morris* and *Orban* as *Orban* explicitly discloses that its liquid cooling system was applicable to fracturing pumps. Further, a POSITA would

²³⁶ Ex. 1011 (*Orban*) [0006].

²³⁷ Ex. 1011 (*Orban*), [0066].

²³⁸ Ex. 1011 (*Orban*), [0065].

²³⁹ See §IX.K above.

have had a reasonable expectation of success in the combination as liquid-based cooling systems for power electronics have been known for over 50 years. Further, a POSITA would have had a reasonable expectation of success in combining the teachings as commercially available VFD systems with liquid cooling were known. Further, incorporating *Orban*'s teachings of a water-based radiator to cool *Morris*'s VFD is applying a known technique (a water-based VFD cooling system) to improve similar devices (*Morris*'s VFD) in the same way. The results of the combination would be predictable: a VFD coupled to a water-based radiator for cooling the VFD and, by extension, the enclosure in which the VFD is located.

304. Accordingly, a POSITA would have been motivated to combine *Morris* and *Orban* and would have had a reasonable expectation of success in doing so.

B. CLAIM 4

The hydraulic fracturing system of claim 1, further comprising:

A cooling system for the enclosure, the cooling system being a liquid cooling system thermally coupled to at least one of the VFD or the transformer.

305. Claim 4 depends from Claim 1. In addition to the discussion regarding Claim 1 discussed in Section XXII above, and incorporated herein by reference, *Orban* discloses the additional limitation of Claim 4 for the same reasons as those

discussed in Ground 4 in Section XV.B above. Accordingly, Claim 4 would have been obvious to a POSITA based on the combined teachings of *Morris* and *Orban*.

C. CLAIM 5

The hydraulic fracturing system of claim 4, wherein the liquid cooling system includes water or glycol.

306. Claim 5 depends from Claim 4. In addition to the teachings regarding Claim 1 and Claim 4 discussed above, and incorporated herein by reference, *Orban* discloses the additional limitations of Claim 5 for the same reasons as those discussed in Ground 4 in Section XV.C above. Accordingly, Claim 5 would have been obvious to a POSITA based on the combined teachings of *Morris* and *Orban*.

XXVI. GROUND 15: OBVIOUS OVER MORRIS IN VIEW OF KARASSIK

A. MOTIVATION TO COMBINE

307. *Morris* already discloses a quintuplex (five-plunger) fracturing pump.²⁴⁰ *Karassik* is a publication that describes fundamental pump theory and operations, including the use of one-, two-, three-, four-, five- six-, seven-, and nine-plunger pumps.²⁴¹ As discussed above in section IX.L, and confirmed by *Karassik*, “[u]nlike a centrifugal pump, a power pump [including a plunger pump] does not

²⁴⁰ See Ground 11, Limitation 1[b] above.

²⁴¹ Ex. 1013 (*Karassik*), pg. 3.11. (Table 7).

develop pressure; it only produces a flow of fluid. The downstream process or piping system produces a resistance to this flow, thereby generating pressure in the piping system and discharge portion of the pump.”²⁴² Additionally, as discussed above in Section IX.L, and also taught by *Karassik*, the flowrate of a plunger pump (at a given speed) is directly proportional to the number of plungers of the pump, the pump’s speed, the pump’s stroke length, and the cross-sectional area of the pump’s plungers. For example, *Karassik* teaches that the ideal flowrate of a plunger pump is governed by

$$D = A \times m \times n \times s \times 6 \times 10^{-5},$$

Where

D = Displacement (volume flow rate, m³/h)

A = cross-sectional area of plunger or piston (mm²)

m = number of plungers or pistons

n = rpm of pump

s = stroke of pump (mm) (half the distance the plunger moves in on rev.)²⁴³

²⁴² Ex. 1013 (*Karassik*), pg. 3.3.

²⁴³ Ex. 1013 (*Karassik*), 3.4.

308. *Karassik* further teaches the use of plunger pumps with up to 9 cylinders.

TABLE 8 The effect of the number of plungers on variations in capacity from the mean (*C* is approx. 6:1)

Type	Number of Plungers	% Above Mean	% Below Mean	Total %	Plunger Phase
Duplex	2	24	22	46	180 deg.
Triplex	3	6	17	23	120 deg.
Quadruplex	4	11	22	33	90 deg.
Quintaplex	5	2	5	7	72 deg.
Sextuplex	6	5	9	14	60 deg.
Septuplex	7	1	3	4	51.5 deg.
Nonuplex	9	1	2	3	40 deg.

Ex. 1013 (*Karassik*) Table 8

Based on the equation above at a given speed (RPM) a nonuplex (9 plunger) pump would have 9 times the flow of a simplex (1 plunger) pump with the same plunger size, stroke and operating speed, 3 times the flow of a Triplex pump and 1.8 times the flow of a quintuplex pump.

309. Further, *Karassik* teaches that as the cylinder (plunger) count goes up, the variations in pressure are reduced. *Karassik* teaches that “the pulsating characteristics of the fluid flowing into and out of power pumps are significantly influenced by the number of plungers or pistons. Discharge flow pulsations are the most critical because of the high energy potential generated when the system resistance reacts with the flow to create pressure. Since the magnitude of the discharge pulsation is mostly affected by the number of cylinders, increasing the

number of cylinders will reduce the flow pulsations.”²⁴⁴ As seen above the pulse variations (variations in flow) for a duplex pump, for example, range between -22% and +24% (46% total), and variations from a triplex pump range from -17% to +6% (23% total). In comparison, pulse variations for a nonuplex pump are only -2% to +1% (3% total). A POSITA would have known, based on the characteristics of a plunger pump described by *Karassik* that variations in flow lead to variations in pressure. Further, a POSITA would have known that pressure variations lead to noise, vibration and potential damage to the piping, valves and other equipment downstream of the pumps.

310. Accordingly, a POSITA implementing *Morris*’s pump would have been motivated to look to references like *Karassik* and its description of the ideal flowrate produced by plunger pumps and their pulse variation characteristics, which would aid a POSITA’s selection of plunger count, pump speed, and stroke length when implementing *Morris*’s pumping system to achieve a desired flowrate and/or a desired pressure variation profile. As such, combining *Morris* with *Karassik* would simply be combining prior art elements (fundamentals of a plunger pump, as taught by *Karassik*, and *Morris*’s plunger pump) according to known methods (operating the pump) to yield predictable results (a desired output flow).

²⁴⁴ Ex. 1013 pg. 3.10.

311. Further, a POSITA would have been motivated to combine the teachings of *Karassik* with those of *Morris* to gain additional flowrates from higher count plunger pumps, as well as reduced pulsations in the fluid, available from the odd and higher count plunger fluid pumps. And a POSITA would have recognized that modifying *Morris* to use seven plungers or nine plungers, as taught by *Karassik*, rather than five plungers would involve the simple substitution of one known element (a seven- or nine-plunger pump, as taught by *Karassik*) for another (*Morris*'s five-plunger pump) to obtain the predictable result of performing fracturing operations with a seven-plunger or nine-plunger pump, and the associated increased flowrates and reduced pressure variations that come from using the higher plunger count pumps. Accordingly, a POSITA would have been motivated to combine *Morris* with *Karassik* and would have a reasonable expectation of success when doing so.

B. CLAIM 6

The hydraulic fracturing system of claim 1, wherein the electric powered, multi-plunger pump is a septuplex pump having seven plungers.

312. Claim 6 depends from Claim 1. In addition to the discussing regarding Claim 1 discussed in Section XXII above, and incorporated herein by reference, *Karassik* discloses the additional limitation of Claim 6 for the same reasons as those

discussed in Ground 5 in Section XVI.B above. Accordingly, Claim 6 would have been obvious to a POSITA based on the combined teachings of *Morris* and *Karassik*.

C. CLAIM 7

The hydraulic fracturing system of claim 1, wherein the electric powered, multi-plunger pump includes at least one of 9 plungers or 11 plungers.

313. Claim 7 depends from Claim 1. In addition to the discussing regarding Claim 1 discussed in Section XXII above, and incorporated herein by reference, *Karassik* discloses the additional limitation of Claim 7 for the same reasons as those discussed in Ground 5 in Section XVI.C above. Accordingly, Claim 7 would have been obvious to a POSITA based on the combined teachings of *Morris* and *Karassik*.

D. CLAIM 8

The hydraulic fracturing system of claim 1, wherein the electric powered, multi-plunger pump includes more than 5 plungers.

314. Claim 8 depends from Claim 1. In addition to the discussing regarding Claim 1 discussed in Section XXII above, and incorporated herein by reference, *Karassik* discloses the additional limitation of Claim 8 for the same reasons as those discussed in Ground 5 in Section XVI.D above. Accordingly, Claim 8 would have been obvious to a POSITA based on the combined teachings of *Morris* and *Karassik*.

XXVII. GROUND 16: MORRIS IN VIEW OF THE KNOWLEDGE OF A POSITA AND, IN THE ALTERNATIVE, KARASSIK

A. MOTIVATION TO COMBINE

315. A POSITA would have been motivated to combine *Morris* with *Karassik* for the same reasons provided above in Ground 15 (Section XXVI.A), which is incorporated herein by reference.

B. CLAIM 10

The hydraulic fracturing system of claim 1, wherein the electric powered, multi-plunger pump is a single pump and a first pump output meets or exceeds a second pump output associated with two quintuplex pumps.

316. As discussed above with reference to Limitation 1[b], *Morris* discloses that its hydraulic pump is a five-plunger pump powered by an electric motor. It was well known in the art that the ideal flow rate of a reciprocating pump is given by the following equation (“Equation 1”):

$$D = A \times m \times n \times s \times 6 \times 10^{-5},$$

where D = displacement (volume flow rate, m³/h), A = cross-sectional area of plunger or piston (mm²), m = number of plungers or pistons, n = rpm of pump, s = stroke of pump (mm) (half the distance the plunger moves in one rev).²⁴⁵ The ’863

²⁴⁵ Ex. 1013 (*Karassik*), 3.4.

Patent uses this known relationship in explaining the purported invention. The '863 Patent states "8 septuplex (7 plungers) pumps with 5" plungers and 10" stroke length can do the same work as 16 quintuplex pumps with 4.5" plungers and 8" stroke length." Assuming a fixed speed (RPM) for each set of pumps of 100 RPM, the 8 septuplex pumps would output $\sim 180,185 \text{ m}^3/\text{hr}$ ($\sim 18,889 \text{ bbl}/\text{min}$) while the 8 quintuplex pumps would output $\sim 166,800 \text{ m}^3/\text{hr}$ ($\sim 17,486 \text{ bbl}/\text{min}$). Claim 10 is simply claiming what was well known to a POSITA, pumps can be configured in a variety of ways and sizes, and a pump that has twice the capacity will output twice the volume of fluid.²⁴⁶

317. As can be seen from Equation 1, there is a direct relationship between a pump's flowrate (D) (i.e., its "*pump output*") and the pump's stroke length (s), pump speed (n), number of plungers (m), and cross-sectional area of the plungers (A). This is an inherent characteristic of plunger pumps. Accordingly, it would have been obvious to a POSITA that operating *Morris's* hydraulic pump at a first speed with a first stroke length and a first cross-sectional area of the plungers would result in a first flowrate ("*first pump output*") that is equal to a second flowrate ("*meets . . . a second pump output*") achieved by two quintuplex (five-plunger) pumps each

²⁴⁶ I note that the claim does not require any particular number of plungers for the "first pump output". The effect would even be greater if a quintuplex pump was compared to a nonuplex pump, which was also known.

operating at either half of the first speed, with half of the first stroke length, or with half of the cross-sectional area for each plunger. In the alternative, *Karassik* renders obvious Claim 10 for the same reasons.

318. Accordingly, Claim 10 is rendered obvious by *Morris* in view of the knowledge of a POSITA and, in the alternative, *Karassik*.

C. **CLAIM 11**

319. It is my opinion that the combination of *Morris* in view of the knowledge of a POSITA and, in the alternative, *Karassik*, renders Claim 11 obvious. As discussed below, *Morris*, the knowledge of a POSITA and, in the alternative, *Karassik* discloses or at least renders obvious each and every limitation of Claim 11.

a. **11[p]: “11. A hydraulic fracturing system, comprising:”**

320. Limitation 11[p] is disclosed by *Morris* for the same reasons as those discussed above regarding Limitation 1[p].²⁴⁷ Accordingly, *Morris* discloses the preamble.

²⁴⁷ I understand that the preamble may not be limiting. I include a discussion of the preamble to Claim 11 out of an abundance of caution.

- b. **11[a]: “an electric powered, multi-plunger pump, arranged on a support structure, the electric powered multi-plunger pump powered by at least one electric motor;**

321. Limitation 11[a] is disclosed by *Morris* for the same reasons as those discussed above regarding Limitation 1[a]. Accordingly, *Morris* discloses Limitation 11[a].

- c. **11[b]: “a variable frequency drive (VFD), arranged on the support structure, connected to the at least one electric motor to control a speed of the at least one electric motor, the VFD positioned separate from the electric powered, multi-plunger pump and within an enclosure; and”**

322. Limitation 11[b] is disclosed by *Morris* for the same reasons as those discussed above regarding Limitation 1[c]. Accordingly, *Morris* discloses Limitation 11[b].

- d. **11[c]: “a transformer, arranged on the support structure, configured to distribute power for operation of the electric powered, multi-plunger pump, the power being received from at least one generator at a voltage higher than an operating voltage of the electric powered pump , the transformer positioned within the enclosure;”**

323. As discussed above regarding limitation 1[d], *Morris* discloses, or at least it is obvious to a POSITA based on the disclosure of *Morris*, a transformer arranged on the support structure, configured to distribute power for operation of the electric powered, multi-plunger pump, the power being received from at least one generator. Further, *Morris* further discloses the use of a conventional step-down

transformer to convert voltage received from the generator at a higher voltage than an operating voltage of the electric powered pump. For example, *Morris* discloses that “[t]he transformers 105 b *within the power and control systems 104* can step one or more input voltages (e.g., 13.8 kilovolts (kV)) to one or more lower voltages (e.g., 4.2 kV, 2.1 kV, 600 and 480 volts (V)).”²⁴⁸ This is a conventional use of a step-down transformer. Further, *Morris* teaches that this lower voltage level is used at least for the electric motors (prime movers). *Morris* discloses that “each of the transports 40, 50 can include one or more transformers 42, 52, and 54 that step down the target output voltage level (e.g., 13.8 kV) to one or more lower voltage levels that equipment (e.g., electric prime movers) mounted on the transports 40, 50 may utilize.”²⁴⁹ To the extent that Patent Owner argues that the “power and control systems 104” does not comprise an enclosure, it would have been obvious to a POSITA to put the control components described by *Morris* in an enclosure, for example to protect them from the elements.

324. Further, the power generated at the input voltage level is generated by “one or more power sources of electricity,” which may include “one or more turbine-electric generator transports 22 that compress and mix combustion air with hydrocarbon fuel to spin and generate mechanical energy and then converts the

²⁴⁸ Ex. 1010 (*Morris*) [0047].

²⁴⁹ Ex. 1010 (*Morris*) [0036].

mechanical energy to electricity.”²⁵⁰ A POSITA would have understood that the “turbine-electric generator transports 22” comprise, and are configured to carry, one or turbine-electric generators that actually generate the disclosed input power.

325. Thus, *Morris* discloses, or at least it would have been obvious to a POSITA based on the teachings of *Morris*, a transformer, arranged on the support structure, configured to distribute power for operation of the electric powered, multi-plunger pump, the power being received from at least one generator at a voltage higher than an operating voltage of the electric powered pump, the transformer positioned within the enclosure as claimed in 11[c]. Accordingly, *Morris* discloses Limitation 11[c].

- e. **11[d]: “wherein the electric powered, multi-plunger pump includes an odd number of plungers configured to reduce kinematic flow ripple .”**

326. As discussed above with reference to Limitation 11[a], *Morris* discloses a quintuplex (five-plunger) pump powered by an electric motor. A POSITA would have understood that *Morris*’s pump is “configured to reduce kinematic flow ripple.” It was well-known in the art that kinematic flow ripple, as indicated by flow variation/pulsations, is reduced by (1) using an odd number of cylinders/plungers and (2) increasing the number of cylinders/plungers of a displacement pump (such

²⁵⁰ Ex. 1010 (*Morris*) [0035].

as a plunger pump). For example, as discussed above regarding Claims 6 – 8, *Karassik* discloses the use of an odd number of plungers (3,5,7,9), as shown in Table 5 of *Karassik*.

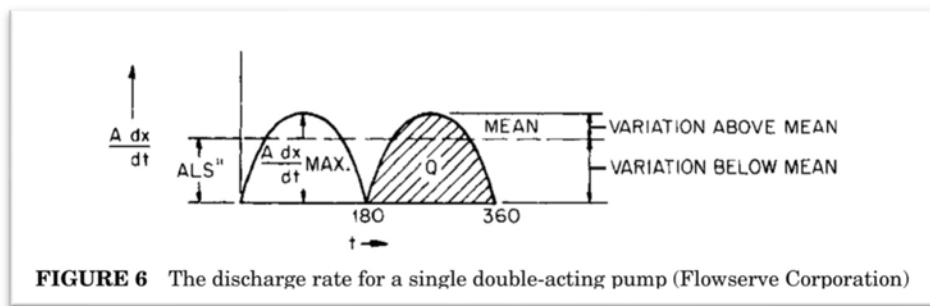
TABLE 5 The pulses per revolution and pulse amplitude for various pump types			
Pump Type	No. of Cylinders	Pulses per Rev.	Pulse Amplitude
Duplex, double-acting	4	8	+24% – 22%
Triplex, single-acting	3	6	+ 6% – 17%
Quintuplex, single-acting	5	10	+ 2% – 5%
Septuplex, single-acting	7	14	+1.2% – 2.6%
Nonoplex, single-acting	9	18	+0.6% – 1.5%

Ex. 1013 (*Karassik*) Table 5

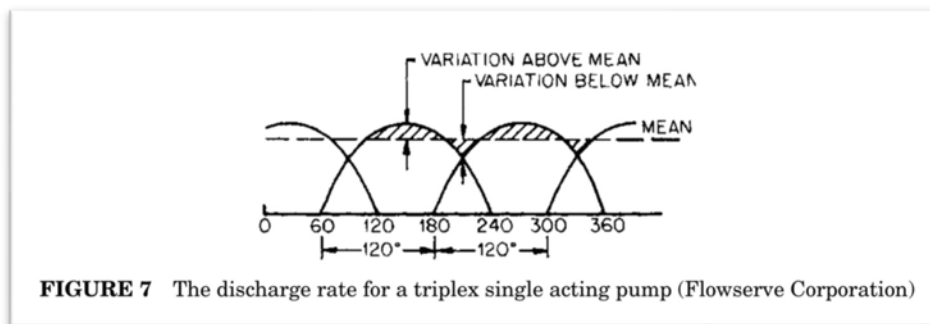
327. *Karassik* also teaches “[t]he pulsating characteristics of the fluid flowing into and out of power pumps are significantly influenced by the number of plungers or pistons. Discharge flow pulsations are the most critical because of the high energy potential generated when the system resistance reacts with the flow to create pressure. Since the magnitude of the discharge pulsation is mostly affected by the number of cylinders, increasing the number of cylinders (i.e. plungers) will reduce the flow pulsations” as would have been noted by a POSITA when viewing Table 5.²⁵¹

²⁵¹ Ex. 1013 (*Karassik*) pg 3.10

328. *Karassik* further teaches that “Figures 6 and 7 show discharge rates for two types of pumps. Tables 8 and 9 show how variations from the mean are related to the change in the number of plungers with a C [discharge capacity] of approximately 6:1. This shows that pumps with an even number of cylinders have a higher flow variation than pumps with an odd number of cylinders.”²⁵²



Ex. 1013 (*Karassik*) Figure 6



Ex. 1013 (*Karassik*) Figure 7

²⁵² Ex. 1013 (*Karassik*) 3.11 – 3.12

TABLE 8 The effect of the number of plungers on variations in capacity from the mean (C is approx. 6:1)

Type	Number of Plungers	% Above Mean	% Below Mean	Total %	Plunger Phase
Duplex	2	24	22	46	180 deg.
Triplex	3	6	17	23	120 deg.
Quadruplex	4	11	22	33	90 deg.
Quintaplex	5	2	5	7	72 deg.
Sextuplex	6	5	9	14	60 deg.
Septuplex	7	1	3	4	51.5 deg.
Nonuplex	9	1	2	3	40 deg.

Ex. 1013 (*Karassik*) Table 8

329. Thus, it was known in the art, as indicated by *Karassik*, that a multi-plunger pump that includes an odd number of plungers is configured to reduce kinematic flow ripple (pulse variations) when compared to pumps containing fewer plungers, especially those with an even number of plungers (e.g., 2 or 4 plungers).

330. Accordingly, it would have been obvious to a POSITA that *Fischer's* five-plunger pump is “*configured to reduce kinematic flow ripple*” when compared to pumps with a lower number of plungers. Thus, *Fischer* renders obvious Limitation 11[d] in view of the knowledge of a POSITA. In the alternative, *Fischer* renders obvious Limitation 11[d] in view of *Karassik* for the same reasons.

331. This understanding is consistent with the '863 Patent, which explains that a “septuplex pump may produce less kinematic flow ripple than the standard quintuplex, which is the most common pump in the oil service industry.”²⁵³

²⁵³ Ex. 1001 ('863 Patent), 2:65-3:2.

D. CLAIM 19

The hydraulic fracturing system of claim 11, wherein the motor is powered by at least one of a turbine generator, a diesel generator, a natural gas generator, grid power, or a combination thereof.

332. Claim 19 depends from Claim 11. In addition to the discussion regarding Claim 11 discussed in Section XXVII.C above and incorporated herein by reference, *Morris* discloses the additional limitation of Claim 19. For example, *Morris* discloses that “FIG. 1 is a schematic diagram of a fracturing fleet[.]. the fracturing fleet 14 includes one or more power sources 20 [annotated in red], a switch gear transport 30 [annotated in blue], a blender-hydration transport 40, and one or more fracturing pump transports 50 [annotated in yellow].”²⁵⁴ Further, *Morris* discloses that “the switch gear transport 20 [*sic* 30] receives electric power from the power sources 20 of electricity at a designated input voltage level and outputs the electric power to the power consumers or transports 40, 50.”²⁵⁵ Further still, *Morris* teaches that “the fracturing pump transport 50 receives the electric power [magenta lines] to power a prime mover (not shown). The prime mover converts electric power to mechanical power for driving one or more pumps (not shown). [i.e. prime mover

²⁵⁴ Ex. 1010 (*Morris*) [0033].

²⁵⁵ Ex. 1010 (*Morris*) [0036].

²⁵⁶ Ex. 1010 (*Morris*) [0038].

Source of electricity 20 → Switchgear transport 30 → fracturing pump transport 50 → prime mover (motor)

334. *Morris* teaches that the motor can be powered from a turbine generator. For example, *Morris* discloses that “the power source 20 of electricity can include one or more turbine-electric generator transports 22 that compress and mix combustion air with hydrocarbon fuel to spin and generate mechanical energy and then converts the mechanical energy to electricity.”²⁵⁷ Further, *Morris* teaches that the motor can be powered from grid power. For example, *Morris* discloses that “the switch gear transport 30 can receive electric power from other types of power sources, such as a power grid.”²⁵⁸

335. Accordingly, *Morris* discloses wherein the motor is powered by at least one of a turbine generator, a diesel generator, a natural gas generator, grid power, or a combination thereof. Thus, *Morris* discloses Claim 19.

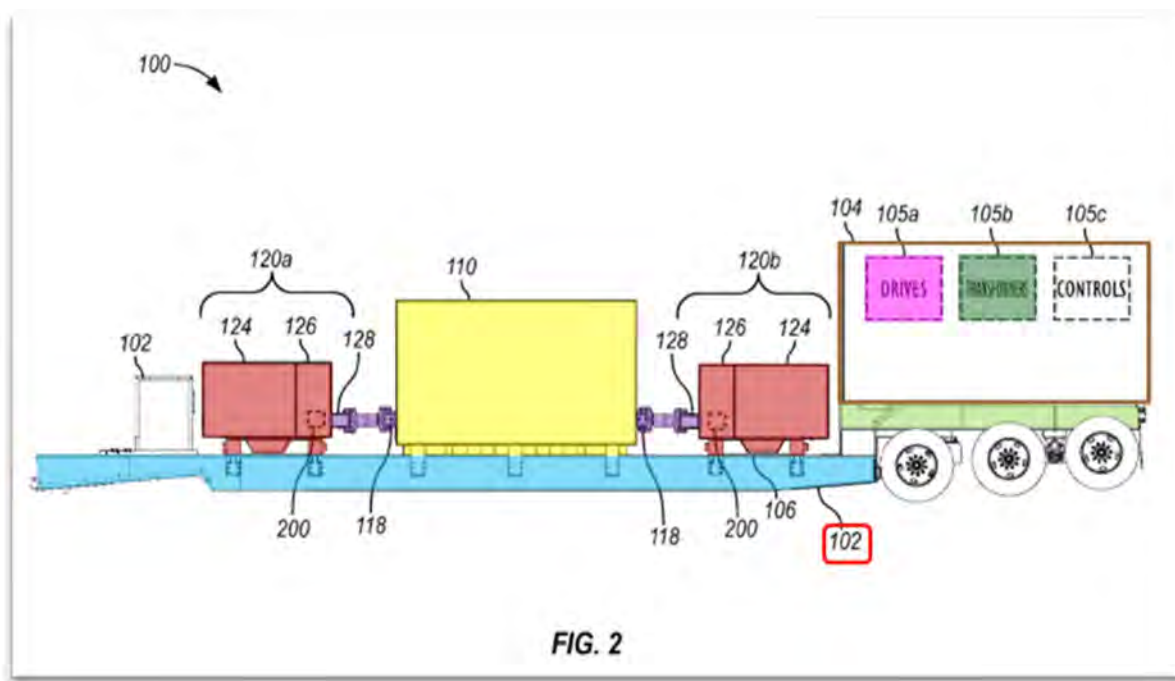
E. CLAIM 20

The hydraulic fracturing system of claim 11, wherein a first length of the support structure is less than or equal to a second length of a second support structure associated with two quintuplex pumps.

²⁵⁷ Ex. 1010 (*Morris*) [0035].

²⁵⁸ Ex. 1010 (*Morris*) [0042].

336. 256. Claim 20 depends from Claim 11. In addition to the discussion regarding Claim 11 discussed in Section XXVII.C above and incorporated herein by reference, *Morris* discloses the additional limitations of Claim 20. As discussed above regarding Claim 11, *Morris* teaches a support structure in the form of a lay down trailer 102 (annotated in red below).



Ex. 1010 (*Morris*) Fig. 2 (annotated)

337. With regard to Fig. 2, *Morris* teaches that the fracturing transport 100 (annotated in red) of Figure 2 contains “a prime mover 110” (annotated in yellow) and “pumps 12_{a-b}” (annotated in maroon) on the transport 100.²⁵⁹ *Morris* further describes that pumps 120_{a-b} are multi-plunger pumps. *Morris* teaches that “each of

²⁵⁹ Ex. 1010 (*Morris*) [0043].

the pumps 120 a-b may be a quintuplex pump [5 plungers] located on the same transport 100.”²⁶⁰

338. As discussed above with reference to Ground 2, Claim 20 appears to compare the “*first length*” of “*the support structure*” (i.e., *Morris*’s lay-down trailer) to the length of a different “*second*” support structure that is “*associated with two quintuplex pumps*.” A POSITA would have understood that such a “*second support structure*” would have been, for example, a second lay-down trailer as described by *Morris* (i.e., comprising a prime mover 110 and two pumps 120). In this configuration, the first and second lay-down trailers are identical, and therefore would have equal lengths.

339. Thus, *Morris* discloses the additional limitations of Claim 20.

XXVIII. GROUND 17: OBVIOUS OVER MORRIS IN VIEW OF KARASSIK AND OEHRING-I

A. MOTIVATION TO COMBINE

340. The motivation to combine *Morris* and *Karassik* is the same as that discussed above in Section XXVI.A. The motivation to combine *Morris* and *Oehring-I* is the same as that discussed above in Section XXIII.A. Nothing in *Oehring-I* or *Karassik* teaches away from the combination. Accordingly, a POSITA would have had a motivation to combine the teachings of *Oehring-I* with those of

²⁶⁰ Ex. 1010 (*Morris*) [0051]

Morris and Karassik, and would have a reasonable expectation of success in combining those teachings for the same reasons as those disclosed in Section XXIII.A and XXVI .A

B. CLAIM 12

The hydraulic fracturing system of claim 11, further comprising:

a slide out platform proximate the electric powered, multi-plunger pump
being driven between a retracted position and a deployed position,
wherein the deployed position provides a work area proximate the
electric powered, multi-plunger pump.

341. Claim 12 depends from Claim 11. As discussed above in Ground 12 with reference to Claim 2, the *Morris-Oehring-I* combination renders obvious “a slide out platform integrated into the first area, the slide out platform being driven between a retracted position and a deployed position, wherein the deployed position provides a work area proximate the electric powered, multi-plunger pump.” A POSITA would have further understood that because *Oehring-I*’s platform assembly “provides access to the pump” (and “provides a work area proximate the electric powered, multi-plunger pump” as recited in Claim 2) the platform assembly (“slide out platform”) itself would be “proximate the electric powered, multi-plunger pump” when incorporated in *Morris*’s pump trailer. Accordingly, *Oehring-I* discloses the

limitations of Claim 12 and Claim 12 would have been obvious to a POSITA over *Morris* in view of *Oehring-I*, the knowledge of a POSITA, and, in the alternative, *Karassik*.

XXIX. GROUND 18: OBVIOUS OVER MORRIS IN VIEW OF KARASSIK AND OEHRING-II

A. MOTIVATION TO COMBINE

342. The motivation to combine *Morris* and *Karassik* is the same as that discussed above in Section XXVI.A. The motivation to combine *Morris* and *Oehring-II* is the same as that discussed above in Section XXIV.A. Nothing in *Oehring-II* or *Karassik* teaches away from the combination. Accordingly, a POSITA would have had a motivation to combine the teachings of *Oehring-II* with those of *Morris* and *Karassik*, and would have a reasonable expectation of success in combining those teachings for the same reasons as those disclosed in Section XXIV.A and XXVI .A

B. CLAIM 13

The hydraulic fracturing system of claim 11, further comprising: a work platform proximate and external to the enclosure, the work platform providing access to the enclosure, wherein the work platform is positioned at an elevation greater than the electric powered, multi-plunger pump.

343. Claim 13 depends from Claim 11. As discussed above in Ground 13 with reference to Claim 3, the *Morris-Oehring-II* combination renders obvious incorporating *Oehring-II*'s elevated platform such that the platform is located "proximate and external to the enclosure, the work platform providing access to the enclosure."²⁶¹ As further discussed above with reference to Claim 3, the elevated platform of the combined *Morris-Oehring-II* system would be placed at the floor level of Fischer's VFD enclosure to provide operators access to the enclosure.²⁶² Because the VFD enclosure, which is located in the "second area" of *Morris*'s pump trailer, is located at an elevation greater than the elevation of the first area on which *Morris*'s "electric powered, multi-plunger pump" is mounted, a POSITA would have understood that *Oehring-II*'s elevated platform is also "positioned at an elevation greater than the electric powered, multi-plunger pump." Accordingly, *Oehring-II* discloses the limitations of Claim 13 and Claim 13 would have been obvious to a POSITA over *Morris* in view of *Oehring-II*, the knowledge of a POSITA, and, in the alternative, *Karassik*.

²⁶¹ See XXIV.B.

²⁶² See XXIV.B.

**XXX. GROUND 19: OBVIOUS OVER MORRIS IN VIEW OF KARASSIK
AND ORBAN**

A. MOTIVATION TO COMBINE

344. The motivation to combine *Morris* and *Karassik* is the same as that discussed above in Section XXVI.A. The motivation to combine *Morris* and *Orban* is the same as that discussed above in Section XXV.A. Nothing in *Orban* or *Karassik* teaches away from the combination. Accordingly, a POSITA would have had a motivation to combine the teachings of *Orban* with those of *Morris* and *Karassik*, and would have a reasonable expectation of success in combining those teachings for the same reasons as those disclosed in Section XXV.A and XXVI .A

B. CLAIM 14

The hydraulic fracturing system of claim 11, further comprising: a cooling system for the enclosure, the cooling system being a liquid cooling system thermally coupled to at least one of the VFD or the transformer.

345. Claim 14 depends from Claim 11. Except for depending from Claim 11, the limitations of Claim 14 are identical to those of Claim 4, and are disclosed for the same reasons as those discussed above in Section XXV.B. Accordingly, *Orban* discloses the limitations of Claim 14 and Claim 14 would have been obvious to a POSITA over *Morris* in view of *Orban*, the knowledge of a POSITA, and, in the alternative, *Karassik*.

C. CLAIM 15

The hydraulic fracturing system of claim 14, wherein the liquid cooling system includes water or glycol.

346. Claim 15 depends from Claim 11. Except for depending from Claim 11, the limitations of Claim 15 are identical to those of Claim 5, and are disclosed for the same reasons as those discussed above in Section XXV.C. Accordingly, *Orban* discloses the limitations of Claim 15 and Claim 15 would have been obvious to a POSITA over *Morris* in view of *Orban*, the knowledge of a POSITA, and, in the alternative, *Karassik*.

XXXI. GROUND 20: OBVIOUS OVER MORRIS, KARASSIK, THE KNOWLEDGE OF A POSITA AND, IN THE ALTERNATIVE, KARASSIK

347. As discussed below, *Karassik* renders obvious the subject matter of Claims 16-18. Because Claim 11, from which Claims 16-18 depend, is challenged based on *Morris* in view of the knowledge of a POSITA and, in the alternative, *Karassik*, Ground 10 is based on *Morris* in view of *Karassik*, the knowledge of a POSITA and, in the alternative, *Karassik*.

A. MOTIVATION TO COMBINE

348. A POSITA would have been motivated to combine *Morris* with *Karassik* for the same reasons provided above in Ground 15 (Section XXVI.A), which is incorporated herein by reference.

B. CLAIM 16

The hydraulic fracturing system of claim 11, wherein the electric powered, multi-plunger pump is a septuplex pump having seven plungers.

349. Other than depending from Claim 11, the limitations of Claim 16 are identical to those of Claim 6 and are disclosed by *Karassik* for the same reasons as those discussed above in Section XXVI.B, and incorporated herein by reference. Accordingly, the combination of *Karassik* and *Morris* render Claim 16 obvious in view of the knowledge of a POSITA and, in the alternative, *Karassik*.

C. CLAIM 17

The hydraulic fracturing system of claim 11, wherein the electric powered, multi-plunger pump includes at least one of 9 plungers or 11 plungers.

350. Other than depending from Claim 11, the limitations of Claim 17 are identical to those of Claim 7 and are disclosed by *Karassik* for the same reasons as those discussed above in Section XXVI.C, and incorporated herein by reference. Accordingly, the combination of *Karassik* and *Morris* render Claim 17 obvious in view of the knowledge of a POSITA and, in the alternative, *Karassik*.

D. CLAIM 18

The hydraulic fracturing system of claim 11, wherein the electric powered, multi-plunger pump includes more than 5 plungers.

351. Other than depending from Claim 11, the limitations of Claim 18 are identical to those of Claim 8 and are disclosed by *Karassik* for the same reasons as those discussed above in Section XXVI.D, and incorporated herein by reference. Accordingly, the combination of *Karassik* and *Morris* render Claim 18 obvious in view of the knowledge of a POSITA and, in the alternative, *Karassik*.

XXXII. SECONDARY CONSIDERATIONS

352. I am not aware of any evidence of secondary considerations that would support a finding of non-obviousness of the '863 Patent. Should the Patent Owner put forth any alleged evidence of secondary considerations, I reserve the right to consider such evidence, to consider whether any such evidence has a nexus to any claims of the '863 Patent, and to update my analysis.

XXXIII. CONCLUSION

353. All statements made herein of my own knowledge are true, and all statements made on information and belief are believed to be true. I further understand that willful false statements and the like are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the United States Code. I declare under penalty of perjury that the foregoing is true and correct.

Executed on March 5, 2025.



Dr. Robert A. Durham

Appendix A

Dr. ROBERT A DURHAM, PhD, FIEEE

Resume
Specialization
Honors & Awards
Publications

Dr ROBERT A DURHAM, PhD, FIEEE

Robert A Durham is the Principal of D² Tech Solutions, a technology related firm concentrating on Mechanical and Electrical systems and energy conversions. He also serves as a Principal Scientist of THEWAY LABs, Tulsa, OK, an engineering and energy consulting firm that provides design and failure analysis of facilities and system installations.

Dr. Durham's work experience is broad and encompasses all areas of the energy industry. Dr. Durham spent 11 years with AEP/CSW, at the time the country's largest utility, in electrical engineering positions in the power generation and transmission planning departments. He then accepted a position as Manager of Electric Infrastructure for New Dominion, LLC., a major independent energy producer in Oklahoma. Dr. Durham then moved on to hold the position of Vice President of Engineering and Project Management for EDG Power Group, an Engineering Procurement and Construction company specializing in design and construction of small to medium size power generating facilities. Dr. Durham left EDG Power Group to accept his current positions. Dr. Durham has been accepted as an expert and offered testimony in several jurisdictions.

Dr. Durham's extensive client list includes the development of a broad spectrum of forensic, electrical and facilities projects for many companies. He has also taught University offered courses in electrical engineering review for board licensure. He has published five books, six magazine articles and over 40 other technical papers and articles. Dr. Durham's extensive work on standards and electrical systems has resulted in his elevation to Fellow of the IEEE, the highest grade of recognition in the electrical technology industry.

Dr. Durham received the B.S. in electrical engineering from the University of Tulsa in 1992 and the M.E. in Technology Management from The University of Tulsa in 1997. Tulsa, OK. In 2004, Dr. Durham received a PhD in Engineering Management from Kennedy Western University.

Degrees Earned

BSEE, with Honors, The University of Tulsa
Master of Engineering, The University of Tulsa
PhD , Kennedy Western University

Area of Specialization

lightning & grounding
failure analysis & forensic engineering
electrical power systems & safety
power generation
utility industry competition
economics & management
petroleum & chemical industry
electrical / mechanical energy conversion

Registration

Professional Engineer - Oklahoma
Professional Engineer – Texas
Professional Engineer – California
Professional Engineer – New Hampshire (Inactive)
Professional Engineer – Kansas
Professional Engineer – North Carolina (Inactive)
Professional Engineer – Missouri
Professional Engineer – Arkansas
Professional Engineer – Virginia (Inactive)
Professional Engineer – Illinois (Inactive)
Electrical Contractor - Oklahoma

Work History

D² Tech Solutions, Inc. 2002 - 2022
Principal

THEWAY Corp. 2004 - 2022
Principal Scientist

EDG Power Group, Inc. 2002 - 2004
Vice President Engineering & Project Management

New Dominion, LLC 2000 - 2002
Mgr Electric Infrastructure

Central & Southwest, Inc 1989 - 2000
Electrical Engineer

Professional Memberships

Fellow	Institute of Electrical and Electronic Engineers
Diplomate	American College of Forensic Examiners, International
Member	National Association of Fire Investigators
Voting Member	National Fire Protection Institute, Electrical Section
Executive Member	Petroleum and Chemical Industry Committee, IEEE
Diplomate,	
Past Board Member	American Board of Forensic Engineering and Technology
Member	IEEE Standards Association
Past Chair	Production Subcommittee, IEEE IAS/PCIC
CFC	American College of Forensic Examiners
Member	International Association of Arson Investigators
CFEI, CVFEI	National Association of Fire Investigators
Past Chair	Tulsa Section IEEE
Chair	IEEE RP1017.1 Working Group
Chair	IEEE RP1017.2 Working Group
Chair	IEEE RP1017.3 Working Group
Chair	IEEE RP1017.4 Working Group
Past Chair	IEEE PCIC Standards Subcommittee
Secretary	IEEE Petroleum and Chemical Industry Committee

Honors and Awards

Fellow of the IEEE

For contributions to submersible electrical equipment analysis and multi-point ground method in hazardous petroleum and chemical environments.

Honor Societies

Tau Beta Pi, national engineering honors
Eta Kappa Nu, national electrical engineering honors

Dr. Durham's publications have often successfully competed for outstanding paper awards from journals of the Institute of Electrical and Electronic Engineers (PCIC and IAS). This is an

international competitive peer review and evaluation of papers that provide a significant contribution to the advancement and understanding of electrical applications.

IEEE Industry Applications Society, New Orleans, LA: Prize Article for “Data Quality and Grounding: Considerations in a Mixed Use Facility”

PCIC, Cincinnati, OH: Prize Paper for “Grounding and Bonding Conductors: Solid, Stranded, Bare or Insulated”

PCIC, New Orleans, LA: Prize paper for "Industrial Design Application for Power Distribution over Extra-Long Distances"

PCIC, Philadelphia, PA: Prize paper for "Paradigm Shifts and Impact on Engineers and Industry"

Transactions on Industry Applications, Orlando, FL: Prize Paper for "Lightning, Grounding, and Protection for Control Systems”.

PCIC, Denver, CO: Prize Paper for “Grounding System Design for Isolated Locations and Plant Systems”

PCIC, St. Louis, MO: First place for "Lightning, Grounding, and Protection for Distributed Control and Communications Systems: A Retrofit".

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Leadership and Success in Relationships and Communication, Marcus O. Durham and Robert A Durham, ISBN 978-1463758769, 2011

Leadership and Success in Organizations, Culture & Ethics: Group or Horizontal Interactions, Marcus O. Durham and Robert A Durham, ISBN 978-1466250338, 2011

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