

UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT TRIAL AND APPEAL BOARD

Intelligent Wellhead Systems

Petitioner

v.

Downing Wellhead Equipment, LLC

Patent Owner

Case No. IPR2023-00584

Patent No. 11,560,770

DECLARATION OF DR. ROBERT DURHAM

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I. INTRODUCTION

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. 11,560,770, which I may abbreviate as the “’770 Patent” or “Challenged Patent.” This declaration is a statement of my opinions on issues related to the unpatentability of claims of the ‘770 Patent. I am being compensated at my standard rate of \$305 per hour for my analysis and expense reimbursement. My compensation does not depend on the content of my opinions or the outcome of this proceeding.

II. EXPERIENCE AND QUALIFICATIONS

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 (“CV”), 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 summary of my qualifications.

4. I am a consulting engineer with experience in several technical areas. I have expertise in the electrification of the oil and gas industry from drilling and

completion to downstream. I have worked with oil field production companies, refining and chemical plants, equipment manufacturers, and technology development companies for nearly twenty years as a consultant. My work relates to the subject matter of the Challenged Patents, which I describe below in Section VII (“Overview of the Challenged Patents”).

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 exchanging 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 Vice Chair of the Standards Subcommittee of the PCIC, a role which I 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, 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 membership of IEEE worldwide.

8. I have worked directly in the 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 consulting engineer. In that role, I have worked in designing, constructing, and analyzing all kinds of power and fluid 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 nearly 50 oil and gas production wells in Oklahoma. As such, I am familiar with the operations of oil and gas wells, including well stimulation, completion, hydraulic fracturing, and production.

11. I have been familiar with oil and gas drilling, fracturing (fracking), and completion operations for nearly twenty years. In addition to being responsible for interfacing with drilling and fracturing operations about electrical needs as an employee of NDL, I have been further educated about drilling, fracturing, and operations as I have consulted and investigated incidents on multiple well drilling, fracturing, and completion pad sites over my engineering consulting engagements.

12. I have been familiar with power distribution, including generation, transmission, and distribution equipment. As an employee, I was 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 am a Principal Scientist of THE WAY Labs. Part of my responsibilities include overseeing the Health Safety and Environmental (HSE) program at THEWAY Labs, including establishing policies and procedures commensurate with Occupational Safety and Health Administration (“OSHA”) requirements at all locations, including requirement for oil and gas sites. I am familiar with 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

investigated injuries and fatalities at oil and gas locations, including drilling, fracturing, and completion operations.

14. I am familiar with valves, control systems for valves, and relief valve systems for my entire practice. I have designed and supervised the installation of such systems, including relief valves, control valves, and control systems for valves in applications including water handling, steam handling, liquid oil handling, natural gas handling, and other fluids. I have studied the operation of valves and relief valve systems as part of these control systems for over 30 years.

15. I authored or co-authored 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 Challenged Patent at issue here and have been an expert in this field since before the Challenged 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 ’609 Patent at the time of its filing.

III. 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”).

IV. 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. 11,560,770 by Jordan Kuehn <i>et al.</i> entitled “Hydraulic Fracturing Plan and Execution of Same” (the “770 Patent”)
1002	Declaration of Dr. Robert Durham
1003	U.S. Patent Publication 2022/0268141 A1 by Andrew Krupa <i>et al.</i> entitled “System and Method for an Automated and Intelligent Frac Pumping” (“Krupa”)
1004	U.S. Patent Publication 2019/0233275 A1 by Jared Micheal Carr <i>et al.</i> entitled “Method and Apparatus for Metering Flow during Centralized Well Treatment” (“Carr”)

1005	PCT International Patent Application Publication WO2020/145978 A1 by Beuterbaugh <i>et al.</i> entitled “Simulfrac Pulsed Treatment” (“ <i>Beuterbaugh</i> ”)
1006	U.S. Patent 8,490,685 B2 by Randy Tolman <i>et al.</i> entitled “Method and Apparatus Associated with Stimulation Treatments for Wells” (“ <i>Tolman</i> ”)
1007	U.S. Patent Publication 2007/0023184 A1 by Robert Jackson <i>et al.</i> entitled “Well Product Recovery Process” (“ <i>Jackson</i> ”)
1008	First Amended Complaint for Patent Infringement, Permanent Injunctive Relief Requested and Demand for Jury Trial, (ECF No. 29); <i>Downing Wellhead Equipment, LLC v. Intelligent Wellhead Systems, Inc., et al.</i> , No. 1:23-cv-01180 (D. Colo.) (“the Litigation”)
1009	Jacobs, Trent. “The Shale Evolution: Zipper Fracture Takes Hold,” J Pet Technol 66 (2014): 60–67. Doi: https://doi.org/10.2118/1014-0060-JPT
1010	’770 Prosecution History
1011	Patent Family Priority Diagram
1012	Patent Family Specification Comparisons
1013	’779 Prosecution History
1014	Downing’s Objections and Responses to IWS’s First Set of Interrogatories in the Litigation
1015	Michael Morton, “Unlocking the Earth: A Short History of Hydraulic Fracturing,” GEO ExPro, Vol. 10, No. 6, December
1016	B.A. Wells and K.L. Wells. “Shooters – A “Fracking” History.” American Oil & Gas Historical Society, (https://aoghs.org/technology/hydraulic-fracturing) (last accessed November 30, 2023)

1017	Carl T. Montgomery and Michael B. Smith, "Hydraulic Fracturing: History of an Enduring Technology," Journal of Petroleum Technology, Vol. 62, Issue 12 (Dec. 2010).
1018	Bourgoyne, A. T., Jr., K. K. Millheim, M. E. Chenevert and F. S. Young, Jr. (1986). Applied Drilling Engineering, Society of Petroleum Engineers.
1019	Vassiliou, M. S. (2018), Historical dictionary of the petroleum industry, Rowman & Littlefield
1020	U.S. Patent Application Publication No. 2013/0306322 to Sanborn et al. entitled "System and Process for Extracting Oil and Gas by Hydraulic Fracturing" ("Sanborn")
1021	U.S. Patent Publication No. 2012/0255734 to Coli et al. ("Coli") entitled "Mobile, Modular, Electrically Powered System for Use in Fracturing Underground Formations"
1022	Waters, George, Dean, Barry, Downie, Robert, Kerrihard, Ken, Austbo, Lance, and Bruce McPherson. "Simultaneous Hydraulic Fracturing of Adjacent Horizontal Wells in the Woodford Shale." Paper presented at the SPE Hydraulic Fracturing Technology Conference, The Woodlands, Texas, January 2009. doi: https://doi.org/10.2118/119635-MS ("Waters")
1023	Pearson, C.M., Bond, A.J., Eck, M.E., and J.H. Schmidt. "Results of Stress-Oriented and Aligned Perforating in Fracturing Deviated Wells." J Pet Technol 44 (1992): 10–18. doi: https://doi.org/10.2118/22836-PA
1024	Mutalik, P N, and Bob Gibson. "Case History of Sequential and Simultaneous Fracturing of the Barnett Shale in Parker County." Paper presented at the SPE Annual Technical Conference and Exhibition, Denver, Colorado, USA, September 2008. doi: https://doi.org/10.2118/116124-MS ("Mutalik")
1025	Mayerhofer, M. J., Lonon, E. P., Warpinski, N. R., Cipolla, C. L., Walser, D., and C. M. Rightmire. "What is Stimulated Reservoir

	Volume (SRV)?" Paper presented at the SPE Shale Gas Production Conference, Fort Worth, Texas, USA, November 2008. doi: https://doi.org/10.2118/119890-MS (“Mayerhofer”)
1026	Roussel, Nicolas P., and Mukul M. Sharma. “Optimizing Fracture Spacing and Sequencing in Horizontal-Well Fracturing.” SPE Prod & Oper 26 (2011): 173–184. doi: https://doi.org/10.2118/127986-PA (“Roussel”)
1027	K. R. Webster, W. C. Goins, Jr., and S. C. Berry, "A Continuous Multistage Tracing Technique," Journal of Petroleum Technology, vol. 17, no. 06, pp. 619-625, 1965, doi: 10.2118/977-pa. (“Webster”)
1028	A. Casero, G. Pace, B. Malone, F. Cantaloube, L. Tealdi, H. Malonga, and R. Seale, “Continuous Pumping, Multistage, Hydraulic Fracturing in Kitina Field, Offshore Congo, West Africa,” in SPE International Symposium and Exhibition on Formation Damage Control, 2008, vol. All Days, SPE-112442-MS, doi: 10.2118/112442-ms. [Online]. Available: https://doi.org/10.2118/112442-MS (“Casero”).
1029	S. Rassenfoss, "A Look Into What Fractures Really Look Like," Journal of Petroleum Technology, vol. 70, no. 11, pp. 28-36, 2018, doi: 10.2118/1118-0028-jpt. at 6 (“Rassenfoss”).
1030	R. Oberhofer, “Application of Ball-Drop Technology to Improve Efficiency and Stimulation of Limited Entry Completion Systems,” in Abu Dhabi International Petroleum Exhibition & Conference, 2016, vol. Day 2 Tue, November 08, 2016, D021S052R004, doi: 10.2118/183427-ms. [Online]. Available: https://doi.org/10.2118/183427-MS (“Oberhofer”).
1031	Tolman, R. C., et al. (2009). Method and Apparatus for Simultaneous Stimulation of Multi-Well Pads. SPE Hydraulic Fracturing Technology Conference (“Tolman Article”).
1032	G. R. Holzhausen and R. P. Gooch, "Impedance of Hydraulic Fractures: Its Measurement and Use for Estimating Fracture Closure Pressure and Dimensions," in SPE/DOE Low Permeability Gas Reservoirs Symposium, 1985, vol. All Days, SPE-13892-MS, doi:

	10.2118/13892-ms. [Online]. Available: https://doi.org/10.2118/13892-MS (“Holzhausen”).
1033	R. W. Paige, L. R. Murray, and J. D. M. Roberts, "Field Application of Hydraulic Impedance Testing for Fracture Measurement," SPE Production & Facilities, vol. 10, no. 01, pp. 7-12, 1995, doi: 10.2118/26525-pa (“Paige”).
1034	L. V. Massaras, A. Dragomir, and D. Chiriac, “Enhanced Fracture Entry Friction Analysis of the Rate Step-Down Test,” in SPE Hydraulic Fracturing Technology Conference, 2007, vol. All Days, SPE-106058-MS, doi: 10.2118/106058-ms. [Online]. Available: https://doi.org/10.2118/106058-MS (“Massaras”).
1035	S. Mondal, "Pressure transients in wellbores: Water hammer effects and implications for fracture diagnostics," 2010 (“Mondal”).
1036	PCT International Patent Application Publication WO2017/201526 A1 by Ciezobka et al. entitled “Hydraulic Fracturing System and Method” (“Ciezobka”)
1037	U.S. Patent Publication 2007/0125543 A1 by McNeel et al. entitled “Method and Apparatus for Centralized Well Treatment” (“McNeel”)
1038	Excerpts from Downing’s Response to IWS’s Initial Invalidity Contentions in the Litigation, dated January 19, 2024
1039	Downing’s Supplemental Objections and Responses to IWS’s First Set of Interrogatories in the Litigation
1040	Order on Motion to Stay in The Litigation, dated Feb. 14, 2023
1041	Declaration of Dr. Robert Durham
1042	<i>Intelligent Wellhead Systems, Inc. v. Downing Wellhead Equipment, LLC</i> , IPR2024-00256, Petition for <i>Inter Partes</i> Review of U.S. Patent No. 11,401,779 (Paper 1)

1043	<i>Intelligent Wellhead Systems, Inc. v. Downing Wellhead Equipment, LLC</i> , IPR2024-00300, Petition for <i>Inter Partes</i> Review of U.S. Patent No. 11,560,770 (Paper 1)
1044	API 6A 20th Edition, Specification for Wellhead and Christmas Tree Equipment, October 2010
1045	Downing Infringement Contentions from The Litigation, dated September 27, 2023

19. Other than citations to the prosecution history, Ex 1010 all citations to exhibits reference original page numbers found in the underlying document, and all emphases are added.

V. **SUMMARY OF CONCLUSIONS AND GROUNDS FOR CHALLENGE**

20. After reviewing the materials identified in the List of Exhibits, I have concluded that each of the Challenged Claims of the '770 Patent would have been anticipated and/or obvious to a person of ordinary skill in the art based on the following grounds. I explain and show below why each of the Challenged Claims is unpatentable in the detailed discussion of Grounds 1-3. I've considered each claim as a whole but have addressed each subpart separately for ease of discussion.

Ground	'770 Claims	Basis for Challenge
1	1, 2, 4-13	Anticipated by Ciezobka
2	1-38	Obvious over Ciezobka
3	2, 3, 14-38	Obvious over Ciezobka in view of McNeel

VI. LEGAL STANDARDS

A. LEVEL OF ORDINARY SKILL IN THE ART

21. 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.

22. I have been instructed by counsel that the 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

23. 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.

24. 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.

25. It is my understanding that in proceedings before the USPTO, the claims of a patent are to be construed under what is referred to as the “*Phillips* standard.” I understand that this means that claim terms of a patent are given the meaning the terms would have to a POSITA, in view of the description provided in the patent itself and the patent’s file history.

26. I understand that to determine how a person of ordinary skill would have understood 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. I understand that, in construing a claim term, 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.

27. 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.

28. 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

29. It is my understanding that the claims of a patent are anticipated by a prior art reference 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

30. 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 disclose 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 need not be explicit in any of the prior art but 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).

31. 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.

32. 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.

33. 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.

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

35. 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.

36. 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

37. 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.

38. 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 at the earlier patent application and ascertaining whether that earlier patent application meets both the written description and enablement requirements as of the earlier application's filing date. I understand that it is not enough that the claim would have been obvious from the earlier application but that the earlier application itself must describe the claimed invention.

39. 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 or 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.

40. I also understand that in order 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.

F. INDEPENDENT AND DEPENDENT CLAIM ANALYSIS

41. I understand that an independent claim does not refer to any preceding claim. The '770 Patent includes numerous dependent claims that refer to the independent claims. Further, I understand that each dependent claim depends from an independent claim or from another dependent claim. I understand that, as a result,

each dependent claim incorporates all of the elements of the claim(s) that it refers to. Therefore, in my analysis of the dependent claims, my analysis of the claim(s) from which they depend is also incorporated.

VII. OVERVIEW OF THE CHALLENGED PATENT

42. I have reviewed the '770 Patent, which is entitled "Hydraulic Fracturing Plan and Execution of Same" (Ex. 1001). I have also reviewed the prosecution history of the '770 Patent (Ex. 1010). I understand that the patent was filed on August 1, 2022, and issued on January 24, 2023. The '770 Patent claims priority to several other documents. Still, as I discuss below in the "Priority Date of the '770 Patent" section, those earlier documents do not support all claim limitations of the '770 Patent.

A. THE SUBJECT MATTER OF THE CHALLENGED PATENT

43. The '770 Patent generally relates communicating fluid to a first well via a first valve and a manifold and a sequence of opening/closing valves in response to determining "one or more conditions" of the fluid has been satisfied. Although the specification describes hydraulic fracturing operations of subterranean formations, at least the independent claims are not limited to hydraulic fracturing operations. The '770 Patent includes a section entitled "Background" that describes the Patent application as relating "generally to oil and gas hydraulic fracturing

applications.”¹ The ’770 Patent does not describe the Prior Art or State of the Art of Fracturing Systems at the time of the application or how the claimed embodiments improve upon the Prior Art.

B. THE CHALLENGED CLAIMS OF THE ’770 PATENT

44. The Challenged Claims of the ’770 Patent, which are Claims 1-38, are set forth below. Some of the claim elements have been further subdivided (and labeled as part “1.1”, “1.2,” or similar, where the first number indicates the claim number and the following decimals refer to sub-parts of that claim) for ease of reference.

Claim Limitation	Claim Language from ’770 Patent
1.1	1. A method, comprising: communicating fluid to a first well via a manifold and a first valve, the first valve being associated with both the manifold and the first well; and
1.2	in response to determining that the fluid communicated via the manifold has satisfied one or more conditions:
1.3	opening a second valve; communicating fluid to a second well via the second valve; and
1.4	closing the first valve after opening the second valve.
2.1	2. The method of claim 1, further comprising: communicating fluid to a third well via the manifold and a third valve, the third valve being associated with both the manifold and the third well; and

¹ Ex. 1001 2:10-14.

Claim Limitation	Claim Language from '770 Patent
2.2	in response to determining that the fluid communicated via the manifold has satisfied the one or more conditions:
2.3	opening a fourth valve; communicating fluid to a fourth well via the fourth valve; and
2.4	closing the third valve after opening the fourth valve.
3.1	3. The method of claim 2, wherein: the first valve is closed after opening both the second valve and the fourth valve; and/or
3.2	the third valve is closed after opening both the second valve and the fourth valve.
4	4. The method of claim 1, wherein the one or more conditions include one or more flow rate conditions.
5	5. The method of claim 4, wherein the fluid communicated via the manifold has satisfied the one or more flow rate conditions when a flow rate of the fluid is below an upper threshold, above a lower threshold, or both.
6	6. The method of claim 4, wherein the fluid communicated via the manifold has not satisfied the one or more flow rate conditions when a flow rate of the fluid is above an upper threshold or below a lower threshold.
7	7. The method of claim 1, further comprising: pumping the fluid into the manifold.
8	8. The method of claim 1, further comprising: determining that the fluid communicated via the manifold has satisfied the one or more conditions.
9	9. The method of claim 8, wherein determining that the fluid communicated via the manifold has satisfied the one or more flow

Claim Limitation	Claim Language from '770 Patent
	rate conditions comprises determining that a flow rate of the fluid is below an upper threshold, above a lower threshold, or both.
10	10. The method of claim 1, wherein the fluid communicated via the manifold is hydraulic fracturing fluid.
11	11. The method of claim 1, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.
12.1	12. The method of claim 1, wherein the second valve is associated with both the manifold and the second well; and
12.2	wherein communicating fluid to the second well via the second valve comprises communicating fluid to the second well via the manifold and the second valve.
13	13. The method of claim 12, wherein the fluid communicated via the manifold is hydraulic fracturing fluid.
14.1	14. An apparatus, comprising: a non-transitory computer readable medium; and a plurality of instructions stored on the non-transitory computer readable medium and executable by one or more processors, wherein, when the instructions are executed by the one or more processors, the following steps are executed:
14.2	communicating fluid to a first well via a manifold and a first valve, the first valve being associated with both the manifold and the first well; and
14.3	in response to determining that the fluid communicated via the manifold has satisfied one or more conditions:
14.4	opening a second valve; communicating fluid to a second well via the second valve; and
14.5	closing the first valve after opening the second valve.

Claim Limitation	Claim Language from '770 Patent
15.1	15. The apparatus of claim 14, wherein, when the instructions are executed by the one or more processors, the following steps are also executed: communicating fluid to a third well via the manifold and a third valve, the third valve being associated with both the manifold and the third well; and
15.2	in response to determining that the fluid communicated via the manifold has satisfied the one or more conditions:
15.3	opening a fourth valve;
15.4	communicating fluid to a fourth well via the fourth valve; and
15.5	closing the third valve after opening the fourth valve.
16.1	16. The apparatus of claim 15, wherein: the first valve is closed after opening both the second valve and the fourth valve; and/or
16.2	the third valve is closed after opening both the second valve and the fourth valve.
17	17. The apparatus of claim 14, wherein the one or more conditions include one or more flow rate conditions.
18	18. The apparatus of claim 17, wherein the fluid communicated via the manifold has satisfied the one or more flow rate conditions when a flow rate of the fluid is below an upper threshold, above a lower threshold, or both.
19	19. The apparatus of claim 17, wherein the fluid communicated via the manifold has not satisfied the one or more flow rate conditions when a flow rate of the fluid is above an upper threshold or below a lower threshold.

Claim Limitation	Claim Language from '770 Patent
20	20. The apparatus of claim 14, wherein, when the instructions are executed by the one or more processors, the following step is also executed: pumping the fluid into the manifold.
21	21. The apparatus of claim 14, wherein, when the instructions are executed by the one or more processors, the following step is also executed: determining that the fluid communicated via the manifold has satisfied the one or more conditions.
22	22. The apparatus of claim 21, wherein determining that the fluid communicated via the manifold has satisfied the one or more flow rate conditions comprises determining that a flow rate of the fluid is below an upper threshold, above a lower threshold, or both.
23	23. The apparatus of claim 14, wherein the fluid communicated via the manifold is hydraulic fracturing fluid.
24	24. The apparatus of claim 14, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.
25.1	25. The apparatus of claim 14, wherein the second valve is associated with both the manifold and the second well; and
25.2	wherein communicating fluid to the second well via the second valve comprises communicating fluid to the second well via the manifold and the second valve.
26	26. The apparatus of claim 25, wherein the fluid communicated via the manifold is hydraulic fracturing fluid.
27.1	27. A system, comprising: a first valve via which fluid is communicated from a manifold to a first well;
27.2	a second valve via which fluid is adapted to be communicated to a second well; and
27.3	one or more controllers, configured to:

Claim Limitation	Claim Language from '770 Patent
27.4	open the second valve to thereby communicate fluid to the second well via the second valve; and
27.5	close the first valve after opening the second valve,
27.6	in response to: determining that the fluid communicated via the manifold has satisfied one or more conditions.
28.1	28. The system of claim 27, further comprising: a third valve via which fluid is communicated from the manifold to a third well;
28.2	a fourth valve via which the fluid is adapted to be communicated to a fourth well; and
28.3	the one or more controllers, configured to: open the fourth valve to thereby communicate fluid to the fourth well via the fourth valve; and
28.4	close the third valve after opening the fourth valve,
28.5	in response to: determining that the fluid communicated via the manifold has satisfied the one or more conditions.
29.1	29. The system of claim 28, wherein the one or more controllers are further configured to: close the first valve after opening both the second valve and the fourth valve; and/or
29.2	close the third valve after opening both the second valve and the fourth valve.
30	30. The system of claim 27, wherein the one or more conditions include one or more flow rate conditions.
31	31. The system of claim 30, wherein the fluid communicated via the manifold has satisfied the one or more flow rate conditions when a flow rate of the fluid is below an upper threshold, above a lower threshold, or both.

Claim Limitation	Claim Language from '770 Patent
32	32. The system of claim 30, wherein the fluid communicated via the manifold has not satisfied the one or more flow rate conditions when a flow rate of the fluid is above an upper threshold or below a lower threshold.
33	33. The system of claim 27, further comprising the manifold.
34.1	34. The system of claim 27, further comprising one or more pumps;
34.2	wherein the one or more controllers are further configured to cause the one or more pumps to pump the fluid into the manifold.
35	35. The system of claim 27, wherein the fluid communicated via the manifold is hydraulic fracturing fluid.
36	36. The system of claim 27, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.
37.1	37. The system of claim 27, wherein the second valve is associated with both the manifold and the second well; and
37.2	wherein communicating fluid to the second well via the second valve comprises communicating fluid to the second well via the manifold and the second valve.
38	38. The system of claim 37, wherein the fluid communicated via the manifold is hydraulic fracturing fluid.

C. PROSECUTION HISTORY OF THE '770 PATENT

45. I have reviewed the prosecution history of the '770 Patent. In this section, I summarize the prosecution history of the '770 Patent. The '770 Patent was filed as U.S. Application No. 17/878,493 (the "'493 Application") on August 1,

2022, as a continuation application of U.S. Application No. 17/388,716 (the “Parent Application” or the “’716 Application”). The Parent Application was issued as U.S. Patent No. 11,401,779 (the “’779 Patent”) after its claims were found allowable for including limitations “similar to” or directed to “determining that the flow rate of the fluid being pumped into the first well is below a flow rate threshold and has been below the flow rate threshold for a threshold amount of time.”²

46. The ’493 Application was filed with claims similar to the Parent Application claims such that the claims recite a sequence of opening/closing valves, but the ’493 Application claims were much broader than the claims presented and/or allowed in the Parent Application. Notably omitted from the ’493 Application Independent Claims were the allowable “flow rate thresholds” elements from the Parent Application. Additionally, the ’493 Application claims are not limited to hydraulic fracturing, continuous pumping, method/apparatus/system that includes a common manifold, common flowlines, or a common fluid, or thresholds for determining or taking subsequent steps. In addition to a broader set of new claims being presented in the ’493 Application, a new Examiner was assigned to examine the claims under an “expedited” examination request.

47. In the only Office Action presented during the prosecution of the ’493 Application, the Examiner rejected the claims on the ground of non-statutory double

² Ex. 1013, p. 110, 116.

patenting as being “not patentably distinct” from the ’779 Patent.³ In response, the Applicant filed a terminal disclaimer and added new claims 31-38, each of which depended from one of the indicated allowable independent claims. A Notice of Allowance was then issued. The Examiner stated that the claims were allowable because the prior art of record failed to disclose: “‘in response to determining that the fluid communicated via the manifold has satisfied one or more conditions: opening a second valve’ in combination with the other limitations,” or “close the first valve after opening the second valve, in response to determining that the fluid communicated via the manifold has satisfied one or more conditions” in combination with the other limitations.”⁴ The ’493 Application was issued as the ’770 Patent on January 24, 2023.

D. PRIORITY DATE OF THE ’770 PATENT

48. I have reviewed the filing history of the ’770 Patent and related applications. For the ’770 Patent, the Application Data Sheet (ADS) filed along with the ’493 Application indicated that the application was a continuation of the ’716 Application (filed July 29, 2021), claimed the benefit of U.S. Provisional Application No. 63/189,663 (the “’663 Provisional”), which was filed May 17, 2021,

³ Ex. 1010 at 3-4.

⁴ Ex. 1010 at 2.

and also indicated that the '716 Application was a “continuation-in-part”⁵ of U.S. Application No. 17/319,854 (“the '854 Application”), which was filed May 13, 2021.⁶ The ADS for the '463 Application also indicated the '463 Application claimed the benefit of a long family chain of the '854 Application.

49. As discussed, the '770 Patent claims the benefit of the '663 Provisional”, which was filed May 17, 2021, and is a continuation of the '716 Application which is a CIP of the '854 Application,” which was filed May 13, 2021. The '854 Application purports to claim priority to seven non-provisional applications, each being related through CIP filings. The '854 Application and the seven parent non-provisional applications are collectively referred to as the “CIP parent applications.” The '854 Application also claims priority to nine provisional applications, collectively referred to as the “parent provisional applications.”

50. Except for some generic background language, the '779 and '770 Patents do not contain any copied portions of the CIP parent applications or the parent provisional applications. Instead, the specifications of the '779 and '770 Patents contains originally drafted descriptions of valve operations for a plurality of

⁵ The ADS originally filed with the '716 Application indicated the '716 Application was a “continuation” of the '854 Application. After prosecution of the '716 Application closed on the merits, Patent Owner filed a corrected ADS to change the '716 Application from a “continuation” application to a “continuation-in-part” (“CIP”) application and amended the specification to reflect the same.

⁶ Ex. 1010 at 1.

wells and fracturing systems and methods, including detailed descriptions of frac legs and associated valves and wells, and operations thereof.

51. The CIP parent applications and the parent provisional applications are not related to and do not disclose valve sequencing for multiple wells or valve sequencing in response to determining that the fluid communicated via the manifold has satisfied one or more conditions. Further, some of the CIP parent applications and parent provisional applications do not even disclose multiple well fracturing systems or operations, such as parent applications titled “Unibody valve and methods of using the valve” and “Method of operating a valve and extending an object through the valve and into a well,” which are instead directed to valve assemblies for passing objects into a well, and parent applications titled “Delivering and metering grease to process valves” and “Grease system for valves used in oil and gas operations,” which are directed to valve greasing systems.

52. I understand that to rely on a parent application’s filing date, the parent application must disclose each element of the claim to an extent where it is clear the inventor had possession of the claimed invention at the time of the parent application. I have also been instructed that only subject matter which is actually or inherently disclosed in a parent application is entitled to the parent application’s filing date. The subject matter that is obvious over the parent application’s disclosure is not entitled to the parent application’s filing date.

53. Because none of the CIP parent applications or the parent provisional applications disclose all the limitations in claims of the '770 Patent, the claims are not entitled to any of the claimed earlier filing dates of the CIP parent applications or the parent provisional applications. Therefore, the earliest priority date to which any claim of the '770 Patent is entitled is that of the '663 Provisional: May 17, 2021.

54. Additionally, I understand that Downing, in response to interrogatories in the parallel district court litigation, admitted that the “earliest effective filing date” of the challenged claims is May 17, 2021. *See* Ex. 1039.

55. That being said, it is also possible that certain claims of the '770 Patent are not even entitled to claim priority as far back as to the '663 Provisional filing date of May 17, 2021. Depending on claim construction, for example, support for certain claim limitations may not be found in the '663 Provisional, in which case, the earliest priority date to which the claims of the '770 Patent may be entitled could be the filing date of the '779 Patent, July 2021.

56. I am also aware that on January 19, 2024, after having seen IWS's invalidity contentions in the parallel district court litigation, and after having seen IWS's prior art and arguments in related IPRs (IPR2024-00256 and IPR2024-00300), Downing took the position that Downing made a public disclosure of the invention claimed in the '779 and '770 Patents as early as September 1, 2020. Ex. 1039. Assuming only for the sake of argument this is true, and to be clear, I do not

agree that Downing's evidence qualifies as a public disclosure based on my understanding of a public disclosure under the patent laws, then additional references that disclose, teach, and/or suggest the limitations of the claims of the '770 Patent beyond those explored in the first IPR petition can be examined, as discussed further in this declaration.

E. COMPARISON OF ASSERTED REFERENCES TO PRIOR ART DISCUSSED DURING PROSECUTION

57. I have been asked to analyze the technical references that I understand Petitioner is asserting as prior art (*Ciezobka* and *McNeel*) and to compare them to the references cited by the USPTO Examiner during prosecution of the '770 Patent.

58. **Primary references:** I have relied upon *Ciezobka* as the base (or primary) reference.

59. **Secondary references:** I have relied upon *McNeel* as the secondary reference, along with the knowledge of a person of ordinary skill in the art, which are used in combination with the primary references.

60. None of the above references were considered during prosecution of the '770 Patent. Accordingly, the prior art grounds discussed in this declaration are different from any prior art ground considered by the Examiner.

VIII. LEVEL OF ORDINARY SKILL IN THE ART

61. A person of ordinary skill in the art would have a Bachelor of Science in Engineering and at least two years of academic or industry experience in the oil

and gas industry, including well-related operations experience, such as well drilling, completion, or production. Additional education could offset experience and vice versa. I meet this standard.

IX. CLAIM CONSTRUCTION

62. In the sections below, I have sought to provide the ordinary and customary meaning of claim terms using the principles I discuss above in the Legal Standards section.

63. I do not believe any claim terms of the '770 Patent need to be construed to assess whether the prior art reads on the challenged claims.⁷

X. TECHNOLOGY BACKGROUND AND STATE OF THE ART

64. In the subsections below, I describe some of the basic principles of engineering that would be used, or at least considered for use, in the field of oil and gas operations and, in particular, wellhead control.

A. DRILLING AND DIRECTIONAL DRILLING

65. Oil and gas exploration and production operations depend on identifying, locating, and collecting hydrocarbon (i.e., oil and gas (natural gas))

⁷ I reserve the right to raise or address claim construction of the claims of the '770 Patent and other arguments in district court. For example, all challenges to the '770 Patent are not raised in the petition, including, for example, validity under 35 U.S.C. 112, and controversies may arise during litigation that require resolution through claim construction not presented here because of the similarities between the prior art and the '770 Patent.

reserves for sale, use as a fuel, for lubrication, or the development of chemicals, pharmaceuticals, and plastics used in modern society. For most of human history, petroleum products such as natural asphalts, coal, and surface seeps of oil have been used for various purposes, including paving, construction, waterproofing of boats, and fuel. Mostly, these materials were naturally occurring on the earth's surface and were collected by digging the materials up and transporting them for use. However, Some hydrocarbon reservoirs are located beneath the earth's surface and must be reached by some type of well-drilling technique. The first recorded petroleum wells were drilled circa 347 AD during the Jin dynasty in modern-day China. These were percussion-type wells similar to cable tool drilling, widely used in the 1800s. Modern oil and gas production depends heavily on drilled wells to reach hydrocarbon-bearing formations below the earth's surface.

66. In 1859, Edwin Drake drilled the first commercial oil well in the United States near Titusville, PA. This well was drilled with a cable-tool percussion drilling rig and struck oil at a depth of 69 feet. A cable tool drilling rig uses a heavy chisel-type tool suspended from cable (usually rope) and repeatedly dropped to chip away at the rock formation. After a certain amount of rock has been chipped, a bucket-type tool (bailer) is lowered to collect and remove the rock chips. The use of cable-tool rigs was widespread through the end of the 19th century. This technique led to the discovery of many large oil and gas fields in the United States, including the NW

Pennsylvania fields, Pico Canyon and Los Angeles fields in California, the Neodesha fields in Kansas (Norman No 1), and the Bartlesville-Dewey field in Oklahoma (Nellie Johnstone No. 1).

67. Rotary drilling techniques, where a drill stem is spun, and a drill bit cuts into the rock, had been used as far back as the Egyptian era but had limited use until Howard Hughes invented the roller cone drill bit in 1908. In a rotary drilling system, the drill bit cuts or pulverizes the rock. A fluid, known as drilling mud, is circulated down the hollow drill stem, out orifices in the bit, and then up the annulus, or the area between the drill stem and the wellbore walls. The drilling mud serves the dual purpose of lubricating and cooling the bit teeth and grinding surfaces, as well as carrying residue from the drilling process out of the hole and to the surface where it is observed for its characteristics (logged), collected (shale shakers) and discarded.

68. The drilling mud is pumped by relatively large positive displacement pumps, often plunger pumps. Plunger pumps pump the same fluid volume with each stroke, regardless of the discharge pressure. Discharging pressure from these pumps is a function of the fluid resistance of the system, along with the speed of the pump. The higher the resistance, the higher the discharge pressure for the same flow rate being pumped.

B. HISTORY OF HYDRAULIC FRACTURING

69. Fracturing the hydrocarbon-bearing formations is a technique that has been used to increase or speed up oil and gas production for nearly as long as oil and gas production has existed. As early as the 1850s, fracturing methods used explosives such as gunpowder ignited by red-hot iron or nitroglycerin “torpedoes.” Hydraulic fracturing, in its modern form of pumping liquids and proppants (e.g., sand) into the formation, began in the 1940s using a process developed by Stanolind Oil and used by Halliburton in the mid-continent region. Early hydraulic fracturing in the 1940s and 1950s used frac pumps, including pumps that could operate at around 1500 hp. On March 17, 1949, Stanolind and Haliburton performed the first commercial application of hydraulic fracturing at a location about 12 miles east of Duncan, Oklahoma.

70. The expansion of directional and horizontal drilling extended the use of hydraulic fracturing into previously underdeveloped “tight” formations, including shale. In oil and gas exploration, directional drilling is a technique for accessing hydrocarbon-bearing formations (oil and gas formations) that are not located immediately beneath the surface location or to increase the amount of formation exposed to the wellbore. Some tool or process is used to cause the wellbore to deviate from the vertical to reach previously inaccessible formation locations, to expose more of the hydrocarbon-bearing formation to the wellbore, or to drill several

wells from a single surface location, such as an offshore platform or a land-based drilling pad. Like most oil and gas industry developments, “the early drilling of directional wells was clearly motivated by economics.” The offshore fields of California spawned the technology, which led to modern directional and horizontal drilling. In the 1930s, directional drilling was used in the Huntington Beach, California field to reach an offshore oil-bearing formation from a well initiated on an onshore pad.

71. Throughout the 1980s, directional drilling (a technique for accessing hydrocarbon-bearing formations (oil and gas formations) that are not located immediately beneath the surface location or to increase the amount of formation exposed to the wellbore) increased. Techniques for drilling wells to intersect natural fractures were, in particular, used initially on offshore pads and in the Austin Chalk trend of central Texas. The Austin Chalk is a soft, loosely cemented, easily pulverized limestone characterized by natural fractures oriented primarily vertically. Horizontally deviated wells were drilled into the chalk to intersect several of the natural fractures, allowing for transport of the hydrocarbons into the wellbore. This was combined with artificial fracturing to increase the flow rate of hydrocarbons into the wellbore.

72. Because more formation is exposed to be fractured, horizontal wells use much higher volumes of fracturing fluid and proppant than do vertical wells.

This requires the use of more and bigger blending and pumping systems. As discussed by Sanborn, pumping systems of 32,000 hp were typically used as early as 2012. Other references, such as Coli, suggest systems of pumps as large as 2,500 hp each, with total system power as high as 40,000 hp, were used in the same time period (four trailers, each with four 2500 hp pumps operating in parallel). These pumps are typically triplex or quintuplex positive displacement (plunger) type pumps. Although some fracturing systems have been converted to electric-driven pump motors, most hydraulic pumping systems “are typically mobilized on skids or tractor-trailers and powered using diesel motors.” These diesel engines require large amounts of fuel and the requisite extra safeguards to address potential safety concerns.

C. TYPES OF PUMPS – FRACTURING PUMP CHAIN

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

74. A modern fracturing process requires multiple pumps operating together as a system to provide fracturing fluid with the suitable composition at the correct flow rate 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.

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

76. 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).

D. SIMULTANEOUS OR SEQUENTIAL FRACTURING (SIMULFRAC OR ZIPPER FRAC)

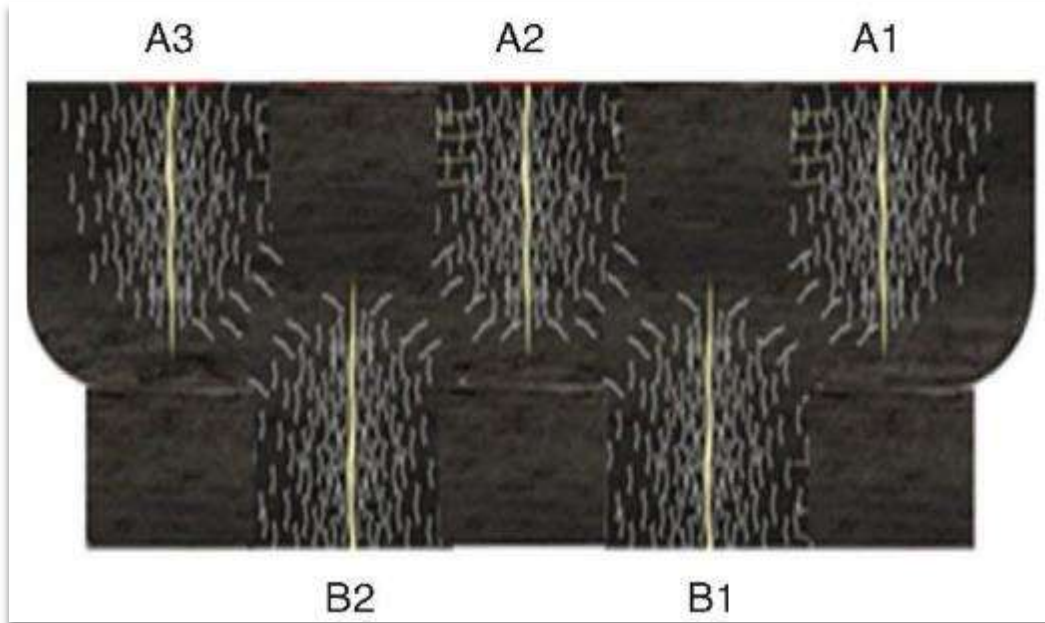
77. For most of the history of hydraulic fracturing, technological advances have been mainly geared towards advancements in chemicals (such as developing corrosion inhibitors, gels, and slickwater fracking), proppants, and increasing flow and pressure of the fracturing operations. The goal, as always, was to create fractures that expose the hydrocarbon-bearing formation to the wellbore, allowing the hydrocarbons to flow into the wellbore. For most of its history, hydraulic fracturing has been performed one well at a time, potentially with several stages (zones) being fractured in a single well. With the increased popularity of horizontal drilling in the 1990s and 2000s, the number of fracturing stages in a well increased dramatically as the “pay zone” (the hydrocarbon-bearing formation) in which the well exposed increased from tens to hundreds of feet to several thousand feet.

78. In the mid-2000s, operators began experimenting with and then using a technique dubbed “zipper fracturing,” in which multiple wells, closely spaced in the formation and often drilled from the same pad, were fractured simultaneously or sequentially. The result was that the fractures formed in one well were affected by the pressures and fractures in another well, leading to so-called “zipper fractures”

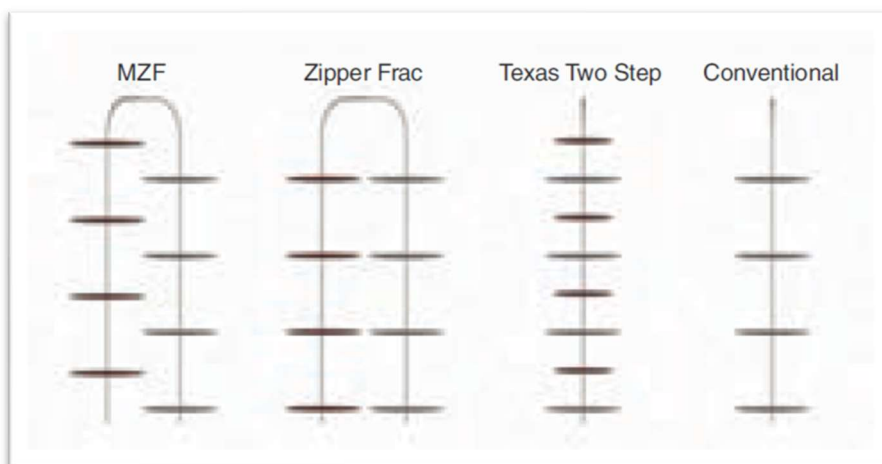
that were longer, multidirectional, and exposed more formation to the wellbores than single well fracturing produced.

79. The image below was captured from *Jacobs*⁸ and shows the influence that simultaneous or sequencing fracturing has on the fractures caused by wells. For the fractures nearest the wellbores, the fractures show a typical pattern of being aligned with the perforations, as shown in the below figure where A1-A3 are perforations and associated fractures from a first horizontal wellbore, and B1-B2 are the perforations/fractures from a second parallel wellbore. However, for fractures near other wellbores, the fracture lengthens and turns, creating a zipper-like pattern to the fracture. This exposes more of the formation to the wellbore and allows for earlier and more complete recovery of hydrocarbons from the formation.

⁸ Jacobs, Trent. “The Shale Evolution: Zipper Fracture Takes Hold,” *J Pet Technol* 66 (2014): 60–67. doi: <https://doi.org/10.2118/1014-0060-JPT> (Ex. 1009).



80. The figure below (with the wellbores represented vertically) from *Jacobs* shows various types of fracturing configurations, beginning with conventional fracking (to the right) and ending with modified zipper fracturing (MZF) on the left. The changes in the location of the perforation and fracturing operations are intended to increase the development of zipper fractures and expand the interface with the hydrocarbon-bearing formation.



Waters at 5.

81. As described by *Waters*, developing zipper fractures involves maintaining pressure in the formation from one wellbore while initiating fractures by pressuring up a proximate wellbore. “In ultra-low permeability reservoirs such as shales, the stimulations do not necessarily have to occur concurrently. Since little to no fluid leaks off into the rock matrix, the fracture systems will remain pressurized until they are flown back. This pressurized system can provide the diversion [zipper fracture] desired when the adjacent lateral is stimulated subsequent to the initial stimulation.”⁹

82. This allows one well stage to be pressurized and shut in (such as with a plug or a ball seal), then an adjacent well stage pressurized, gaining the benefits of the stress induced by the other pressurized well. This has advantages not only to the development of fractures downhole but also operational advantages. As *Waters* states below, one fracturing crew and one perforating crew can treat multiple wells

⁹ Waters, George, Dean, Barry, Downie, Robert, Kerrihard, Ken, Austbo, Lance, and Bruce McPherson. "Simultaneous Hydraulic Fracturing of Adjacent Horizontal Wells in the Woodford Shale." Paper presented at the SPE Hydraulic Fracturing Technology Conference, The Woodlands, Texas, January 2009. doi: <https://doi.org/10.2118/119635-MS>, p. 8. (Ex. 1022).

simultaneously or in an alternating arrangement, allowing for faster completion of the fracturing process.¹⁰

- This “Zipper-Frac” method provides some significant operational efficiencies:
 - When two wells drilled from the same pad are being stimulated only one stimulation crew and perforating crew is required. While the fracturing crew is stimulating one well, the perforating crew is setting the frac plug and perforating the adjacent wellbore. The two crews continue to work back and forth between the two wells to efficiently complete them in a timely manner.
 - If more than two wells are being stimulated at the same time then a completion sequence can be developed to most effectively create a dense fracture network throughout the acreage. For example, if four laterals are being stimulated with two crews the outer wells can be stimulated first, followed by the inner wells where a more dense fracture pattern can be created. The treatment sizes can be adjusted based on the order in which the wells are stimulated. The completion sequence utilized will be a function of the well spacing, the structural geology, surface logistics, and the desire for hydraulic fracture density versus fracture length.

83. The advantages of zipper fractures have been known for decades, as shown by *Pearson*, an article published in the Journal of Petroleum Technology in 1992.¹¹ While not directly discussing the simultaneous or alternating process, *Pearson* does discuss the results of such a process. “This paper reports the first results of stress-oriented and aligned perforating of deviated wells at the Kuparuk River field, Alaska. Preferred perforation alignment and spacing are calculated for each well so the fractures from individual perforations link to produce a single ‘zipper’ fracture plane along the deviated [horizontal] wellbore.”¹² *Pearson* further

¹⁰ Ex. 1022 at 8.

¹¹ Pearson, C.M., Bond, A.J., Eck, M.E., and J.H. Schmidt. "Results of Stress-Oriented and Aligned Perforating in Fracturing Deviated Wells." J Pet Technol 44 (1992): 10–18. doi: <https://doi.org/10.2118/22836-PA> (Ex. 1023).

¹² Ex. 1023 at Summary.

states that “[d]uring the past 7 years [prior to 1992], more than 600 new development wells have been fracture stimulated in the Kapurak River field. The large number of treatments has provided the opportunity for significant advances in the technical and operational aspects of hydraulically fracturing deviated wells.”¹³

84. The Zipper-frac process (alternating perforations and pressurization of adjacent wells) has been well-known in the industry since at least 2008, particularly to those operators and fracturing companies operating in Shale regions such as the Barnett, Woodford, and Marcellus shale formations. This contributed to the general engineering knowledge that a fracturing designer (engineer) had when planning operations of fracturing systems. *Waters* is one example of the well-known nature of this process, and dates to 2008.

85. Another example of the well-known nature of the zipper-frac process in shale-producing regions is *Mutalik*, a paper published by the SPE in 2008.¹⁴ *Mutalik* discusses multiple case studies of wells using a “simo-frac” process to create more effective downhole formation fractures in the Barnett Shale. “In this paper, the case history of sequential and simultaneous fracturing of four similarly drilled

¹³ Ex. 1023 at Introduction.

¹⁴ Mutalik, P N, and Bob Gibson. "Case History of Sequential and Simultaneous Fracturing of the Barnett Shale in Parker County." Paper presented at the SPE Annual Technical Conference and Exhibition, Denver, Colorado, USA, September 2008. doi: <https://doi.org/10.2118/116124-MS> (Ex. 1024).

and completed horizontal azimuth wells in Eastern Parker County is discussed.”¹⁵

Mutalik further describes:¹⁶

Simultaneous fracturing (simo-fracs) of paired offset wells is one of the recent trends in Barnett fracturing and is being increasingly used by many operators. In this technique, two or more adjacent wells that are roughly parallel to each other are fractured simultaneously. The goal is to expose the shale to more pressure and produce a more complex, “three-dimensional web” of fractures by increasing the density of the hydraulic fracture network and increasing the surface area created by the frac job.

Mutalik describes the operational benefits of a simultaneous frac process. “Simo-fracs [are] expensive and require[] much more coordination and logistics and a larger location. At the same time, they are cost-effective as the fracturing equipment is being utilized more efficiently and two wells are being completed in one week instead of two weeks.”¹⁷ *Mutalik* further teaches that, as of 2008, “simultaneous fracturing operators are now experimenting with triple fracs (‘trifectas’) or even quad-fracs in some cases.”¹⁸

¹⁵ Ex. 1024 at Abstract.

¹⁶ Ex. 1024 at Background.

¹⁷ *Id.*

¹⁸ *Id.*

86. In addition to the above references, *Mayerhofer*¹⁹ and *Rousell*²⁰ provide more information on the advantages and benefits of such a process. For example, *Mayerhofer* discusses, “it may be more beneficial to drill laterals at closer spacing, with the chance of overlapping SRVs” (Stimulated Reservoir Volume).²¹ This is the reason for the so-called “simul-fracs” and “zipper-fracs” in shale reservoirs where multiple parallel wellbores are either stimulated simultaneously or in short alternating sequence from one lateral to the next.”²²

87. *Rousell* teaches that “[t]he numerical calculation of the fracture spacing required to avoid fracture deviation during propagation, for all three fracturing techniques, demonstrate the potential advantages of alternate fracture sequencing and zipper-fracs to improve the performance of stimulation treatments in horizontal wells. Simultaneous fracturing of two or more parallel adjacent wells, also referred to as simul-fracs or zipper-fracs, aim to generate a more complex fracture network in the reservoir.”²³

¹⁹ Mayerhofer, M. J., Lolon, E. P., Warpinski, N. R., Cipolla, C. L., Walser, D., and C. M. Rightmire. "What is Stimulated Reservoir Volume (SRV)?" Paper presented at the SPE Shale Gas Production Conference, Fort Worth, Texas, USA, November 2008. doi: <https://doi.org/10.2118/119890-MS> (Ex. 1025).

²⁰ Roussel, Nicolas P., and Mukul M. Sharma. “Optimizing Fracture Spacing and Sequencing in Horizontal-Well Fracturing.” SPE Prod & Oper 26 (2011): 173–184. doi: <https://doi.org/10.2118/127986-PA>. (Ex. 1026).

²¹ Ex. 1025 at 12.

²² *Id.*

²³ Ex. 1026 at 1.

88. By at least 2014, the zipper-frac process was widespread in hydraulic fracturing operations. As described by *Jacobs*:

A horizontal well completion method known as zipper fracturing has been rapidly adopted over the last couple of years by companies in the Eagle Ford shale of south Texas. Instead of drilling and hydraulically fracturing one well at a time, the zipper method involves drilling multiple wells from a pad site and then hydraulically fracturing a stage in one well, while getting ready for the next, as wireline and perforation operations take place in another. The multiwell completion method earns its name from the zipper-like configuration of the fracture stages from wells drilled with relatively tight spacing.

Jacobs at 1. In addition to discussing the production and operational benefits of such a process, *Jacobs* examines the prevalence of this process by 2014. For example, by 2014, nearly half of Schlumberger's completions in North America were completed with the zipper-fracturing method, and "in less than 3 years, the proportion of zipper-fracturing completions ... in the Eagle Ford shale of Texas ... increased threefold to 85%."²⁴

E. CONTINUOUS PUMPING FRACTURING

89. As hydraulic fracturing has increased in the number of stages and wells treated, various techniques have been employed to meet the overall goal of reducing financial costs and non-productive time (NPT) at the well site. At the same time, techniques were developed to minimize wear and damage to the high-horsepower pumps, valves, and related equipment. One technique that furthers both goals is

²⁴ Ex. 1009 at 3.

continuous pumping to treat multiple stages in a well or multiple wells simultaneously or sequentially.

90. Early continuous pumping techniques from at least the 1960s were directed toward treating multiple zones (stages) in a well without stopping the pumps. “Wells with multiple producing zones can be fractured one zone at a time during continuous pumping.”²⁵ Webster further describes that continuous pumping “is less expensive than treating one zone at a time using isolating packers.”²⁶ By at least 2007, continuous pumping equipment and techniques were well-known and practiced internationally. In 2007, Casero described the completion of three wells in the Kitina field of West Africa using a “Continuous Pumping Multi-State System (CPMSS) technique,” which “ha[d] been used for six years in North America.”²⁷ The CPMSS technique “allows pumping multiple hydraulic fracturing treatments without the need of intermediate operation such as bridge plugs or proppant plugs.” Casero further teaches multiple benefits of a continuous pumping system, including:

²⁵ K. R. Webster, W. C. Goins, Jr., and S. C. Berry, "A Continuous Multistage Tracing Technique," *Journal of Petroleum Technology*, vol. 17, no. 06, pp. 619-625, 1965, doi: 10.2118/977-pa (Ex. 1027).

²⁶ Ex. 1027 at Abstract.

²⁷ A. Casero, G. Pace, B. Malone, F. Cantaloube, L. Tealdi, H. Malonga, and R. Seale, "Continuous Pumping, Multistage, Hydraulic Fracturing in Kitina Field, Offshore Congo, West Africa," in *SPE International Symposium and Exhibition on Formation Damage Control*, 2008, vol. All Days, SPE-112442-MS, doi: 10.2118/112442-ms. [Online]. Available: <https://doi.org/10.2118/112442-MS> (Ex. 1028).

- With adequate bulk capacity, all stimulation can be done in hours instead of weeks.
- Quicker fluid recovery due to the short time for the injection process.
- Reducing rig costs may encourage additional fracturing treatments for enhanced well stimulation.

91. By 2018, *Rassenfoss* observed that wells drilled in 2015 in the Permian were fractured using “zipper fracturing” and teaches “Zipper fracturing speed work by allowing continuous pumping and it reduces the risk of frac hits because the method only fractures rock where pressure has not been depleted by production. Now zipper fracturing is used to fracture even more wells at once.”²⁸ *Rassenfoss* further observes, “Simultaneous fracturing is likely to create stronger connections [between wells] because the time between stages is relatively short.”²⁹

F. OPERATION PARAMETERS FOR FRACTURING

92. Whether part of a zipper fracturing operation and/or continuous pumping operation, a hydraulic fracturing operation includes operational parameters such as fluid flow and pressure specific to the operation. *Casero* further discusses reducing the flow rate between stages to allow for the mechanical execution of the

²⁸ S. Rassenfoss, "A Look Into What Fractures Really Look Like," *Journal of Petroleum Technology*, vol. 70, no. 11, pp. 28-36, 2018, doi: 10.2118/1118-0028-jpt. at 6 (Ex. 1029).

²⁹ *Id.*

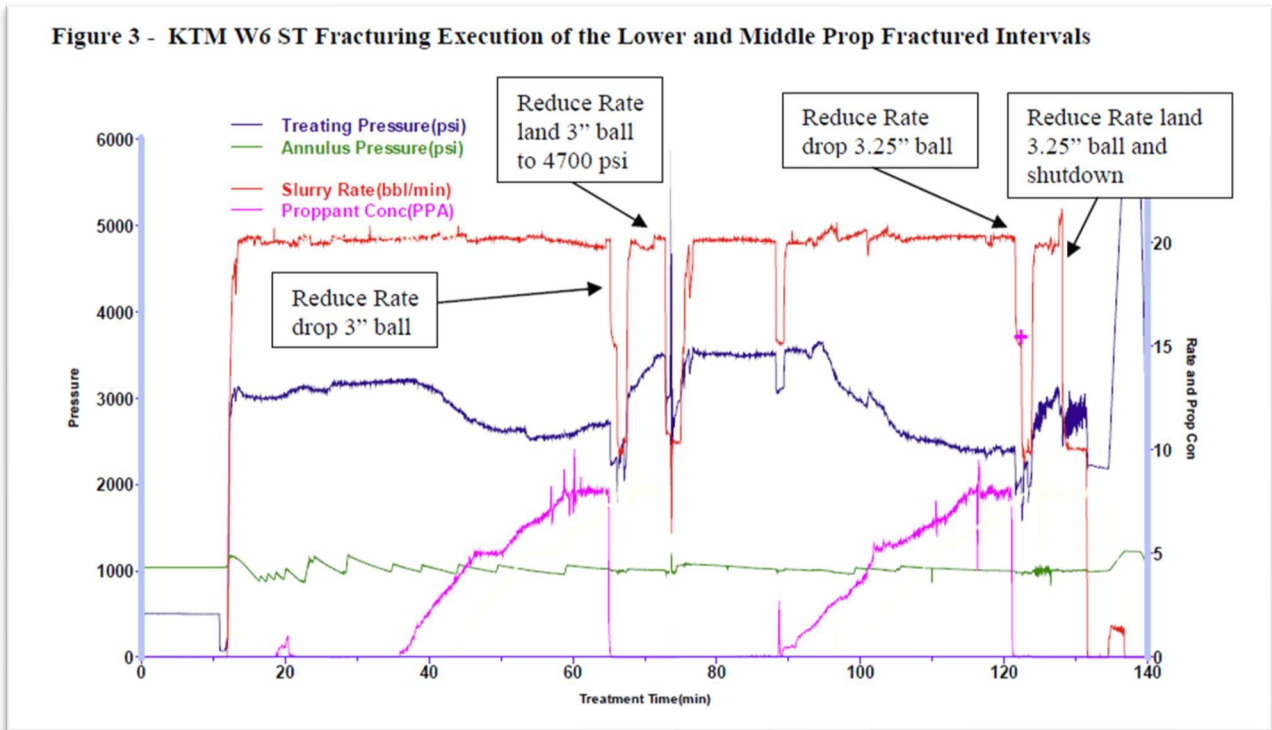
frac job. Using the CPMSS technique, a mechanical operation includes dropping a degradable ball from the surface where it lands on a packer sleeve. The ball performs two functions. First, it acts as a seal to isolate the stages below the ball (like a valve). After the ball lands, the pump rate is increased again, and the differential pressure across the ball/seat causes activation of a sleeve, opening access to the perforations to be fractured.³⁰

93. Before the mechanical functions are completed, *Casero* describes, “[t]he pumping rate is consistent at 20 bpm until the rate is reduced to have a controlled launch of the frac ball on the surface and then again when the ball is calculated to land at the fracture port”.³¹ *Casero*’s Figure 3 shows the rate reduction used to complete the mechanical action.³²

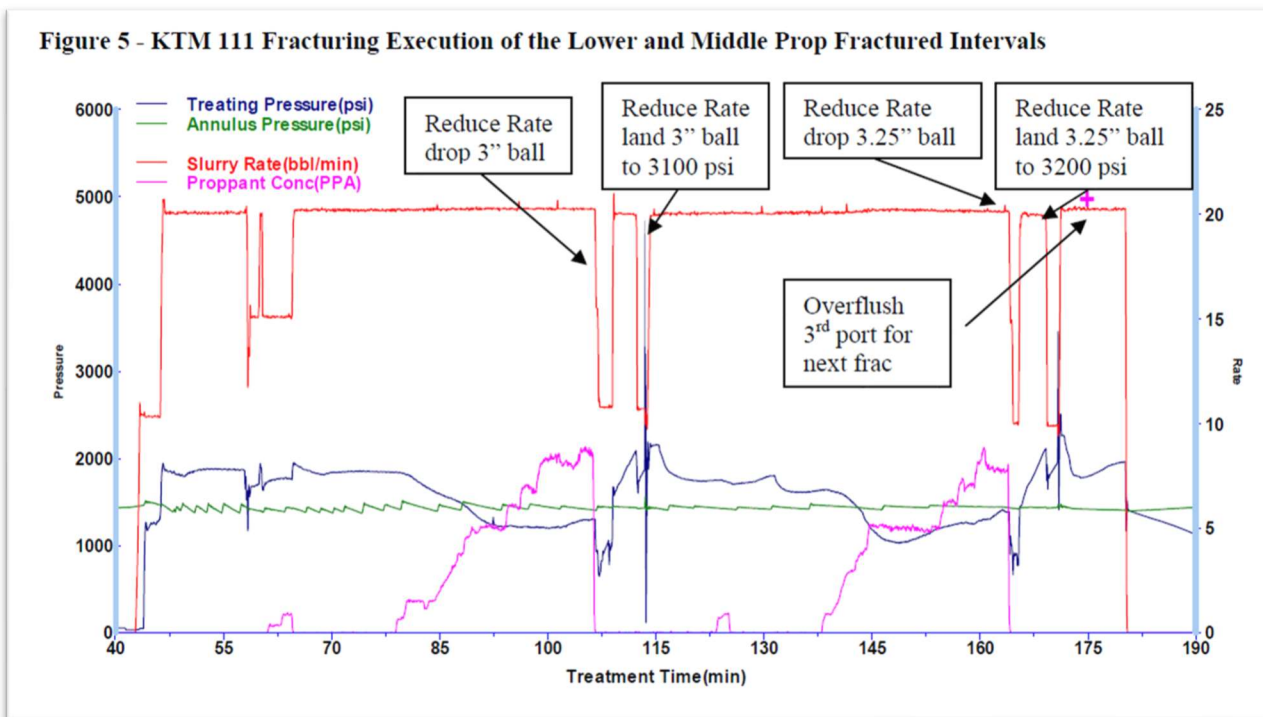
³⁰ R. Oberhofer, "Application of Ball-Drop Technology to Improve Efficiency and Stimulation of Limited Entry Completion Systems," in *Abu Dhabi International Petroleum Exhibition & Conference*, 2016, vol. Day 2 Tue, November 08, 2016, D021S052R004, doi: 10.2118/183427-ms. [Online]. Available: <https://doi.org/10.2118/183427-MS> ([Ex. 1028](#)), p. 4.

³¹ Ex. 1028 at 5.

³² Ex. 1028 at 16.



94. Figure 3 shows not only the reduction in rates necessary for controlled mechanical operations but also the increase and then decaying pressures consistent with a fracturing operation taking place when using positive displacement pumps. As further teaching, Figure 5 of *Casero* shows similar rate reductions to undertake mechanical operations.



95. The *Tolman Article* describes another “Method and Apparatus Associated for Simultaneous Stimulation of Multi-Well Pads” in which “ExxonMobil has drilled multiple wells from single pads, and new technologies have been developed to efficiently stimulate the multiple pay zones in each well.”³³ The technologies described by the *Tolman Article* enable “simultaneous stimulation of multiple wells on the same or different well pads, and while drilling additional wells.”³⁴ Like *Casero*, the *Tolman Article* teaches suspending mechanical

³³ Tolman, R. C., et al. (2009). Method and Apparatus for Simultaneous Stimulation of Multi-Well Pads. SPE Hydraulic Fracturing Technology Conference (Ex. 1031).

³⁴ Ex. 1031 at 1.

operations during high flow (high pressure) operations.³⁵ In the system described in the *Tolman Article*, where the pumps are continuously operating, the “high pressure pumping” resulting in/from high flow pumping must be reduced for mechanical operations, such as valve manipulations, to occur.

96. The restriction on mechanical operations during high flow / high-pressure conditions described by at least Casero and the *Tolman Article* is because mechanical operations, such as closing a valve or opening a valve, during high flow / high-pressure conditions could result in damage to equipment and safety concerns. For example, closing a valve when there is high flow through the valve would result in high fluid velocity through the valve orifice, particularly as the valve neared a full close position. This high velocity increases damage to components such as the valve seats and seals, as well as causing vibrations through the piping system. Additionally, in systems using positive displacement pumps, such as those used for hydraulic fracturing, closing a valve during high flow conditions would create extremely high-pressure increases and damage to pumps, seals, piping (iron), or other mechanical equipment. This is due to the inherent characteristics of positive displacement pumps. (See Section X.A.).

³⁵ Ex. 1031 at 4.

97. The above examples show that it has been well-known and documented that operational parameters, including flow rate, are commonly considered during valve and pump mechanical operations for hydraulic fracturing.

G. TESTING

98. It has also long been established to vary operational parameters to conduct performance testing for fracturing operations. For example, since at least the 1980s, the value of measuring oscillations in the pressure of a fracturing system to indicate the extent of the fractures downhole has been known. Oscillations in the well are created in two primary ways. First, during flowing conditions, if the flow is suddenly changed (reduced) either through shutting a valve or a reduction in rate, the momentum of the flowing fluid creates a natural oscillation called a water hammer. Second, during some well tests, an intentional pressure transient or spike is created by suddenly opening and then closing a valve or by the forced oscillations of the positive displacement pumps. The changes in the pressure oscillations, either natural or artificial, provide information about the extent of the fractures downhole.

99. According to *Holzhausen*, “[t]he growth of a hydraulic fracture increases the period of free oscillation in a well. Simultaneously, the decay rate of free oscillations decreases.”³⁶ *Holzhausen* refers to the “impedance of the hydraulic

³⁶ G. R. Holzhausen and R. P. Gooch, "Impedance of Hydraulic Fractures: Its Measurement and Use for Estimating Fracture Closure Pressure and

fracture” as the effect that fractures have on the fluid stream. “Because impedance is a function of fracture dimensions and the elasticity of the surrounding rock, impedance analysis offers a promising new approach for evaluating fracture geometry.”³⁷ *Holzhausen* defines fracture impedance as “the ratio of volume change [in a fracture] to head [pressure] change” and is used to describe the effect that fractures have on the fluid stream.³⁸ The primary reason that analysis of the fracture impedance is possible is “[t]he configuration of surface and downhole pipe (tubing, casing, etc.) remains constant during a hydraulic-fracturing treatment, whereas the geometry of the fracture changes continuously as it is being created.”³⁹ Accordingly, any change in the behavior of the oscillations (decay, period, etc.) can be attributed to the changes in the fracture geometry.⁴⁰

100. *Paige* tested *Holzhausen*’s concepts in field testing. During *Paige*’s tests, “a pressure pulse is introduced into a well, and the resulting pressure trace is interpreted to give fracture dimensions.”⁴¹ *Paige* refers to this as “Hydraulic

Dimensions," in *SPE/DOE Low Permeability Gas Reservoirs Symposium*, 1985, vol. All Days, SPE-13892-MS, doi: 10.2118/13892-ms. [Online]. Available: <https://doi.org/10.2118/13892-MS> at 1 (Ex. 1032).

³⁷ *Id.*

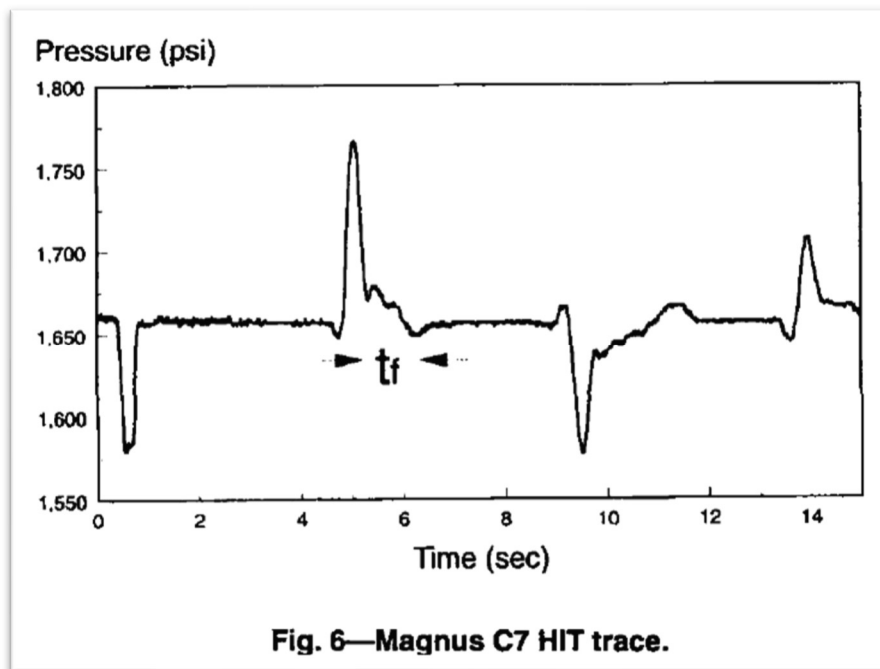
³⁸ *Id.* at 3.

³⁹ *Id.* at 2.

⁴⁰ *Id.* at 4.

⁴¹ R. W. Paige, L. R. Murray, and J. D. M. Roberts, "Field Application of Hydraulic Impedance Testing for Fracture Measurement," *SPE Production & Facilities*, vol. 10, no. 01, pp. 7-12, 1995, doi: 10.2118/26525-pa. (Ex. 1033), p. 1.

impedance testing (HIT).”⁴² Further, “HIT uses the transient response of the fluid in the wellbore and fracture that results from the introduction of a pressure pulse into the well to provide information about the fracture.”⁴³ Through field tests, Paige determined that “fracture length is obtained from the delay time ($t_f = 1.8$ sec in Fig. 6) and the wavespeed”.⁴⁴ Thus, as was common in well testing, *Paige’s* testing involved varying and monitoring operational parameters over a period of time to assess the effects in the well.



101. *Massaras* describes using the same principles as *Paige* and *Holzhausen* to analyze fracture geometry using a “Rate Step-down Test (RST) also referred to as

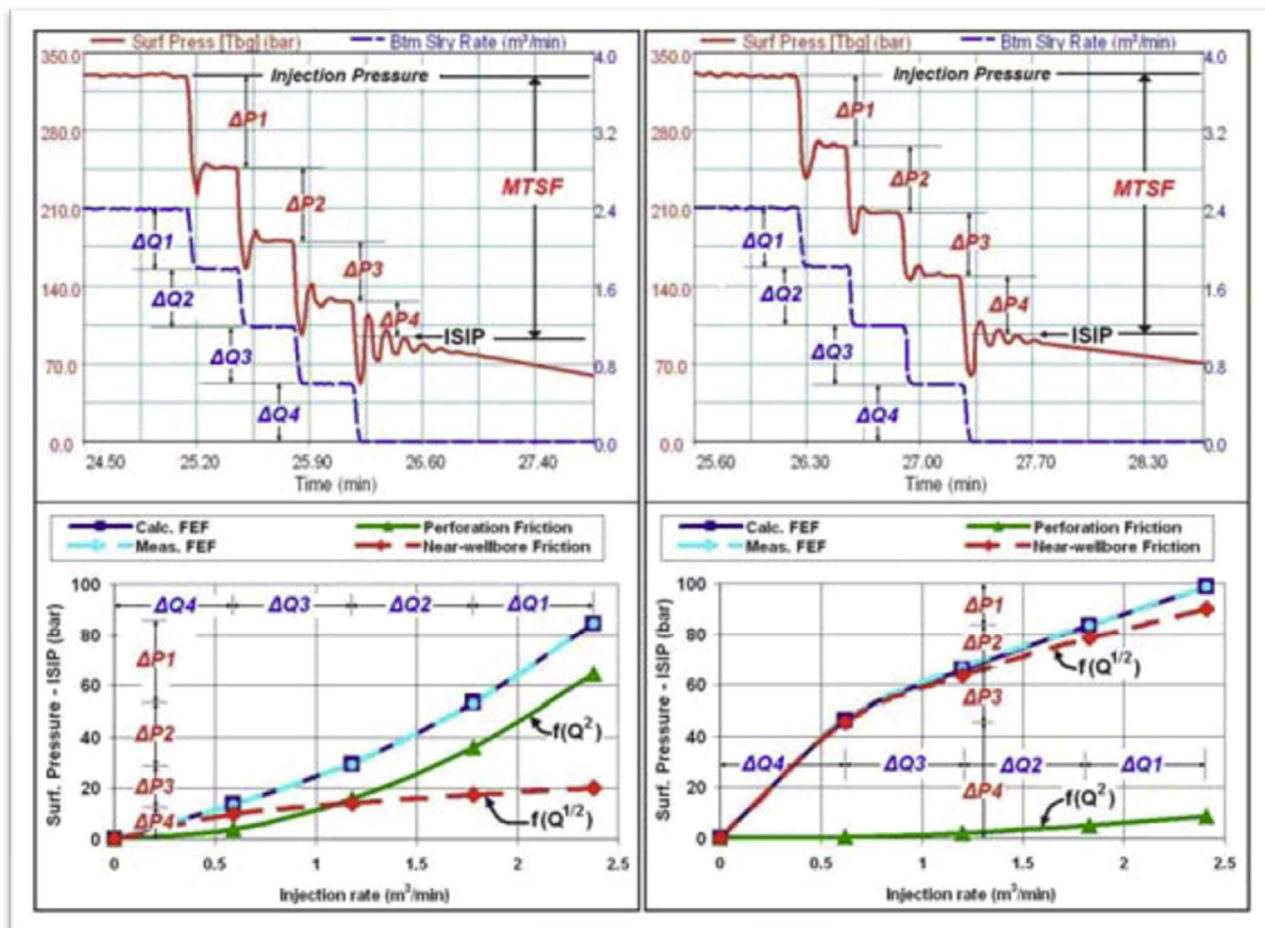
⁴² *Id.*

⁴³ *Id.*

⁴⁴ *Id.* at 4

“Step-Down Test (SDT)” which, by 2007 “have been used worldwide for over 15 years”.⁴⁵ To properly execute an RST, “a relatively large fluid volume should be injected prior to initiating the RST procedure of abrupt flow rate changes.” During a properly designed RST “the fracture geometry will not change dramatically during the very short RST procedure” because of the large volume injected into the fractures prior to the RST. As one example, Figure 9 of Manassas compares conditions where the friction at the perforations dominates (left side plots) and compares it to conditions where the fracture friction dominates (right side plots). The characteristics of the pressure transients after a flow-rate reduction (often referred to as water hammer) indicate fracture geometry and the relationship between FEF and wellbore friction.

⁴⁵ L. V. Massaras, A. Dragomir, and D. Chiriac, "Enhanced Fracture Entry Friction Analysis of the Rate Step-Down Test," in *SPE Hydraulic Fracturing Technology Conference*, 2007, vol. All Days, SPE-106058-MS, doi: 10.2118/106058-ms. [Online]. Available: <https://doi.org/10.2118/106058-MS>. (Ex. 1034).



Massaras, Figure 9

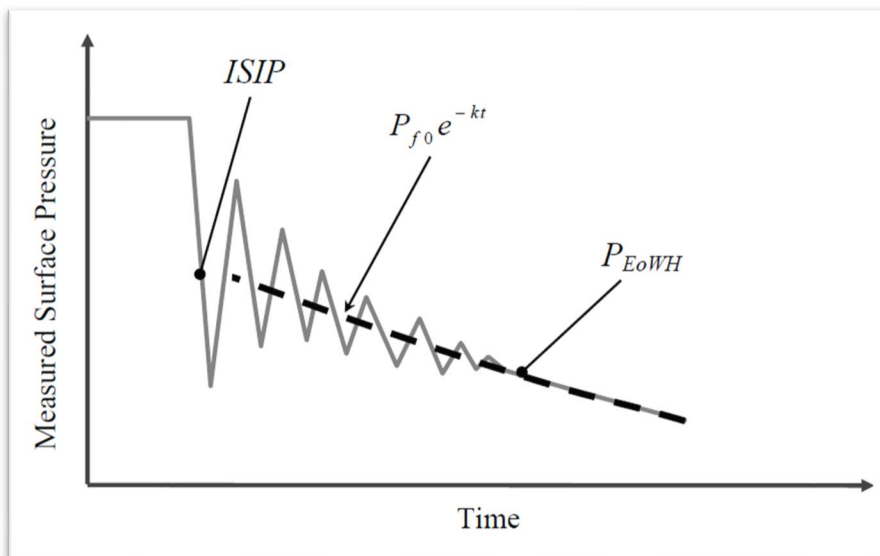
102. Mondal expanded the understanding of pressure transient analysis, particularly regarding measured “water hammer.” “Water hammer is a surge or pressure wave created due to a sudden change in flow velocity in a confined system.”⁴⁶ However, traditional water hammer analysis is incomplete in a fractured well as “the presence of a porous medium [fractures] at the downstream/upstream

⁴⁶ S. Mondal, "Pressure transients in wellbores: Water hammer effects and implications for fracture diagnostics," 2010. at 12 (Ex. 1035).

end of an injection/production well makes it different from the traditional pipeline water hammer analysis.”⁴⁷ In *Mondal*, based on work by *Paige* and others, “pressure and rate transients can be calculated at any point in the well or at the bottomhole” based on known well and fluid parameter relationships.⁴⁸ In *Mondal*’s analysis, a step change reduction in flow rate was applied to a well, and the resulting pressure oscillations (water hammer) were evaluated and applied using the known well and fluid relationships to determine the geometry of the fractures at the end of the wellbore. The energy storage characteristics of the wellbore and fluid create the resonance, as measured by the period (length of time) of the wellbore, and resistive features of the wellbore generate a loss of oscillation height over time. The relationships between these yield characteristics of the fractures.

⁴⁷ *Id.* at 21.

⁴⁸ *Id.* at 34.



Mondal, Figure 2.9

Mondal teaches that the period of these oscillations is several seconds (~6-10 seconds, depending on well length). To properly evaluate the characteristics of the well using these oscillations, which can last several seconds, a sufficient number of the oscillations must be captured to calculate the period and decay rate, as shown in Figure 2.9 above. This data allows the user to “estimate fracture dimensions from water hammer data.”⁴⁹ Accordingly, a POSITA would have been well aware of operationally reducing flow at the end of the fracture stage to perform a rate step down (RST) or water hammer analysis. Further, a POSITA would have been well aware that the reduction in flow would need to be held steady for a period of time necessary to capture sufficient oscillations for the trend described above to be

determined. Flow schedules such as the ones in *Massaras* and the *Tolman Article* with intentional reductions in flow rate below a threshold would have been well known to a POSITA long before the '770 Patent application. These data allow the user to “estimate fracture dimensions from water hammer data.”⁵⁰

XI. OVERVIEW OF THE PRIOR ART

A. CIEZOBKA (EX. 1036)

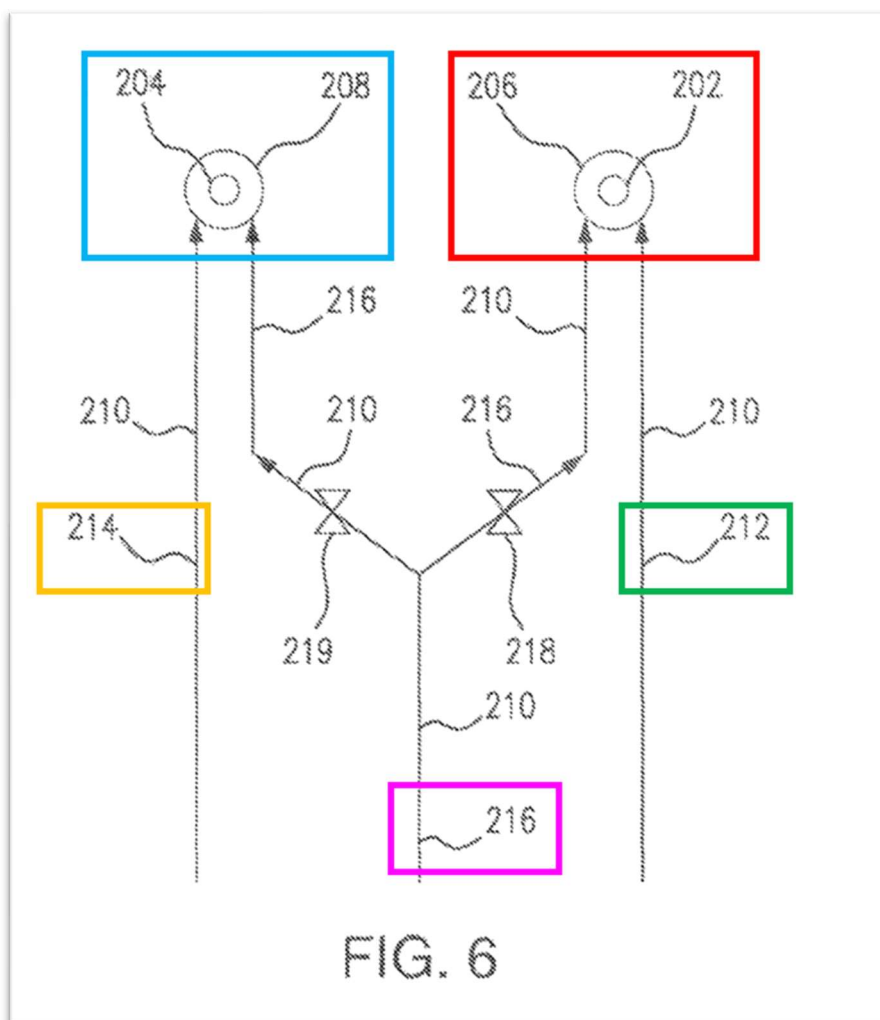
103. WO2017/201526 (“*Ciezobka*”) was filed May 22, 2017, and published November 23, 2017, before the earliest possible priority date (May 17, 2021) of the '770 Patent and before the filing date of the earliest application in the chain of CIP parent applications to the '770 Patent (December 14, 2017). (Exhibit 1036). Thus, *Ciezobka* is prior art to the '770 Patent.

104. *Ciezobka* is titled “Hydraulic Fracturing System and Method.” *Ciezobka* discloses “hydraulic fracturing system and method for enhancing effective permeability of earth formations to increase hydrocarbon production, enhance operation efficiency by reducing fluid entry friction due to tortuosity and perforation, and to open perforations that are either unopened or not effective using traditional techniques.”⁵¹ Further, the system of, “includes a pair of wellheads **202**, **204**

⁵⁰ *Id.* at 66.

⁵¹ Ex. 1036 at Abstract.

[annotated in red, and blue] each connected to a wellbore **206, 208**⁵² as shown in Fig. 6.



105. *Ciezobka* teaches that in a fracturing process, both diverter valves **218** and **219** are initially open, allowing fluid flow “to be provided to both of the wellheads **202, 204**.”⁵³ The second diverter valve **219** (e.g., second valve) is then

⁵² Ex. 1036 at 11:25.

⁵³ Ex. 1036 at 12:8-9.

closed for a “short period of time.” At the same time, the first diverter valve **218** (e.g., first valve) remains open to provide a decreased flow rate (shown as **232** in Fig. 7) to the second well **204** and an increased flow rate (shown as **222** in Fig. 7) to the first well **202** for a “short period of time.”⁵⁴

106. As depicted in Fig. 7, after the short period of time with the second diverter valve closed, the second valve (e.g., **219**) is opened to resume fluid flow “to both of the wellheads **202**, **204**.”⁵⁵ The sequence of events is depicted in Fig. 7. Hydraulic fluid flow paths to the first well are identified in pink, and hydraulic fluid flow paths to the second well are identified in green.

⁵⁴ Ex. 1036 at 12:10-11.

⁵⁵ Ex. 1036 at 12:8.

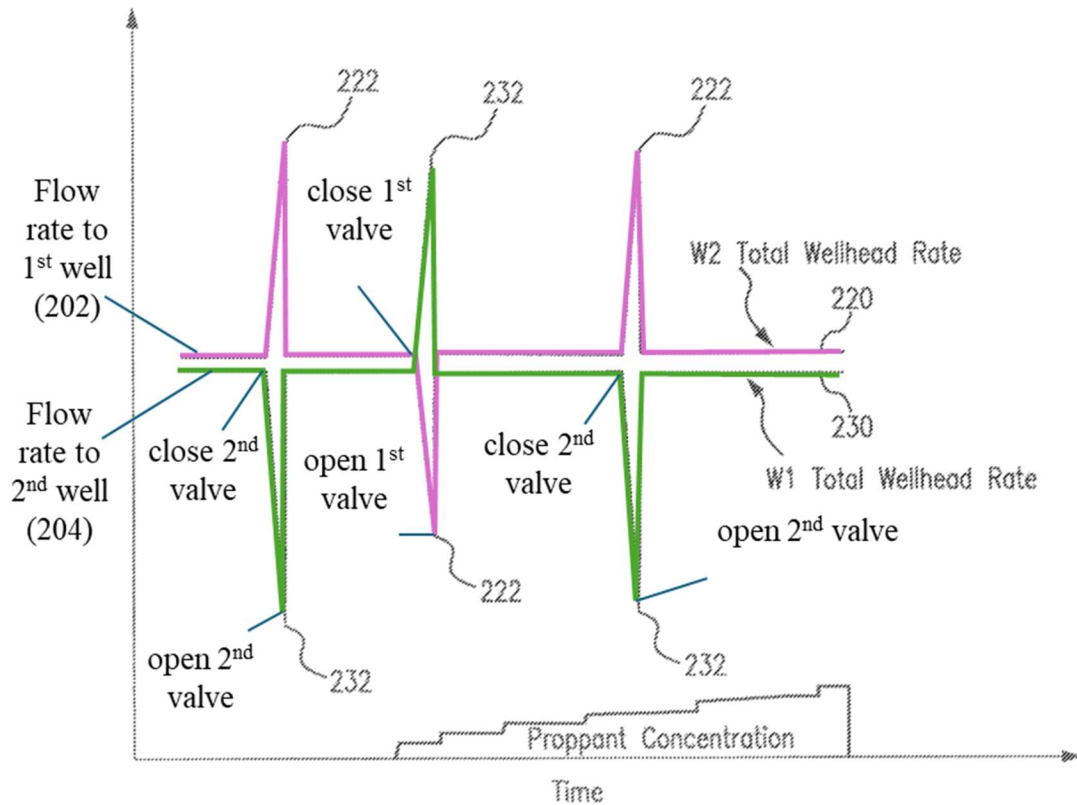


FIG. 7

B. McNEEL (EX. 1037)

107. U.S. Patent Publication No. 2007/0125543 (“*McNeel*”) was filed December 1, 2005, and published June 7, 2007.⁵⁶ *McNeel* is prior art to the ’770 Patent because *McNeel*’s filing date and publication date are before the ’770’s earliest possible priority date (May 17, 2021) and are even before the filing date of the earliest application in the chain of CIP parent applications to the ’770 Patent (December 14, 2017).

⁵⁶ Ex. 1037, Cover.

108. *McNeel* is entitled “Method and Apparatus for Centralized Well Treatment” and discloses “a method of communicating between a central location and multiple well locations ... that includes the steps of stimulating a first well from the central location using a first stimulation fluid through a first fluid line; and simultaneously stimulating a second well from the central location using a second stimulation fluid through a second fluid line.”

109. *McNeel* also discloses “[a]n apparatus for centralized well operations ... that includes a well treatment operations factory which manufactures and pumps a well stimulation fluid; a first connection between a first well location and the well operations factory; a second connection between a second well location and the well operations factory; and means for simultaneously flowing a first stimulation fluid to the first well location and a second stimulation fluid to a second well location.” “Manifolds for centralized well stimulation are disclosed.”

110. *McNeel* explicitly discloses simultaneous flow to third and fourth wells, explaining “[i]n reference to FIG. 4, in one embodiment, the central manifold **107** can be connected to one or more additional manifolds **405**. The additional manifolds are operable to connect to multiple well locations **401-404** and deliver well treatment fluids and receive production fluids via connections **406-409**, respectively, in the same way as the central manifold **107** described above.”⁵⁷

⁵⁷ Ex. 1037 at [0024].

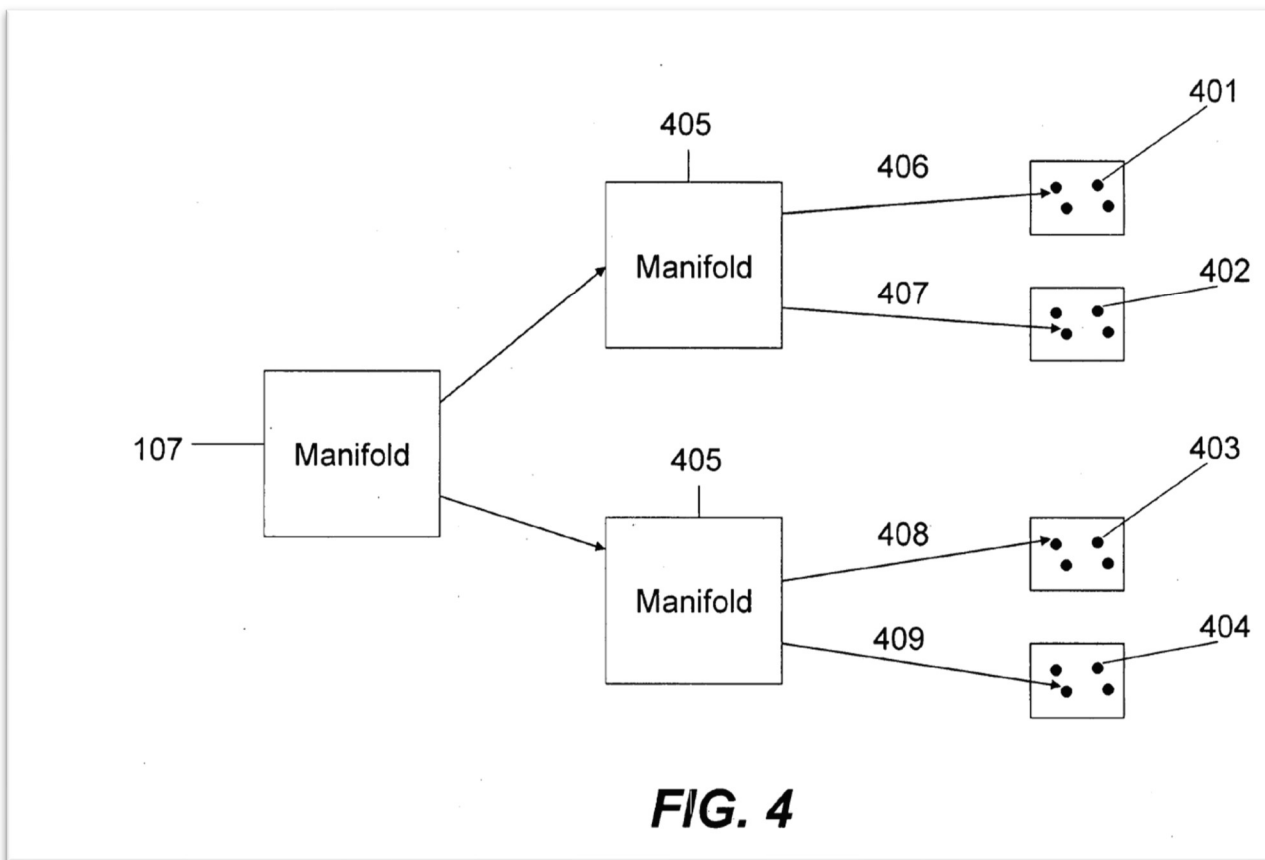


Fig. 4 of *McNeel*

111. *McNeel* also discloses valves in flow lines between a manifold and a well and that the “valves may be either plug valves or check valves and can be manually or electronically monitored and controlled.”

XII. GROUNDS 1 & 2: ANTICIPATED BY / OBVIOUS OVER *CIEZOBKA*

112. It is my opinion that *Ciezobka* discloses or renders obvious each and every element of Claims 1-38 of the '770 Patent. Particularly, it is my opinion that Claims 1, 2, and 4-13 are anticipated by *Ciezobka*. To the extent that the Board

determines *Ciezobka* does not anticipate the claims, it is my opinion that *Ciezobka* renders all Claims 1-38 of the '770 Patent obvious.

A. INDEPENDENT CLAIM 1

113. It is my opinion that *Ciezobka* discloses (and therefore anticipates), or at least renders obvious, Claim 1 of the '770 Patent. Details regarding the specific disclosures of *Ciezobka* are contained in the following subsections. To the extent the Board determines that *Ciezobka* does not explicitly disclose the limitations of Claim 1, a POSITA would have found Claim 1 to be obvious in light of the disclosure and teachings of *Ciezobka*.

a. 1.1: “1. A method, comprising: communicating fluid to a first well via a manifold and a first valve, the first valve being associated with both the manifold and the first well; and”

114. To the extent the preamble is limiting, *Ciezobka* discloses a method of hydraulically fracturing multiple wells simultaneously.⁵⁸ The title of *Ciezobka* is “Hydraulic Fracturing System and Method.”⁵⁹ *Ciezobka* further describes a “hydraulic fracturing system and method for enhancing effective permeability of earth formations to increase hydrocarbon production, enhance operation efficiency by reducing fluid entry friction due to tortuosity and perforation, and to open

⁵⁸ I understand that the preambles may not be limiting. However, I include analysis of the preamble for Claim 1 out of an abundance of caution.

⁵⁹ Ex. 1036.

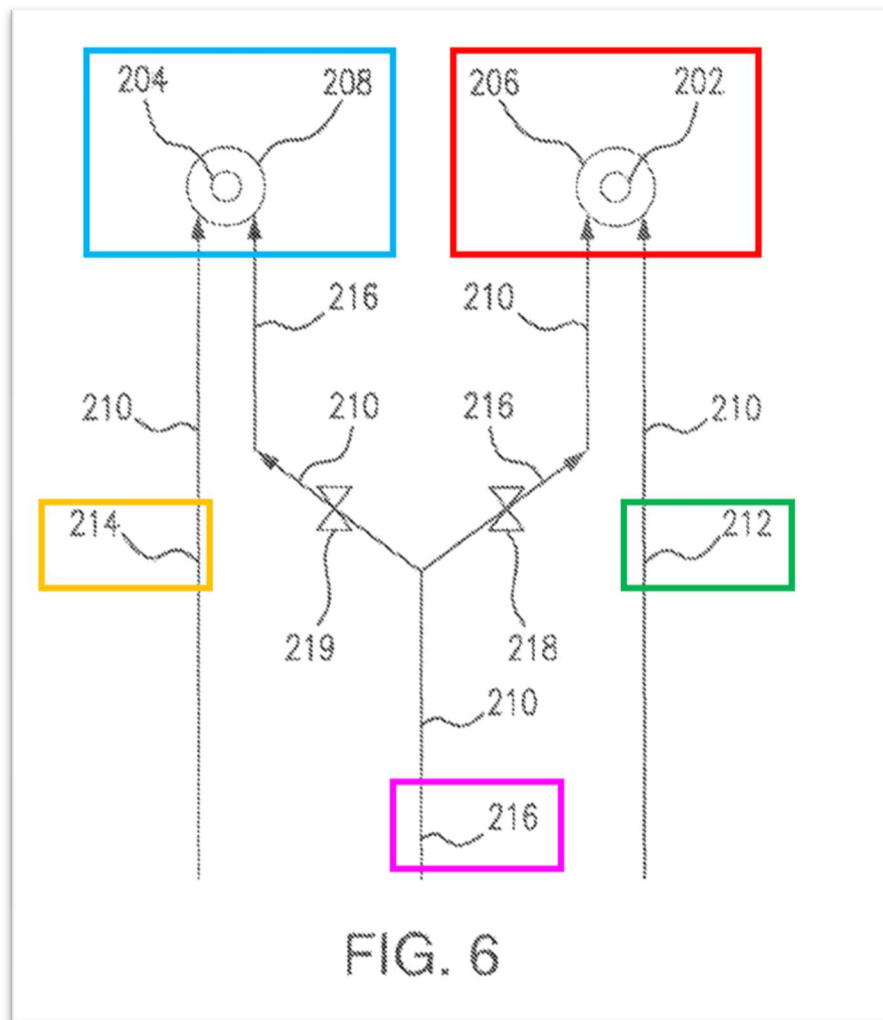
perforations that are either unopened or not effective using traditional techniques”⁶⁰
Further, *Ciezobka* teaches a “system and method for enhancing an effective permeability of low permeability earth formations to increase hydrocarbon production.”⁶¹

115. *Ciezobka* discloses a system for hydraulically fracturing multiple wells simultaneously. As an example embodiment, the system of *Ciezobka* “includes a pair of wellheads **202**, **204** [annotated in red, blue] each connected to a wellbore **206**, **208**,”⁶² as shown in Fig. 6.

⁶⁰ Ex. 1036 at Abstract.

⁶¹ Ex. 1036 at 1:11-13.

⁶² Ex. 1036 at 11:25.



116. *Ciezobka* further discloses, “A first percentage of the flow rate passes through the first constant rate flow line **212**, [annotated in green], a second percentage of the flow rate passes through the second constant flow rate line **214**, [annotated in orange] and a third percentage of the flow rate passes the diverter line **216**” (annotated in pink).⁶³ A POSITA would have understood this teaching to mean that the system and methods of *Ciezobka* apply to multiple wells and that fracturing

⁶³ Ex. 1036 at 11:34-12:2.

fluid is pumped to multiple wells simultaneously. A POSITA would have further recognized this to mean that the fluid is pumped continuously to the valves at each well during the fracturing process.

117. Further, *Ciezobka* discloses a manifold associated with the valves and wells. *Ciezobka* teaches, “[t]he manifold receives the fracturing fluid, with or without proppant, at a low pressure from the pre-blender or the slurry-blender and distributes the fluid and/or slurry to the high-pressure fracturing pumps. The manifold then receives the fluids at a high pressure from the high-pressure fracturing pumps and directs the fluid to a ground iron leading to the wellhead and wellbore.”⁶⁴ Further still, “the flow line comprises a plurality of pipes which connect the high-pressure fracturing pumps, through a single or multiple common manifolds, to a wellhead of the wellbore. In an embodiment of this invention, the plurality of flow lines comprise at least one constant-flow flow line and at least one variable-flow flow line.”⁶⁵ A POSITA would have understood, based on the teachings of *Ciezobka*, that flow lines **212**, **214**, and **216** as well as valves **218** and **219** to be supplied fluid “through a single or multiple common manifolds.” Further, the fluid from the “high-pressure fracturing pumps” is communicated to the first and second valves, and first and second wells, via the manifold.

⁶⁴ Ex. 1036 at 3:10-14.

⁶⁵ Ex. 1036 at 3:16-20.

118. Accordingly, *Ciezobka* discloses limitation 1.1.

b. **1.2: “in response to determining that the fluid communicated via the manifold has satisfied one or more conditions:”**

119. As an initial matter, *Ciezobka* discloses measuring a flow rate. *Ciezobka* teaches several percentage flowrate thresholds for the pulses, including “from 10% to nearly 100% lower”, “25% to 75% lower,” and “50% lower” than the primary flow rate.⁶⁶ To compare a flow rate that is, for example, “50% lower” than a primary flow rate, it would be necessary to measure the flow rate. A POSITA would understand that, in each of these cases, the flow rate is below, for example, “10% lower” or “25% lower”. *Ciezobka* further teaches that this flow rate is measured, as graphs showing flow rate changes over time are included in *Ciezobka*, including Fig. 7.

120. Further still, *Ciezobka* teaches specific flowrate measurements, including “for example, the constant flow line supplies a constant flow rate **92** of 50% of the total flow, equaling 45 bpm, and the variable flow line supplies a variable flow rate **94** of 50% of the total flow, equaling 45 bpm.”⁶⁷ Further, *Ciezobka* teaches several specific thresholds such as “90 bpm”, “45 bpm”, and “20 bpm.”⁶⁸ A POSITA

⁶⁶ See, e.g. Ex. 1036 at 4:1-15.

⁶⁷ Ex. 1036 at 10:31-34, see also 9:4-13.

⁶⁸ See, e.g., Ex. 1036 at 9:4-13.

would recognize that such specific flowrates would need to be measured in the system of *Ciezobka*. Flowrate is one example of a “fluid condition.”

121. *Ciezobka* also teaches “selection and design of variable rate fracturing processing and parameters including, for example, for variable rate fracturing, parameters such as flow rate (e.g., magnitude of change and duration) as well as frequency (for example, such as measured in terms of the period of time between the endings of successive flow rate variations).”⁶⁹ For example, a “pulse flow rate may be greater than the initial flow rate and/or the secondary flow rate may ... be greater than or less than the initial flow rate.”⁷⁰ Optionally, “the pressure pulse includes increasing the initial flowrate to a pre-pulse or intermediate flow rate, rapidly dropping the flow rate to a primary or pulse flow rate and returning the flow rate to the pre-pulse or intermediate flow rate and this cycle for a number of times before returning the flow rate to the initial flow rate.”⁷¹ A POSITA would understand that *Ciezobka*’s methods including selection, design, and application of flow rate parameters for variable rate fracturing would thus include determining the fluid flow rates and flow rate durations in a fracturing process and comparing them to certain thresholds (e.g., initial, pre-pulse, pulse, and secondary flow rates), including upper and/or lower flow rate thresholds and durations.

⁶⁹ Ex. 1036 at 15:17-21.

⁷⁰ Ex. 1036 at 4:11-13.

⁷¹ Ex. 1036 at 4:26-31.

122. When fluid is pumped into a well according to selected parameters (e.g., flow rate and duration), a subsequent valve sequence may be performed to move the fracturing operation to the next step, according to the designed variable rate fracturing plan.⁷² For example, *Ciezobka* claims methods of injecting “fracturing fluid under pressure into a well at an initial flow rate to at least one of: open perforations, create a fracture and open natural fractures; changing the initial flow rate to a primary flow rate lower than the initial flow rate to introduce a change of flow rate into the well for a period of time” and, after the flow rate parameters of the lower “primary flow rate” and “period of time” are performed, the methods include “modulating a valve to change between the primary flow rate and [a] secondary flow rate.”⁷³

123. Additionally, in Figs. 6 and 7 of *Ciezobka*, diverter valves **218**, **219** associated with first and second wells are opened and closed to divert a third percentage of the fluid being pumped to the wells to alternately direct fluid pulses to the first and second wells.⁷⁴ For example, a pulse to the first well is induced by closing the second diverter valve **219**, “increasing the total flow rate **220** to the first wellhead **202** and decreasing the total flow rate **230** to the second wellhead **204** for

⁷² See e.g., Ex. 1036 at 4:26-31.

⁷³ Ex. 1036 at Claims 1, 9.

⁷⁴ Ex. 1036 at 12:7-15.

a short period of time.”⁷⁵ After the pulse to the first well is delivered, meeting the first pulse flow rate conditions (e.g., within the pulse flow rate range and for the pulse period of time), the second diverter valve **219** is reponed to resume the third percentage of fluid flow to both of the first and second wells.

124. Therefore, a POSITA would understand *Ciezobka*’s disclosure as teaching that once flow rate conditions for a fluid pulse are met, a valve is operated to redirect the fluid flow and end the fluid pulse.

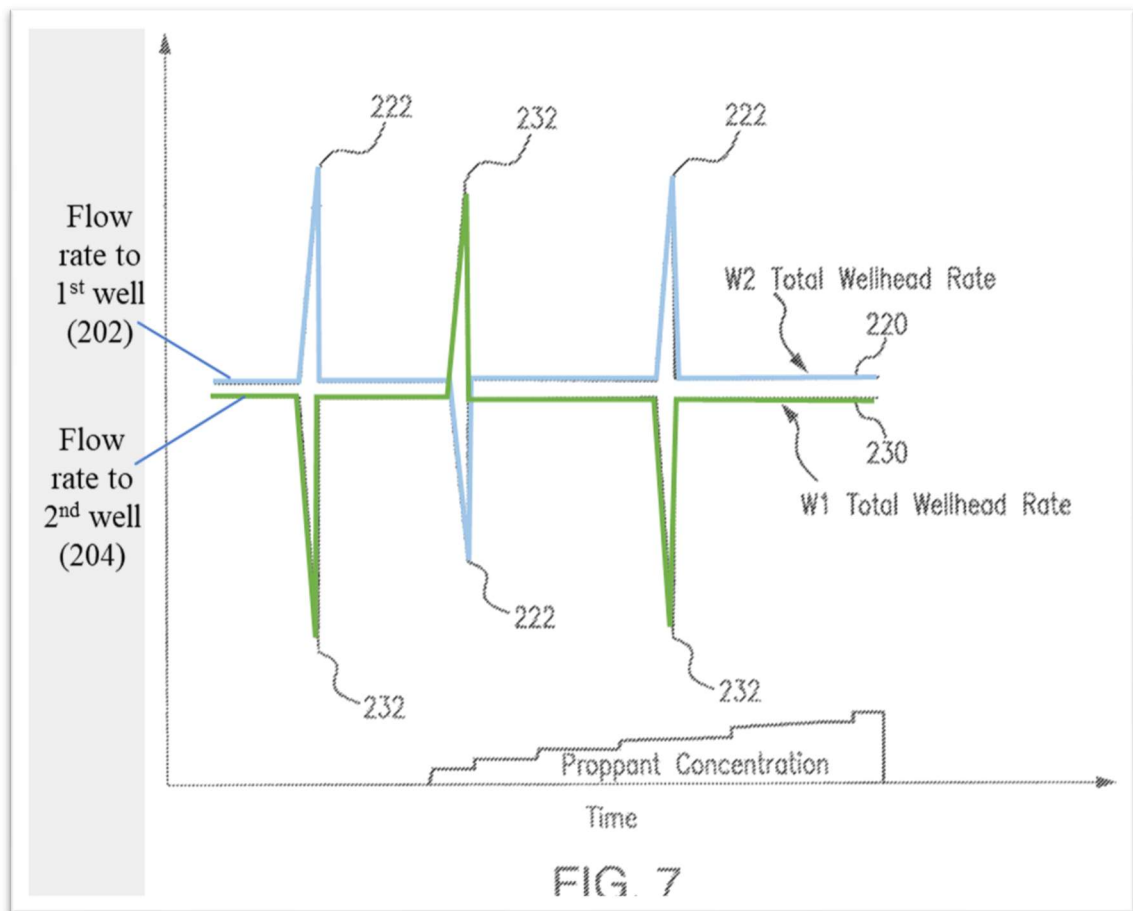
125. Accordingly, *Ciezobka* discloses, or at least renders obvious, Limitation 1.2.

c. **1.3: “opening a second valve; communicating fluid to a second well via the second valve; and”**

126. *Ciezobka* discloses this limitation. *Ciezobka* teaches, “In Fig. 7, the high-pressure fracturing pump provides a first total flow rate **220** [annotated in blue] to the first wellhead **202** and a second total flow rate **230** [annotated in green] to the second wellhead **204**.”⁷⁶

⁷⁵ Ex. 1036 at 12:8-11.

⁷⁶ Ex. 1036 at 5-7.



127. *Ciezobka* teaches that in a fracturing process, initially, both diverter valves **218**, **219** “are open allowing” fluid flow “to be provided to both of the wellheads **202**, **204**.”⁷⁷ The second diverter valve **219** (e.g. second valve) is then closed for a “short period of time.”⁷⁸ At the same time, the first diverter valve **218** (e.g., first valve) remains open to provide a decreased flow rate (shown as **232** in Fig. 7) to the second well **204** and an increased flow rate (shown as **222** in Fig. 7) to

⁷⁷ Ex. 1036 at 12:7-8.

⁷⁸ Ex. 1036 at 12:8-11.

the first well **202** for a “short period of time.”⁷⁹ In the annotated Fig.6 below, hydraulic fluid flow paths to the first well are identified in pink, and hydraulic fluid flow paths to the second well are identified in green.

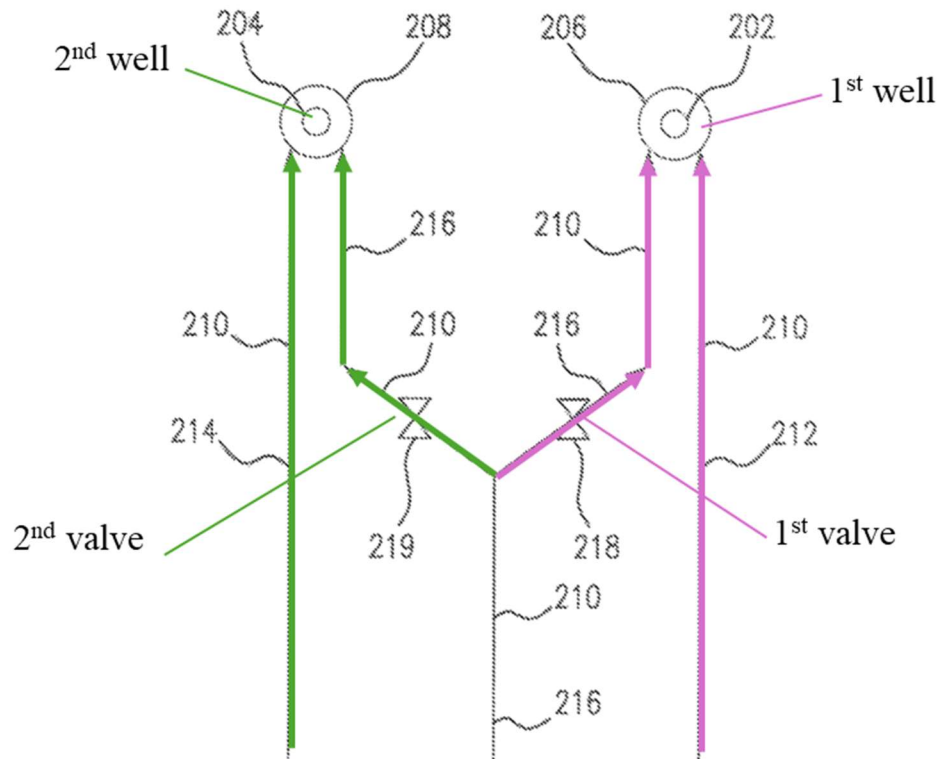


FIG. 6

128. A POSITA would have understood, based on the description of the sequence of events, particularly the “short period of time” and the flowrates depicted in Fig. 7, that, after the short period of time with the second diverter valve closed, the second valve (e.g., **219**) is opened to resume fluid flow “to both of the wellheads

⁷⁹ *Id.*

202, 204.”⁸⁰ The sequence of events is depicted in Fig. 7. As with Fig. 6 above, hydraulic fluid flow paths to the first well are identified in pink, and hydraulic fluid flow paths to the second well are identified in green.

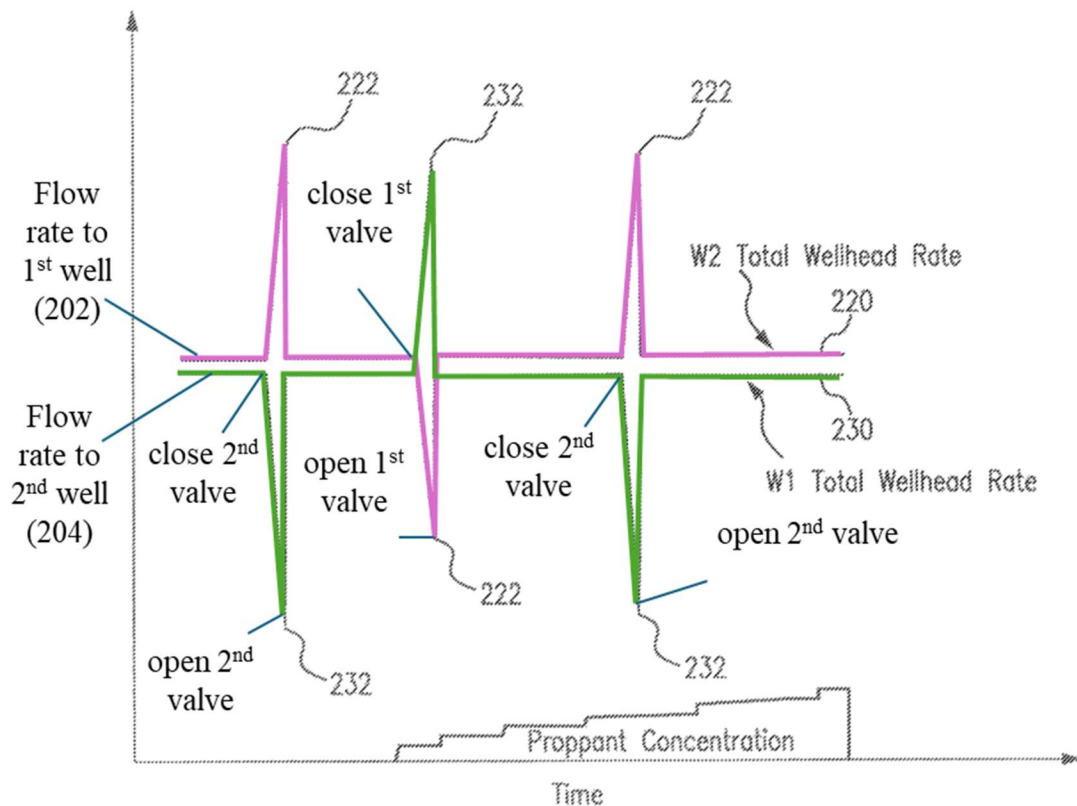


FIG. 7

129. A POSITA would have understood that *Ciezobka*’s disclosure of closing valve **219** for a “short period of time” would include opening a second valve (e.g., **219**) associated with a second well (e.g., **204**) while fluid is being pumped into the first well (e.g., **202**) via the first associated valve (e.g., **218**) and that this occurs while fluid is being pumped to the second well. As Fig. 7, combined with Fig. 6,

⁸⁰ Ex. 1036 at 12:8.

shows, fluid is continuously pumped to both wells **202** and **204** and valves **218** and **219**.

130. The sequence of valve opening and closing is described below using annotated Fig. 6 and Fig. 7, showing valves open (valve body blank) and valves closed (valve body filled in). *Ciezobka* discloses, “Initially, both valves **218** [and **219**] are open, allowing [a] third percentage of flow rate to be provided to both of the wellheads **202**, **204**.”⁸¹ The portion of Fig 7 representative of this stage is shown adjacent.

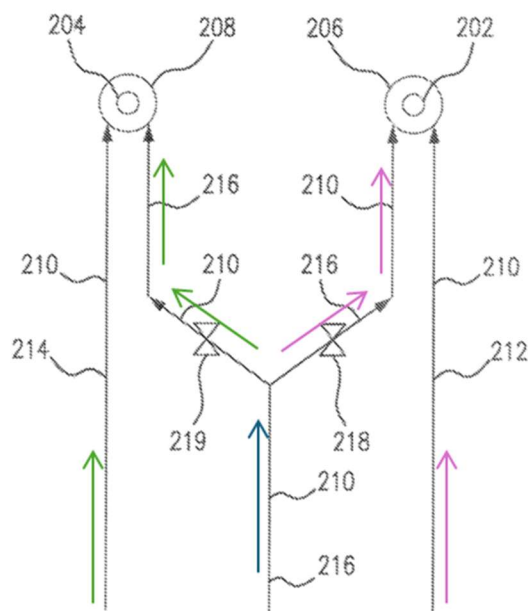


FIG. 6

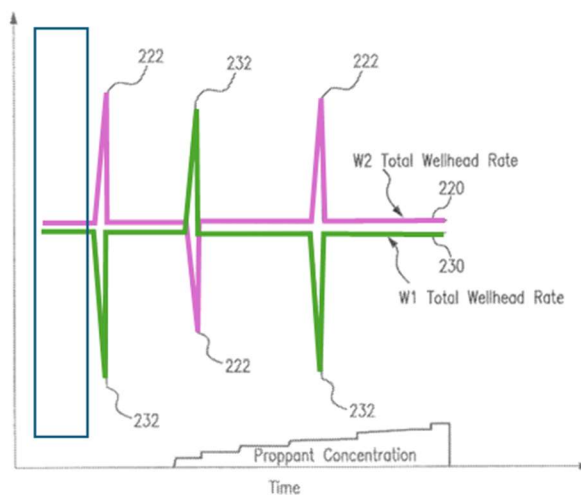
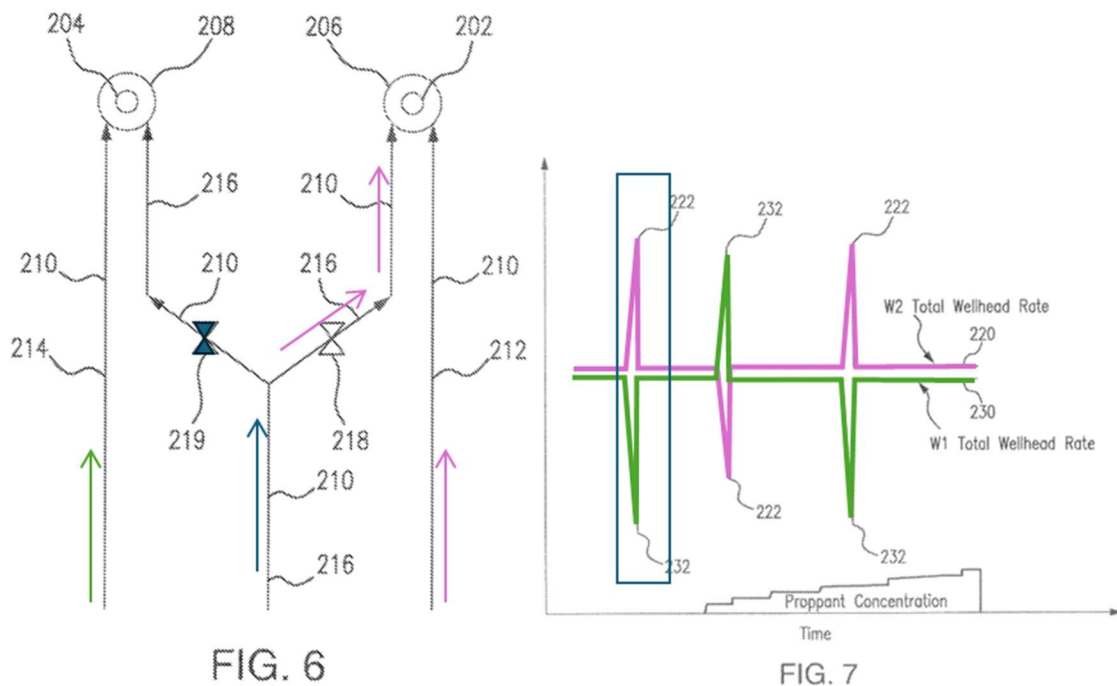


FIG. 7

131. *Ciezobka* further describes, “A pressure pulse ... is induced by closing one of the valves **219**, increasing the total flow rate... to the first wellhead **202** and

⁸¹ Ex. 1036 at 12:7-8.

decreasing the total flow rate... to the second wellhead **204** for a short period of time.”⁸² This case is shown below. As can be seen, fluid is still pumped to valves **218** and **219**. However, valve **219** is closed, and flow is restricted to the second well.



132. This stage is represented in Fig. 7 in the annotated portion up to the time of events **222** / **232**. At the time of events **222** and **232**, valve **219** is opened, allowing full fracturing fluid flow to second well **204** to resume. Pressure stabilizes, and flow to the wells stabilizes. During the opening of the second valve (e.g., **219**), fluid is continuously pumped into the first well (**202**) via the first valve (**218**).

⁸² Ex. 1036 at 12:8-11.

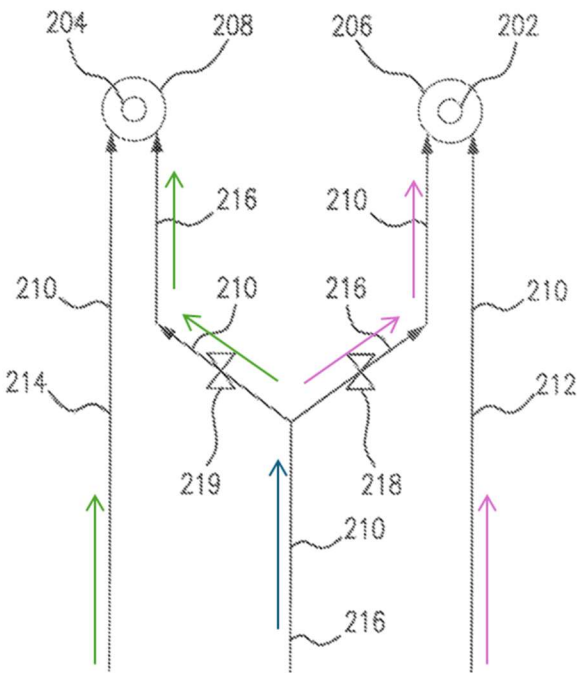


FIG. 6

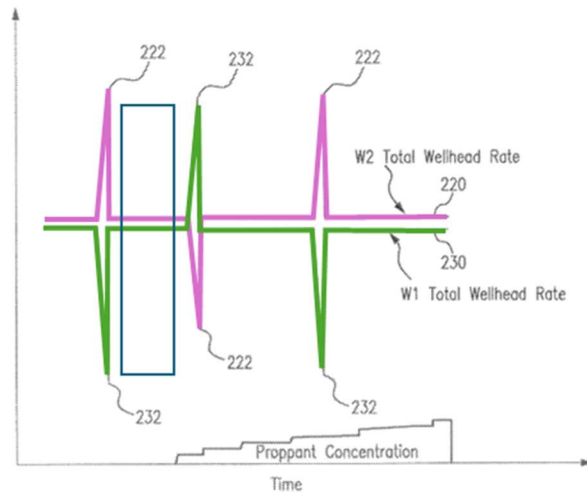


FIG. 7

133. Accordingly, *Ciezobka* discloses during the pumping of the fluid into the first well (202) via the first valve (218), opening a second valve (219) associated with the second well (204), and communicating fluid to the second well via the second valve. A POSITA would have recognized that the second valve is opened in response to the pulse flowrates (fluid condition) into the first and second wells being met—e.g., the flowrate into the second well dropping to a specific level such as “25% to 75% lower” or “50%” lower than the primary flowrate and the flowrate into the first well inversely increasing. Further, a POSITA would also have recognized that reducing flow by closing a valve “for a short period of time” is another example

of a fluid condition. As discussed above, action (closing, opening valves) takes place “in response to” meeting these fluid conditions (i.e., flow rate and time).

134. To the extent that *Ciezobka* does not explicitly state that the second valve opening is “in response to” the fluid conditions (i.e., reduced flowrates and/or a “short period of time”), it would have been obvious to a POSITA to use flowrate and/or time conditions as a trigger to open the second valve based on *Ciezobka*’s teachings of specific flowrate percentages, as well as “a short period of time.” A POSITA would have understood that fluid conditions, i.e., flowrate percentages such as “50% lower”, were the desired conditions of the system of *Ciezobka* during a pulse, and, once that flow rate had been established, the pulses were performing as desired (i.e., the specific volume of fluid had flowed into the well to initiate the pressure pulse). Accordingly, it would have been obvious to a POSITA to open the valve once the desired reduced flow rate had been reached.

135. Accordingly, *Ciezobka* discloses, or at least renders obvious, Limitation 1.3.

d. 1.4: “closing the first valve after opening the second valve.”

136. *Ciezobka* discloses this limitation. As discussed above regarding Limitation 1.3, *Ciezobka* teaches several switching sequences, including “closing the first valve after opening the second valve.” For example, Fig. 7 of *Ciezobka* depicts a series of switching events that occur over time.

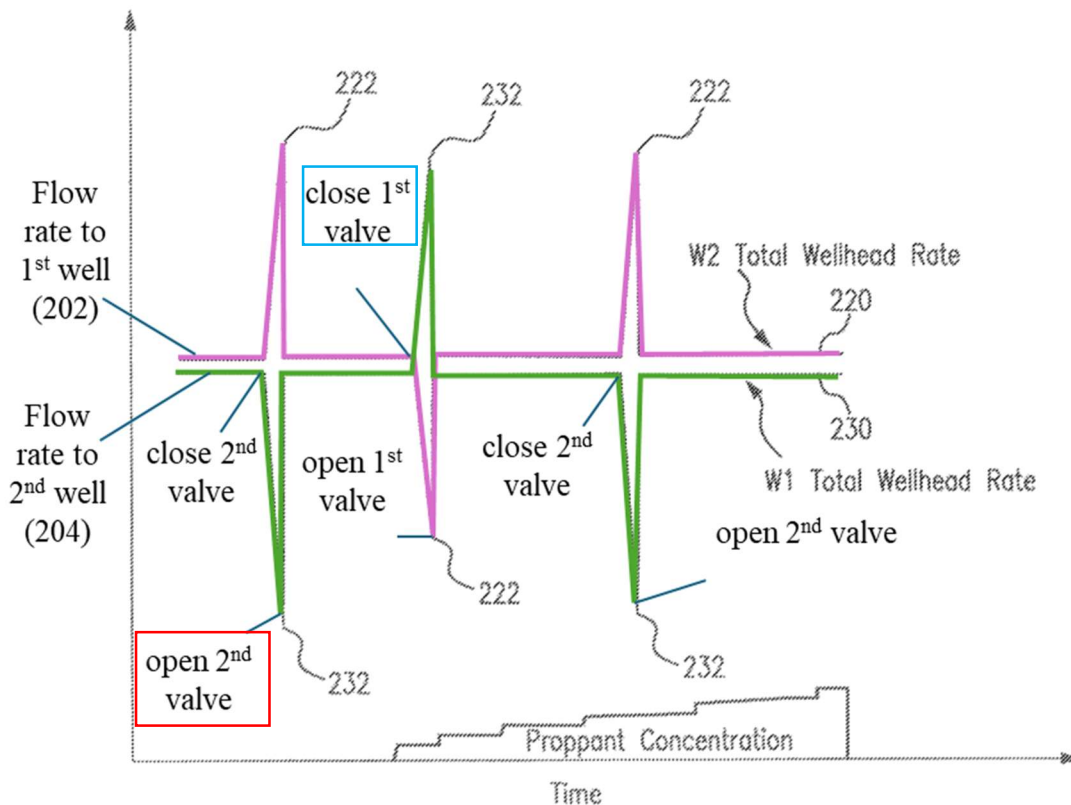


FIG. 7

137. The initial event shown in Fig. 7 is to “close 2nd valve” and then to “open 2nd valve” (annotated in red). Both occur before the event “close 1st valve” (annotated in blue) takes place. Accordingly, *Ciezobka* discloses “closing the first valve after opening the second valve,” as claimed in Limitation 1.4.

138. Because *Ciezobka* discloses each and every element of Claim 1, Claim 1 is anticipated and/or rendered obvious by *Ciezobka*.

B. DEPENDENT CLAIM 2

139. Dependent Claim 2 depends from Claim 1. In addition to the disclosure of the limitations of Claim 1 discussed above, *Ciezobka* discloses, or at least renders obvious, the additional limitations of Claim 2:

- a. **2.1: “2. The method of claim 1, further comprising: communicating fluid to a third well via the manifold and a third valve, the third valve being associated with both the manifold and the third well; and”**

140. *Ciezobka* discloses this limitation, or at least renders it obvious.

141. As discussed above regarding Claim 1, *Ciezobka* discloses opening/closing valves to associated first and second wells to alternate delivering pulses of increased and decreased flow rates into the wells, where the pulses of increased flow rate open new fractures in the well. *Ciezobka* teaches valves associated with the first well (i.e., **218**) and the second well (i.e., **219**). These valves are used as part of a hydraulic fracturing method. *Ciezobka* further discloses, when discussing its system and method, “[s]imilar variations may utilize multiple wells or multiple fluid flow lines to the wellhead or from one or more pumps.”⁸³ There is no limitation in *Ciezobka* restricting “multiple wells” to one or two wells. Accordingly, a POSITA would recognize the teachings of *Ciezobka* to include a third, fourth, or any number of wells.

⁸³ Ex. 1036 at 28:22-23.

142. To the extent the Board finds that *Ciezobka* does not expressly disclose “third and fourth wells”, it would have been obvious to a POSITA to apply the teachings of a “first and second well” from *Ciezobka* to a “third and fourth well” to take advantage of the increased hydrocarbon production, operating efficiencies, and reduced friction taught by *Ciezobka* at multiple well locations, not just one or two.

143. Further, As discussed above regarding the preamble, *Ciezobka* discloses communicating fluid to a well in a multi-well environment. As was well known to a POSITA, a well pad may include one, two, three, four, or more wells. Thus, although *Ciezobka* discusses a first well and a second well in detail, it would have been obvious to a POSITA to perform the same method or sequence of the first and second wells on a third well, a fourth well, and any additional wells based on *Ciezobka*’s teaching of performing the method on multiple wells. Moreover, mere repetition of elements has no patentable significance unless a new and unexpected result is produced. Here, performing the method of Claim 1 on additional wells in the same environment (*i.e.*, third well and fourth well) would be performed in the same way and produce the same expected results as in the first and second well and, therefore, would have been obvious to a POSITA.

144. As discussed above regarding Limitation 1.1, *Ciezobka* teaches that fluid is supplied to the valves and wells via a manifold. This teaching would apply to the third (and fourth) valves and wells as well.

145. Accordingly, *Ciezobka* discloses, or at least renders obvious, Limitation 2.1.

b. **2.2: “in response to determining that the fluid communicated via the manifold has satisfied the one or more conditions:”**

146. *Ciezobka* discloses, or at least renders obvious, this limitation. This limitation is identical to Limitation 1.2 discussed above and is disclosed by *Ciezobka* for the same reasons. Limitation 1.2 would have also been equally applicable to third and fourth wells and valves, as *Ciezobka* discloses its methods can be used with “multiple wells.”⁸⁴ Thus, a POSITA would have understood that in the same way *Ciezobka* discloses opening and closing valves to first and second wells in response to determining pulse fluid flow conditions to the first/second wells are met, valves to third and fourth wells would be opened and closed in response to determining pulse fluid flow conditions to the third/fourth wells are met.

147. Accordingly, *Ciezobka* discloses Limitation 2.2.

c. **2.3: “opening a fourth valve; communicating fluid to a fourth well via the fourth valve; and**

148. *Ciezobka* discloses, or at least renders obvious, opening a fourth valve and communicating fluid to a fourth well via the fourth valve. Based on the discussion regarding Limitation 2.1 above, *Ciezobka* discloses, or at least suggests,

⁸⁴ Ex. 1036 at 28:22-25.

applying its switching method and system to “multiple wells” which would include a fourth well. Based on that analysis, *Ciezobka* teaches “opening a fourth valve” and “communicating fluid to a fourth well via the fourth valve” for the same reasons as those regarding “opening a second valve; communicating fluid to a second well via the second valve” from Limitation 1.3.

149. Accordingly, *Ciezobka* discloses, or at least renders obvious, the limitations of 2.3.

d. 2.4: “closing the third valve after opening the fourth valve.”

150. *Ciezobka* discloses, or at least renders obvious, opening a fourth valve and communicating fluid to a fourth well via the fourth valve. Based on the discussion regarding limitation 2.1 above, *Ciezobka* discloses, or at least suggests, applying its switching method and system to “multiple wells,” which would include a fourth well. Based on that analysis, *Ciezobka* teaches “closing the third valve after opening the fourth valve” for the same reasons as those regarding “closing the first valve after opening the second valve” from Limitation 1.4.

151. Accordingly, *Ciezobka* discloses, or at least renders obvious, Limitation 2.4.

152. Because *Ciezobka* discloses, or at least renders obvious, each and every element of Claim 2, Claim 2 is anticipated and/or rendered obvious by *Ciezobka*.

C. DEPENDENT CLAIM 3

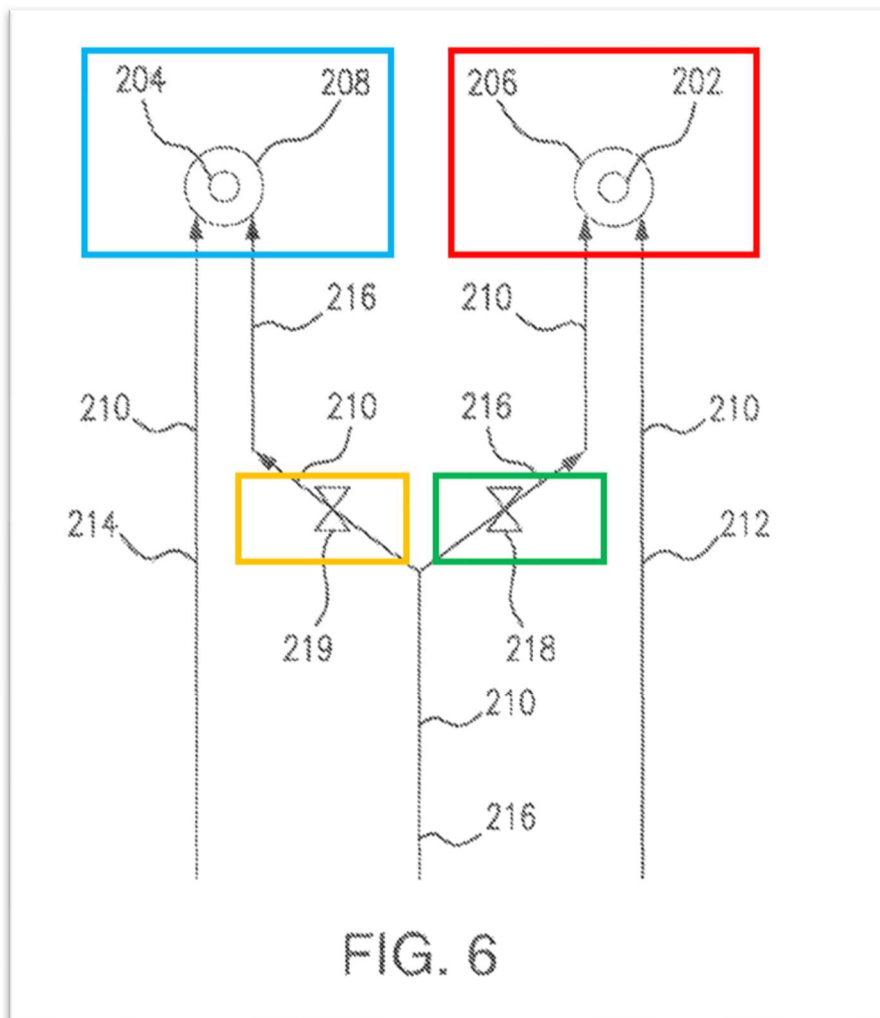
153. Dependent Claim 3 depends from Claim 2, which depends from Claim 1. In addition to the disclosure of the limitations of Claims 1 and 2 discussed above, *Ciezobka* renders the additional limitations of Claim 3 obvious:

- a. **3.1: “3. The method of claim 2, wherein: the first valve is closed after opening both the second valve and the fourth valve; and/or”**

154. As discussed above regarding Claim 2, *Ciezobka* teaches directing fluid between wells continuously by operating the valves associated with individual wells.

155. *Ciezobka* discloses, “the high-pressure fracturing pump provides a first total flow rate **220** to the first wellhead **202** [annotated in red] and a second total flow rate **230** to the second wellhead **204** [annotated in blue]. Initially, both valves **218** [sic **218, 219** annotated in yellow, green] are open allowing the third percentage of the flow rate to be provided to both of the wellheads **202, 204**.”⁸⁵

⁸⁵ Ex. 1036 at 12:5-8.



156. In addition to the explicit valves **218** associated with the first well **202** and **219** associated with well **204**, *Ciezobka* teaches that “one or more of the flow lines **44** may include a valve, not shown, that can be opened and closed to restrict a flow of fluid to the wellbore”.⁸⁶ Thus, applying this teaching to Fig. 6, a POSITA would understand flow lines **212** and **214** to include valves that can be opened and closed to restrict fluid to wellbores **202** and **204**.

⁸⁶ Ex. 1036 at 11:21-23.

157. *Ciezobka* further teaches, “[t]he manifold receives the fracturing fluid, with or without proppant, at a low pressure from the pre-blender or the slurry-blender and distributes the fluid and/or slurry to the high-pressure fracturing pumps. The manifold then receives the fluids at a high pressure from the high-pressure fracturing pumps and directs the fluid to a ground iron leading to the wellhead and wellbore.”⁸⁷ Further still, “the flow line comprises a plurality of pipes which connect the high pressure fracturing pumps, through a single or multiple common manifolds, to a wellhead of the wellbore. In an embodiment of this invention, the plurality of flow lines comprise at least one constant-flow flow line and at least one variable-flow flow line.”⁸⁸ A POSITA would have understood, based on the teachings of *Ciezobka*, that flow lines **212**, **214**, and **216** as well as valves **218** and **219** to be supplied fluid “through a single or multiple common manifolds.”

158. As discussed above regarding Claim 16, a POSITA would have understood the teachings of *Ciezobka* to contain “variations [that] may utilize multiple wells,”⁸⁹ with no limitation on the number of wells. Further, a POSITA would have found it obvious to apply the teachings of *Ciezobka* to a third well, fourth well, and any number of wells, as discussed regarding Claim 2. Accordingly, a POSITA would understand the teachings of *Ciezobka* regarding a manifold and

⁸⁷ Ex. 1036 at 3:10-14.

⁸⁸ Ex. 1036 at 3:16-20.

⁸⁹ Ex. 1036 at 28:22-23.

continually pumping to a first valve and second valve to apply equally to a manifold associated with a third valve and a fourth valve, or at least a POSITA would have found it obvious to do so.

159. Further, *Ciezobka* discloses using “multiple flow lines” and “one or more pumps.” Accordingly, a POSITA would have found it obvious to, for example, create a pulse in the first and third wells simultaneously using different pumps and valves to take advantage of the efficiency taught by *Ciezobka*. Similarly, a POSITA would have found it obvious to, for example, create a pulse in the second and fourth wells simultaneously using different pumps and valves to take advantage of the efficiencies of *Ciezobka*.

160. As discussed above regarding Limitation 1.4, *Ciezobka* discloses closing the first valve after the second valve is opened. In a method where wells 2 and 4 are on the same pad and receive treatment “simultaneously,” as taught or suggested by *Ciezobka*, the second and fourth valves would be opened and closed simultaneously, and the first valve would be closed after the second and fourth valves are opened in order to take advantage of the creation of zipper fractures, which were known.⁹⁰

161. Further, as it is known to use multiple fracturing “fleets” to perform fracturing operations at multiple wellpads at the same time, it would be obvious,

⁹⁰ See sections X.D-X.F

while performing the valve switching, pulse generating techniques of *Ciezobka* at at least two wellpads at the same time. In such a case, it would be nearly inevitable that, at some point in the “simultaneous” fracturing operation at multiple pads, the first valve would be closed after the second valve is opened (as specifically disclosed by *Ciezobka*) and after the fourth valve is opened.

162. For example, Fig. 7, showing the switching operation and corresponding flowrates of a first well (annotated in pink) and a second well (annotated in green), is shown below, along with a second Fig. 7 annotated to show the switching operation and corresponding flowrates of a third well (annotated in green) and a fourth well (annotated in blue) occurring at the same time, using, for example, “a single or multiple common manifolds” to pump to “multiple wells.”⁹¹ Accordingly, the flow rates would line up temporally, as shown.

⁹¹ Ex. 1036 at 3:16-18 and 28:22-25.

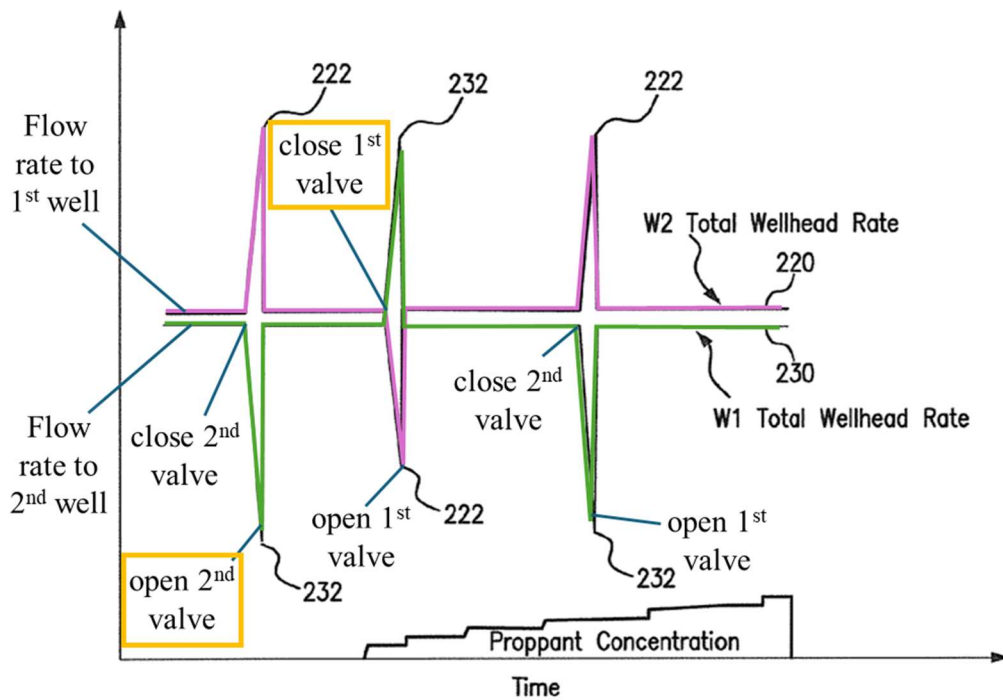


FIG. 7
(Annotated)

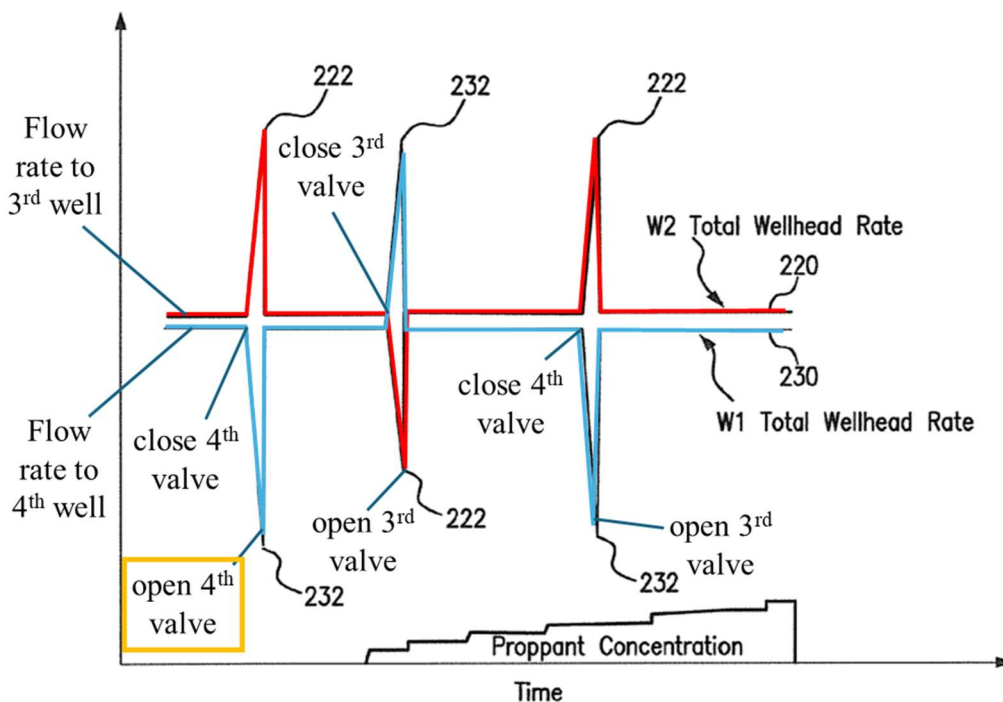


FIG. 7
(Annotated)

163. As seen in the above Figures, the first valve would be closed after the second valve is opened and the fourth valve is opened (events annotated in orange).

164. Additionally, Limitation 3.1 is the first prong in an “and/or” Claim. Thus, because Limitation 3.1 is disclosed or at least rendered obvious by *Ciezobka*, Claim 3 as a whole is at least rendered obvious by *Ciezobka*. Further, as discussed below, *Ciezobka* also renders obvious the second prong of the “and/or” statement contained in Limitation 3.2.

b. 3.2: “the third valve is closed after opening both the second valve and the fourth valve.”

165. For the same reasons discussed above regarding Limitation 3.1, *Ciezobka* renders obvious simultaneous treatment of the second and fourth wells. Further, for the same reasons, *Ciezobka* teaches or at least renders obvious simultaneous treatment of the first and third well. In a method where wells 1 and 3 are “simultaneously treated” and switched with wells 2 and 4 according to the method of *Ciezobka*, the second and fourth valves would be opened and closed simultaneously, and the first and third valve would be closed simultaneously, and after the second and fourth valves are opened.

166. Accordingly, Claim 3 is obvious over *Ciezobka* alone for the above reasons.

D. DEPENDENT CLAIM 4

167. Dependent Claim 4 depends from Claim 1. In addition to the disclosure of the limitations of Claim 1 discussed above, *Ciezobka* discloses the limitations of Claim 4:

a. 4: “4. The method of claim 1, wherein the one or more conditions include one or more flow rate conditions.”

168. As discussed above regarding Limitation 1.2, *Ciezobka* discloses the use of flow rate thresholds, including percentages such as “from 10% to nearly 100% lower”, “25% to 75% lower,” and “50% lower” than the primary flow rate.⁹² Further, specific flowrate conditions are disclosed, such as “for example, the constant flow line supplies a constant flow rate **92** of 50% of the total flow, equaling 45 bpm, and the variable flow line supplies a variable flow rate **94** of 50% of the total flow, equaling 45 bpm.”⁹³ Each of these are as fluid conditions disclosed by *Ciezobka* which are specifically flowrates. *Ciezobka* further teaches that flowrate “parameters” for delivering fluid pulses to a well include “magnitude of change and duration.”⁹⁴ For example, *Ciezobka* teaches delivering a fluid pulse to a well at a pulse flow rate for a pulse period of time.⁹⁵ Thus, *Ciezobka* teaches that flow rate conditions also include a flow rate duration.

⁹² See, e.g. Ex. 1036 at 4:3-15.

⁹³ Ex. 1036 at 10:31-34, see also 9:4-13.

⁹⁴ Ex. 1036 at 15:16-21.

⁹⁵ Ex. 1036 at 4:2-15.

169. Accordingly, the limitations of Claim 4 are disclosed by *Ciezobka*, and Claim 4 is anticipated by *Ciezobka*, or in the alternative, obvious over *Ciezobka* alone for the above reasons.

E. DEPENDENT CLAIM 5

170. Dependent Claim 5 depends from Claim 4, which depends from Claim 1. In addition to the disclosure of the limitations of Claims 1 and 4 discussed above, *Ciezobka* discloses the additional limitations of Claim 5:

- a. **5: “5. The method of claim 4, wherein the fluid communicated via the manifold has satisfied the one or more flow rate conditions when a flow rate of the fluid is below an upper threshold, above a lower threshold, or both.”**

171. As discussed above regarding Limitation 1.2 and Claim 4, *Ciezobka* discloses the use of flowrate thresholds, including percentages such as “from 10% to nearly 100% lower”, “25% to 75% lower,” and “50% lower” than the primary flowrate.⁹⁶ Each of these would have been recognized as an example of fluid conditions disclosed by *Ciezobka*, which are specifically flowrates. Further, a flow that is between “25% to 75% lower” than the primary flow rate, for example, would be both below “25% lower” (upper threshold) and above “75% lower” (lower threshold) of the primary flow rate.

⁹⁶ See, e.g. Ex. 1036 at 4:3-15.

172. Further, a pulse of a flow rate change to the first well is induced by closing the second diverter valve **219**, thereby “increasing the total flow rate **220** to the first wellhead **202** and decreasing the total flow rate **230** to the second wellhead **204** for a short period of time.”⁹⁷ After the pulse to the first well is delivered, meeting the first pulse flow rate conditions (e.g., within the pulse flow rate range and for the pulse period of time), the second diverter valve **219** is reopened to resume the third percentage of fluid flow to both of the first and second wells.⁹⁸

173. Additionally, in Figs. 6-7, a first percentage of fluid pumped from a fracturing system (which includes a manifold) is directed to the first well via a first constant rate flowline, a second percentage of the fluid is directed to the second well via a second constant rate flowline, and a third percentage of the fluid is directed to the first and/or second wells via an associated diverter flowline.⁹⁹ Thus, when the second diverter valve **219** along the second diverter flowline to the second well is closed, the “third percentage” flow is prevented from entering the second well, and instead, the “third percentage” flow is diverted into the first well, thereby “increasing the total flow rate” to the first well “and decreasing the total flow rate” to the second well for a pulse period of time.¹⁰⁰

⁹⁷ Ex. 1036 at 12:8-11.

⁹⁸ Ex. 1036 at Fig. 7.

⁹⁹ Ex. 1036 at 11:28-12:2.

¹⁰⁰ Ex. 1036 at 12:1-11.

174. When the “third percentage” flow is diverted away from the second well and into the first well, the decreased total flowrate to the second well preferably “ranges from 25% to 75% lower” than the initial total flowrate to the second well and is decreased for the “pulse period of time.”¹⁰¹ A POSITA would understand that with the “third percentage” flow diverted into the first well, an inverse flow rate increase would be provided to the first well, also within a flow rate change range (between an upper and lower threshold) for the pulse period of time, as shown by the flow rate peak **222** of fluid flow pulsed to the first well in Fig. 7.¹⁰² Thus, the pulse flow rate conditions for fluid pumped to the first well are met when the inverse flow rate increase (e.g., between the thresholds of 25% and 75% change in flow rate) is directed into the first well for the pulse period of time.

175. In the cases where the flow rate is, for example, below an upper threshold, the second valve would be opened to re-establish 100% of the primary flow rate, as discussed above regarding Limitation 1.3. Accordingly, *Ciezobka* discloses both prongs of the “or” statement contained in Claim 5.

176. Accordingly, the limitations of Claim 5 are disclosed by *Ciezobka*, and Claim 5 is anticipated by *Ciezobka*, or in the alternative, obvious over *Ciezobka* alone for the above reasons.

¹⁰¹ Ex. 1036 at 4:6-7; 12:19-20.

¹⁰² Ex. 1036 at 12:4-10.

F. DEPENDENT CLAIM 6

177. Dependent Claim 6 depends from Claim 4, which depends from Claim

1. In addition to the disclosure of the limitations of Claims 1 and 4 discussed above, *Ciezobka* discloses the additional limitations of Claim 6:

- a. **6. The method of claim 4, wherein the fluid communicated via the manifold has not satisfied the one or more flow rate conditions when a flow rate of the fluid is above an upper threshold or below a lower threshold.**

178. As discussed above regarding Limitation 1.2 and Claim 4, *Ciezobka* discloses the use of flowrate thresholds, including percentages such as “from 10% to nearly 100% lower”, “25% to 75% lower,” and “50% lower” than the primary flowrate (or the inverse for pulses with flow rate increases).¹⁰³ Each of these would have been recognized as fluid conditions, which are specifically flowrates. Further, a POSITA would recognize a flow that is outside of the pulse flow rate range (e.g., above “25% lower” than the primary flow rate, for example, to be above the upper threshold, and a flowrate below “75% lower” than the primary threshold to be below a lower threshold) as not meeting flow rate conditions for delivering the fluid pulse. When the fluid flow does not meet the pulse flow rate conditions, a POSITA would recognize that the second valve would not be opened. Accordingly, *Ciezobka* discloses both prongs of the “or” statement in Claim 6.

¹⁰³ See, e.g. Ex. 1036 at 4:3-15.

179. To the extent that *Ciezobka* does not explicitly state that the flow rate condition is not met when the flow rate is above an upper threshold or below a lower threshold, it would have been obvious to a POSITA that that was the case. Whenever a flow rate is outside of a flow rate range, that flow rate does not meet the flow rate range condition.

180. Accordingly, the limitations of Claim 6 are disclosed, or at least rendered obvious, by *Ciezobka*. Claim 6 is anticipated by *Ciezobka*, or in the alternative, obvious over *Ciezobka* alone for the above reasons.

G. DEPENDENT CLAIM 7

181. Dependent Claim 7 depends from Claim 1. In addition to the disclosure of the limitations of Claim 1 discussed above, *Ciezobka* discloses the additional limitations of Claim 7:

a. 7: “7. The method of claim 1 further comprising: pumping the fluid into the manifold.”

182. *Ciezobka* discloses this limitation. *Ciezobka* teaches, “[t]he manifold receives the fracturing fluid, with or without proppant, at a low pressure from the pre-blender or the slurry-blender and distributes the fluid and/or slurry to the high-pressure fracturing pumps. The manifold then receives the fluids at a high pressure from the high-pressure fracturing pumps and directs the fluid to a ground iron

leading to the wellhead and wellbore.”¹⁰⁴ A POSITA would have recognized “the manifold the receives the fluids at a high pressure from the high-pressure fracturing pumps” to disclose “pumping fluid into the manifold.”

183. Accordingly, the limitations of Claim 7 are disclosed by *Ciezobka*, and Claim 7 is anticipated by *Ciezobka*, or in the alternative, obvious over *Ciezobka* alone for the above reasons.

H. DEPENDENT CLAIM 8

184. Dependent Claim 8 depends from Claim 1. In addition to the disclosure of the limitations of Claim 1 discussed above, *Ciezobka* discloses the limitations of Claim 8:

- a. **8: “8. The method of claim 1, further comprising: determining that the fluid communicated via the manifold has satisfied the one or more conditions.”**

185. Claim 8 is a portion of Limitation 1.2 and is disclosed by *Ciezobka* for the same reasons as those discussed above regarding Limitation 1.2 in Section XII.A.b. For example, *Ciezobka* describes with Figures 6 and 7 that when a flow rate change is provided to a well for a pulse period of time, a valve is operated to move the fracturing operation to the next step.

¹⁰⁴ Ex. 1036 at 3:10-14.

186. Accordingly, the limitations of Claim 8 are disclosed by *Ciezobka*, and, Claim 8 is anticipated by *Ciezobka*, or in the alternative, obvious over *Ciezobka* alone for the above reasons.

I. DEPENDENT CLAIM 9

187. Dependent Claim 9 depends from Claim 8, which depends from Claim 1. In addition to the disclosure of the limitations of Claims 1 and 8 discussed above, *Ciezobka* discloses the additional limitations of Claim 9:

- a. **9. The method of claim 8, wherein determining that the fluid communicated via the manifold has satisfied the one or more flow rate conditions comprises determining that a flow rate of the fluid is below an upper threshold, above a lower threshold, or both.**

188. First, Claim 9 lacks antecedent basis for “the one or more flow rate conditions,” unless the fluid condition of Claim 1 is interpreted as limited to “one or more flow rate conditions.” Nevertheless, except for depending from Claim 8, Claim 9 is identical to Claim 5 and the limitations of Claim 9 are disclosed by *Ciezobka* for the same reasons as those described above regarding Claim 5 in Section XII.E.

189. Accordingly, the limitations of Claim 9 are disclosed by *Ciezobka*, and Claim 9 is anticipated by *Ciezobka*, or in the alternative, obvious over *Ciezobka* alone for the above reasons.

J. DEPENDENT CLAIM 10

190. Dependent Claim 10 depends from Claim 1. In addition to the disclosure of the limitations of Claim 1 discussed above, *Ciezobka* discloses the additional limitations of Claim 10:

- a. **10: “10. The method of claim 1, wherein the fluid communicated via the manifold is hydraulic fracturing fluid.”**

191. *Ciezobka* discloses the limitations of Claim 10. *Ciezobka* teaches, “[t]he manifold receives the fracturing fluid, with or without proppant, at a low pressure from the pre-blender or the slurry-blender and distributes the fluid and/or slurry to the high-pressure fracturing pumps. The manifold then receives the fluids at a high pressure from the high-pressure fracturing pumps and directs the fluid to a ground iron leading to the wellhead and wellbore.”¹⁰⁵ A POSITA would immediately recognize the “fracturing fluid” received from the pre-blender, the “fluid and/or slurry” being discharged from a blender and the “fluid” discharged from the pumps to each be hydraulic fracturing fluid, although of potentially different compositions and pressures.

192. Accordingly, the limitations of Claim 10 are disclosed by *Ciezobka*, and *Ciezobka* anticipates and/or renders obvious Claim 10 for the above reasons.

¹⁰⁵ Ex. 1036 at 3:10-14.

K. DEPENDENT CLAIM 11

193. Dependent Claim 11 depends from Claim 1. In addition to the disclosure of the limitations of Claim 1 discussed above, *Ciezobka* discloses the additional limitations of Claim 11:

- a. **“11. The method of claim 1, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.”**

194. *Ciezobka* discloses this limitation, or at least renders it obvious. The ‘770 Patent describes a zipper valve **170a-170b** as “(such as, for example, gate valves) [annotated in red] operably coupled to, and adapted [to] communicate fluid between the zipper manifold **145** [annotated in blue] and the well **105a** [annotated in green].”¹⁰⁶ A POSITA would have understood that a “gate valve” is a common type of valve used widely throughout the Oil and Gas industry, including in fracturing operations.¹⁰⁷

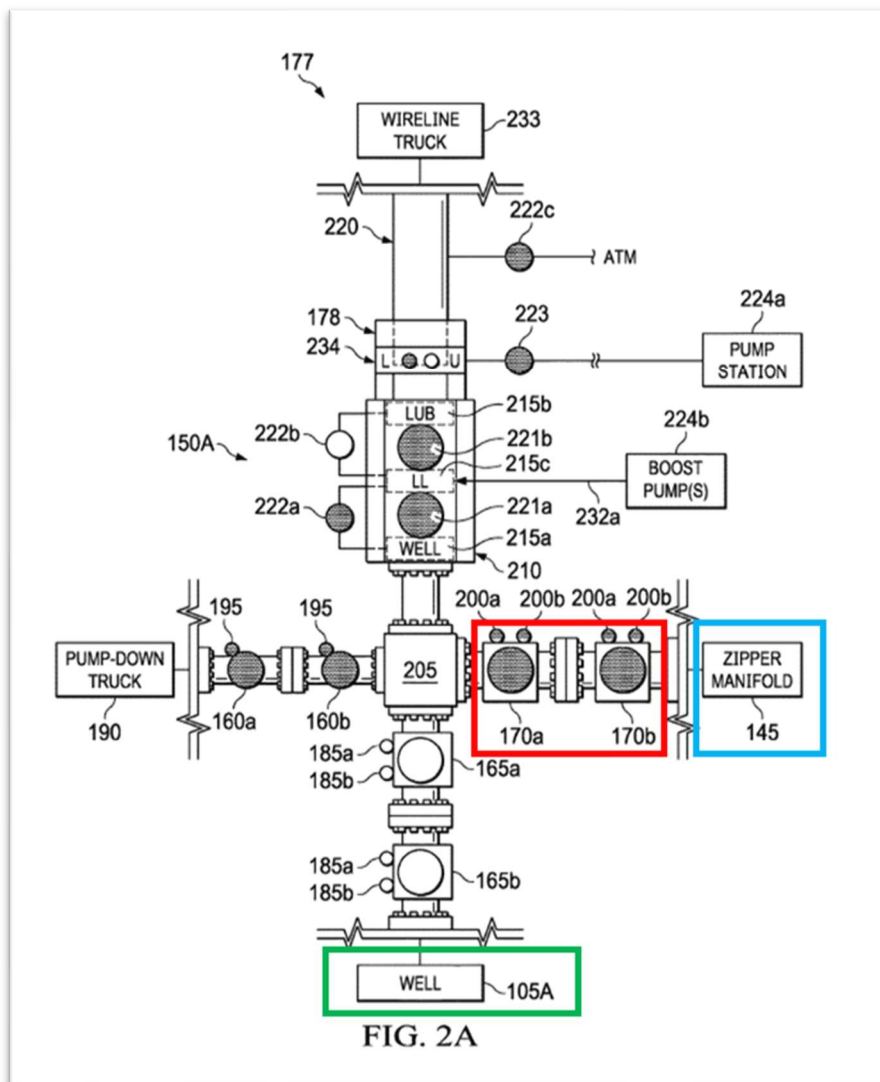
¹⁰⁶ Ex. 1001 at 7:60-63.

¹⁰⁷ See, e.g., API 6A 20th Edition, *Specification for Wellhead and Christmas Tree Equipment*, October 2010 (Ex. 1044).

3.1.51

gate valve

valve assembly with a gate operating within the body, 90° to the conduit, to effect a closure



195. The '770 Patent further describes the zipper manifold as being "adapted to communicate the pressurized hydraulic fracturing fluid from the discharge manifold **130** to a plurality of hydraulic fracturing legs (or "frac legs") **150A** through **150C+n**, each of which is adapted to communicate the pressurized hydraulic fracturing fluid from the zipper manifold **145** to a corresponding one of the wells

105A through **105C+n**.”¹⁰⁸ In other words, a zipper manifold distributes fluid from a pump discharge manifold to multiple wells.

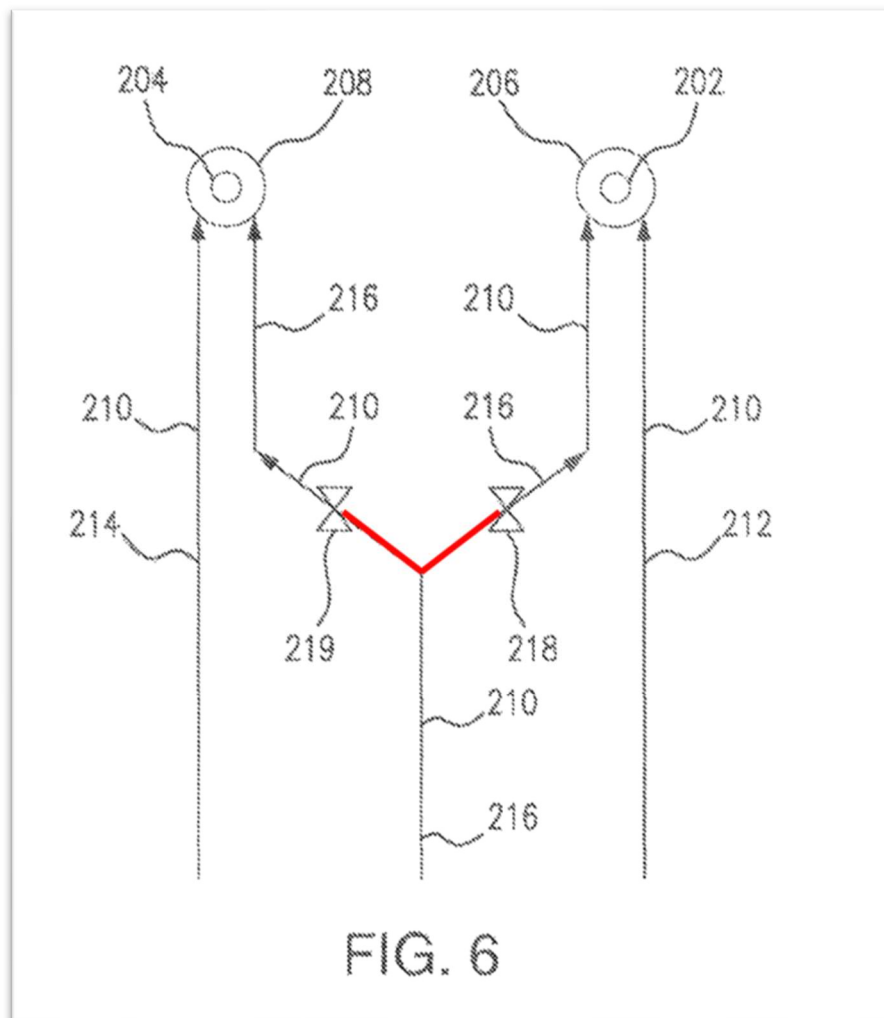
196. *Ciezobka* further teaches, “[t]he manifold receives the fracturing fluid, with or without proppant, at a low pressure from the pre-blender or the slurry-blender and distributes the fluid and/or slurry to the high-pressure fracturing pumps. The manifold then receives the fluids at a high pressure from the high-pressure fracturing pumps and directs the fluid to a ground iron leading to the wellhead and wellbore.”¹⁰⁹ Further still, “the flow line comprises a plurality of pipes which connect the high-pressure fracturing pumps, through a single or multiple common manifolds, to a wellhead of the wellbore. In an embodiment of this invention, the plurality of flow lines comprise at least one constant-flow flow line and at least one variable-flow flow line.”¹¹⁰ A POSITA would have understood, based on the teachings of *Ciezobka*, that flow lines **212**, **214**, and **216** as well as valves **218** and **219** to be supplied fluid “through a single or multiple common manifolds,” including the discharge manifold for the high-pressure pumps. A POSITA would have further understood the manifold connected to valves **218** and **219** to be a “zipper manifold” as it is used to distribute fluid from one of the “common manifolds” (i.e., discharge manifold) to multiple wells through valves **218** and **219**.

¹⁰⁸ Ex. 1001 at 5:55-61.

¹⁰⁹ Ex. 1036 at 3:10-14.

¹¹⁰ Ex. 1036 at 3:16-18.

197. A POSITA would also have understood that the “diverter valves **218**, **219**” would have been valves used to distribute flow in the same manner as the “zipper valves” do and accordingly would have been zipper valves. Based on Ciezobka's teachings explained with Limitation 1.2, these valves are associated with the communicated fluid between the zipper manifold (annotated in red) and the wells (e.g., **202**, **204**).



198. To the extent that the Board determines that the portion of Fig. 6 used to distribute fluid from the flow line 216 to multiple wells is not a “zipper manifold,” it would have been obvious to a POSITA to use a zipper manifold for such a purpose. As discussed above in Sections X.C – X.E, the use of zipper manifolds or zipper fracturing was well known at the time of the filing of the ‘770 Patent.

199. Accordingly, *Ciezobka* discloses Claim 11. To the extent that the Board determines that a “zipper valve” is not explicitly disclosed by *Ciezobka*, then it would have been obvious to a POSITA with general engineering knowledge regarding such operations that the valves associated with zipper manifold would have been “zipper valves,” based on the teachings of *Ciezobka* regarding simultaneous (i.e., zipper) fracturing operations.¹¹¹

200. Accordingly, *Ciezobka* discloses, or at least renders obvious, the limitations of Claim 11. Thus, Claim 11 is anticipated by *Ciezobka*, or in the alternative, obvious over *Ciezobka* alone for the reasons discussed above.

L. DEPENDENT CLAIM 12

201. Dependent Claim 12 depends from Claim 1. In addition to the disclosure of the limitations of Claim 1 discussed above, *Ciezobka* discloses the additional limitations of Claim 12:

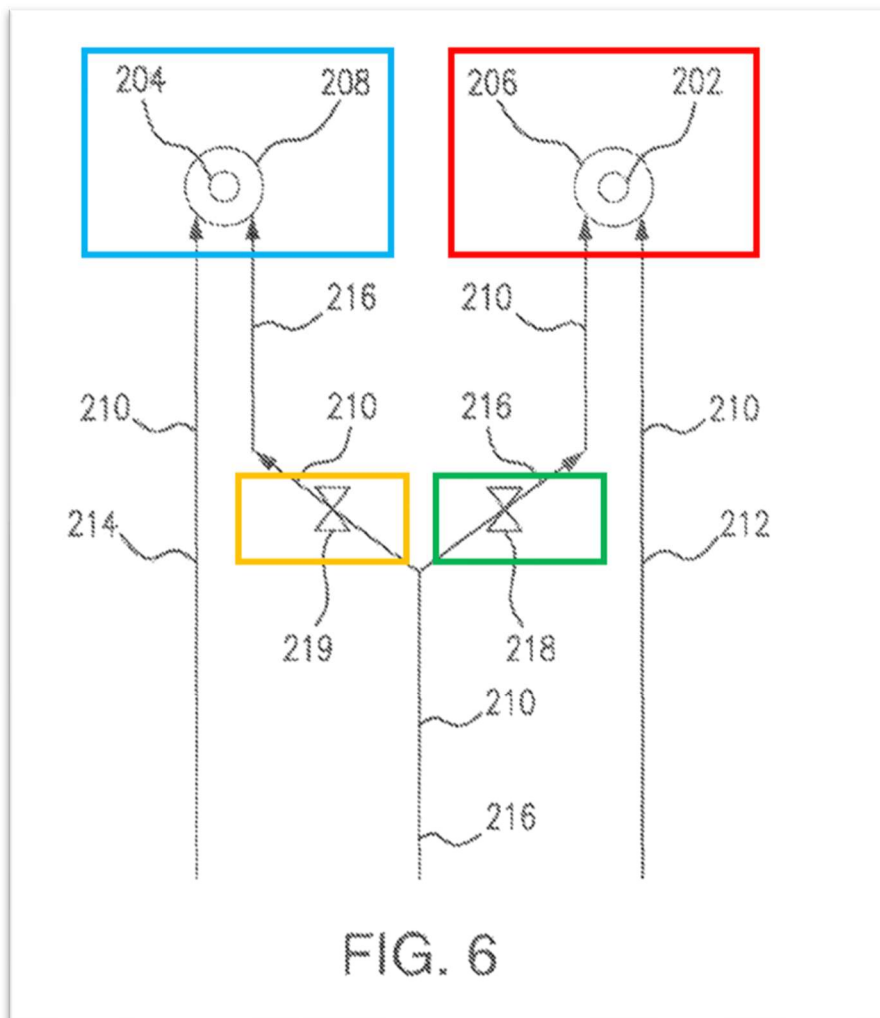
¹¹¹ See, e.g., Sections X.D-X.E

- a. 12.1: “12. The method of claim 1, wherein the second valve is associated with both the manifold and the second well, and”

202. *Ciezobka* discloses the limitations of this Claim. As discussed above regarding Claim 1, *Ciezobka* teaches hydraulic fracturing operations at a multi-well fracturing site.

203. Further still, *Ciezobka* discloses, “the high-pressure fracturing pump provides a first total flow rate **220** to the first wellhead **202** [annotated in red] and a second total flow rate **230** to the second wellhead **204** [annotated in blue]. Initially, both valves **218** [sic **218** and **219** annotated in yellow and green] are open allowing the third percentage of the flow rate to be provided to both of the wellheads **202**, **204**.”¹¹²

¹¹² Ex. 1036 at 12:5-8.



204. In addition to the explicit valves **218** associated with the first well **202** and **219** associated with well **204**, *Ciezobka* teaches that “one or more of the flow lines **44** may include a valve, not shown, that can be opened and closed to restrict a flow of fluid to the wellbore.”¹¹³ Thus, applying this teaching to Fig. 6, a POSITA would understand flow lines **212** and **214** to also include valves that can be opened and closed to restrict fluid to wellbores **202** and **204**.

¹¹³ Ex. 1036 at 11:21-22.

205. *Ciezobka* further teaches, “[t]he manifold receives the fracturing fluid, with or without proppant, at a low pressure from the pre-blender or the slurry-blender and distributes the fluid and/or slurry to the high-pressure fracturing pumps. The manifold then receives the fluids at a high pressure from the high-pressure fracturing pumps and directs the fluid to a ground iron leading to the wellhead and wellbore.”¹¹⁴ Further still, “the flow line comprises a plurality of pipes which connect the high-pressure fracturing pumps, through a single or multiple common manifolds, to a wellhead of the wellbore. In an embodiment of this invention, the plurality of flow lines comprise at least one constant-flow flow line and at least one variable-flow flow line.”¹¹⁵ A POSITA would have understood, based on the teachings of *Ciezobka*, that flow lines **212**, **214**, and **216** as well as valves **218** and **219** to be supplied fluid “through a single or multiple common manifolds” and are, accordingly, associated with both the manifold(s) and the well. Thus, second valve **219** is associated both with second well **204** and the manifold(s).

206. Accordingly, the limitations of 12.1 are disclosed by *Ciezobka*.

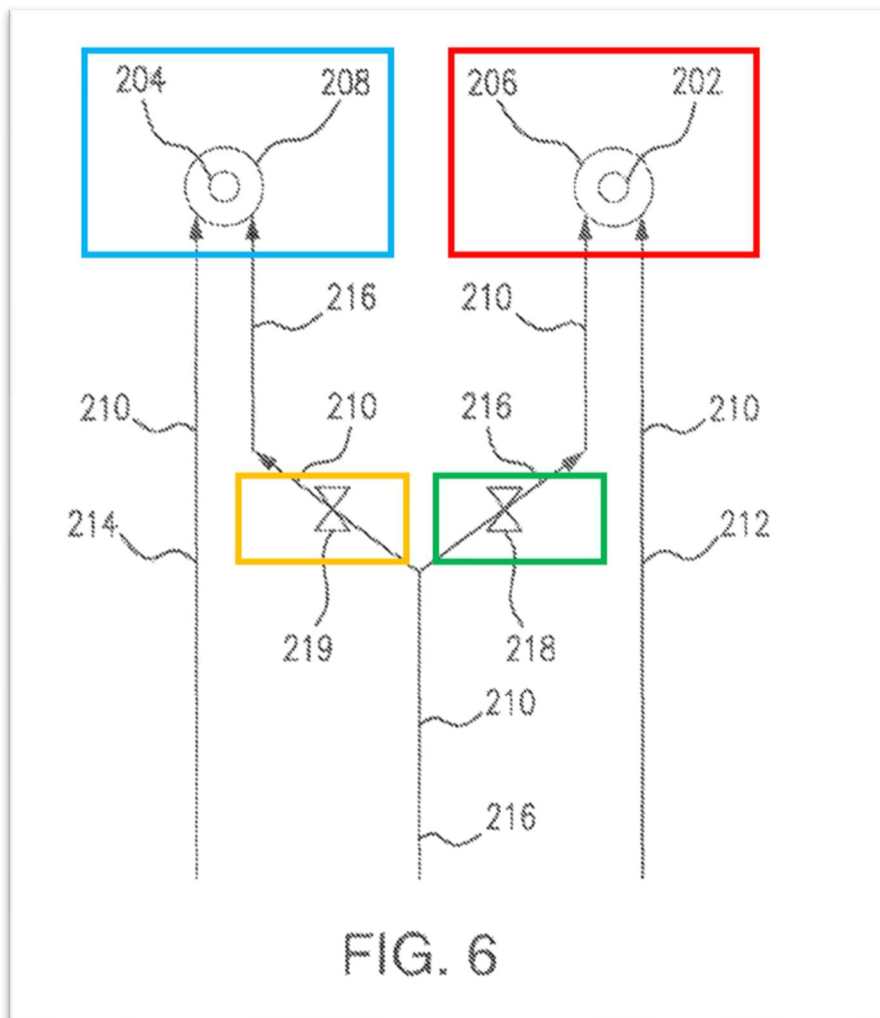
¹¹⁴ Ex. 1036 at 3:10-14.

¹¹⁵ Ex. 1036 at 3:16-20.

- b. **12.2: “wherein communicating fluid to the second well via the second valve comprises communicating fluid to the second well via the manifold and the second valve.”**

207. Further still, *Ciezobka* discloses, “the high-pressure fracturing pump provides a first total flow rate **220** to the first wellhead **202** [annotated in red] and a second total flow rate **230** to the second wellhead **204** [annotated in blue]. Initially, both valves **218** [sic **218,219** annotated in yellow, green] are open, allowing the third percentage of the flow rate to be provided to both of the wellheads **202, 204.**”¹¹⁶

¹¹⁶ Ex. 1036 at 12:5-8.



208. Thus, applying this teaching to Fig. 6, a POSITA would understand flow lines **212** and **214** to also include valves that can be opened and closed to restrict fluid to wellbores **202** and **204**.

209. *Ciezobka* further teaches, “[t]he manifold receives the fracturing fluid, with or without proppant, at a low pressure from the pre-blender or the slurry-blender and distributes the fluid and/or slurry to the high-pressure fracturing pumps. The manifold then receives the fluids at a high pressure from the high-pressure fracturing

pumps and directs the fluid to a ground iron leading to the wellhead and wellbore.”¹¹⁷

Further still, “the flow line comprises a plurality of pipes which connect the high-pressure fracturing pumps, through a single or multiple common manifolds, to a wellhead of the wellbore. In an embodiment of this invention, the plurality of flow lines comprise at least one constant-flow flow line and at least one variable-flow flow line.”¹¹⁸ A POSITA would have understood, based on the teachings of *Ciezobka*, that flow lines **212**, **214**, and **216** as well as valves **218** and **219** to be supplied fluid “through a single or multiple common manifolds.”

210. Accordingly, *Ciezobka* discloses Limitation 12.2.

211. Thus, each and every limitation of Claim 12 is disclosed by *Ciezobka*. Claim 12 is anticipated, or at least rendered obvious, by *Ciezobka* for the above reasons.

M. DEPENDENT CLAIM 13

212. Dependent Claim 13 depends from Claim 12, which depends from Claim 1. In addition to the disclosure of the limitations of Claims 1 and 12 discussed above, *Ciezobka* discloses the additional limitations of Claim 13:

¹¹⁷ Ex. 1036 at 3:10-14.

¹¹⁸ Ex. 1036 at 3:16-20.

- a. **“ 13. The method of claim 12, wherein the fluid communicated via the manifold is hydraulic fracturing fluid.”**

213. Except for depending from Claim 12, the limitation of Claim 13 is identical to that of Claim 10. Accordingly, *Ciezobka* discloses the limitations of Claim 13 for the same reasons as those discussed regarding Claim 10 in Section XII.J. above. Claim 13 is anticipated by *Ciezobka*, or in the alternative, obvious over *Ciezobka* alone for the above reasons.

N. **INDEPENDENT CLAIM 14**

214. It is my opinion that Claim 14 of the '770 Patent would have been obvious based on the teachings of *Ciezobka*. Details regarding the specific disclosures of *Ciezobka* are contained in the following subsections.

- a. **14.1: “An apparatus comprising: a non-transitory computer readable medium; and a plurality of instructions stored on the non-transitory computer readable medium and executable by one or more processors, wherein, when the instructions are executed by the one or more processors, the following steps are executed:”**

215. A POSITA would have recognized the claimed apparatus elements contained in Limitation 14.1 as a generic computer operating software. *Ciezobka* discloses using a “a software toolbox which incorporates all of the data handling and data analysis elements for real time application in the field during hydraulic

fracturing operations.”¹¹⁹ A POSITA would have understood that the description of using the software toolbox “real time in the field” to necessitate a generic computing device, such as described in Limitation 14.1, to be “in the field” at the location of the hydraulic fracturing. A POSITA would have also recognized that using the computer for “all of the data handling and data analysis elements” requires the computer to be connected to the system of *Ciezobka* in such a way that all flow rate measurements, pressure measurements, proppant concentrations, etc. are fed into the computer for “real time application in the field.”

216. To the extent that *Ciezobka* does not disclose using this computer for actual control of the valves, it would have been obvious to a POSITA to use the computer of *Ciezobka* for both measurement and determination functions (i.e., data handling and analysis) as well as control of the valves. *Ciezobka* describes that, through the data handling and analysis, the computer of *Ciezobka* would decide when to open/close the diverter valves of *Ciezobka*, what flowrate reduction/increases were appropriate, and in what sequence to open/close the valves. It would have been obvious to use the computer then to perform the actual switching of the valves. At the time of *Ciezobka*, computerized control systems for valves at

¹¹⁹ Ex. 1036 at 27:26-28.

fracturing operations were well known and understood by a POSITA as such control systems had been used at fracturing locations for decades.¹²⁰

217. Accordingly, *Ciezobka* renders obvious a computing system (Limitation 14.1) which is an example of the apparatus as described in the rest of Claim 14.

- b. **14.2: “communicating fluid to a first well via a manifold and a first valve, the first valve being associated with both the manifold and the first well; and”**

218. Limitation 14.2 is identical to Limitation 1.1 discussed above. Thus, Limitation 14.2 is disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 1.1 in Section XII.A.a.

- c. **14.3: “in response to determining that the fluid communicated via the manifold has satisfied one or more conditions:”**

219. Limitation 14.3 is identical to Limitation 1.2 discussed above. Thus, Limitation 14.3 is disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 1.2 in Section XII.A.b.

- d. **14.4: “opening a second valve; communicating fluid to a second well via the second valve; and”**

220. Limitation 14.4 is identical to Limitation 1.3 discussed above. Thus, Limitation 14.4 is disclosed, or at least rendered obvious, by *Ciezobka* at least for

¹²⁰ See, e.g., Ex. 1020 at [0030]; Ex. 1021 at [0072].

the same reasons as those discussed above regarding Limitation 1.3 in Section XII.A.c.

e. **14.5: “closing the first valve after opening the second valve.”**

221. Limitation 14.5 is identical to Limitation 1.4 discussed above. Thus, Limitation 14.5 is disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 1.4 in Section XII.A.d.

222. In view of the above, *Ciezobka* renders obvious an apparatus that includes a non-transitory computer-readable medium and a plurality of instructions stored on the non-transitory computer-readable medium and executable by one or more processors, wherein, when the instructions are executed by the one or more processors, the steps of Limitations 14.2-14.5 (which are the same as the steps of Claim 1) are executed.

223. Thus, Claim 14 is obvious over *Ciezobka* alone for the above reasons.

O. DEPENDENT CLAIM 15

224. Dependent Claim 15 depends from Claim 14. In addition to the disclosure of the limitations of Claim 14 discussed above, *Ciezobka* discloses the additional limitations of Claim 15:

- a. **15.1: “15. The apparatus of claim 14, wherein, when the instructions are executed by the one or more processors, the following steps are also executed: communicating fluid to a third well via the manifold and a third valve, the third valve being associated with both the manifold and the third well; and”**

225. Except for being an apparatus claim and depending from Claim 14, which merely claims a computer implements/executes the steps, Limitation 15.1 is substantially similar to those of Limitation 2.1 discussed above.

226. Thus, the limitations of 15.1 are disclosed by *Ciezobka* at least for the same reasons as those above regarding Limitation 2.1 in Section XII.B.a.

- b. **15.2: “in response to determining that the fluid communicated via the manifold has satisfied the one or more conditions:”**

227. Except for being an apparatus claim and depending from Claim 14, the limitations of 15.2 are identical to those of Limitation 2.2 discussed above. Thus, the limitations of 15.2 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 2.2 in Section XII.B.b.

- c. **15.3-15.4: “opening a fourth valve; communicating fluid to a fourth well via the fourth valve; and”**

228. Except for being an apparatus claim and depending from Claim 14, the limitations of 15.3-15.4 are identical to those of Limitation 2.3 discussed above. Thus, the limitations of 15.3-15.4 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 2.3 in Section XII.B.c.

d. **15.5: “closing the third valve after opening the fourth valve.”**

229. Except for being an apparatus claim and depending from Claim 14, the limitations of 15.5 are identical to those of Limitation 2.4 discussed above. Thus, the limitations of 15.5 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 2.4 in Section XII.B.d.

230. It would have been obvious to perform the steps in Claim 15 using the claimed generic computer elements for the same reasons provided above with the discussion of Claim 14. Accordingly, *Ciezobka* discloses the limitations of Claim 15, and thus, Claim 15 is obvious over *Ciezobka* alone for the above reasons.

P. **DEPENDENT CLAIM 16**

231. Dependent Claim 16 depends from Claim 15, which depends from Claim 14. In addition to the disclosure of the limitations of Claims 14 and 15 discussed above, *Ciezobka* discloses the additional limitations of Claim 16:

a. **16.1: “16. The apparatus of claim 15, wherein: the first valve is closed after opening both the second valve and the fourth valve, and/or”**

232. Except for being an apparatus claim and depending from Claim 15, the limitations of 16.1 are identical to those of Limitation 3.1 discussed above. Thus, the limitations of 16.1 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 3.1 in Section XII.C.a.

b. **16.2: “the third valve is closed after opening both the second valve and the fourth valve.”**

233. Except for being an apparatus claim and depending from Claims 14 and 15, the limitations of 16.2 are identical to those of Limitation 3.2 discussed above. Thus, the limitations of 16.2 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 3.2 in Section XII.C.b.

234. Accordingly, *Ciezobka* discloses the limitations of Claim 16. Thus, Claim 16 is obvious over *Ciezobka* alone for the reasons discussed above.

Q. DEPENDENT CLAIM 17

235. Dependent Claim 17 depends from Claim 14. In addition to the disclosure of the limitations of Claim 14 discussed above, *Ciezobka* discloses the limitations of Claim 17:

a. **17. The apparatus of claim 14, wherein the one or more conditions include one or more flow rate conditions.**

236. Except for being an apparatus claim and depending from Claim 14, the limitations of Claim 17 are identical to those of Claim 4 discussed above. Thus, the limitations of Claim 17 are disclosed by *Ciezobka*, at least for the same reasons as those discussed above regarding Claim 4 in Section XII.D. Accordingly, Claim 17 is obvious over *Ciezobka* alone for the above reasons.

R. DEPENDENT CLAIM 18

237. Dependent Claim 18 depends from Claim 17, which depends from Claim 14. In addition to the disclosure of the limitations of Claims 14 and 17 discussed above, *Ciezobka* discloses the limitations of Claim 18:

- a. **18. The apparatus of claim 17, wherein the fluid communicated via the manifold has satisfied the one or more flow rate conditions when a flow rate of the fluid is below an upper threshold, above a lower threshold, or both.**

238. Except for being an apparatus claim and depending from Claim 17, the limitations of Claim 18 are identical to those of Claim 5 discussed above. Thus, the limitations of Claim 18 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Claim 5 in Section XII.E. Accordingly, Claim 18 is obvious over *Ciezobka* alone for the reasons discussed above.

S. DEPENDENT CLAIM 19

239. Dependent Claim 19 depends from Claim 17, which depends from Claim 14. In addition to the disclosure of the limitations of Claims 14 and 17 discussed above, *Ciezobka* discloses the limitations of Claim 19:

- a. **19. The apparatus of claim 17, wherein the fluid communicated via the manifold has not satisfied the one or more flow rate conditions when a flow rate of the fluid is above an upper threshold or below a lower threshold.**

240. Except for being an apparatus claim and depending from Claim 17, the limitations of Claim 19 are identical to those of Claim 6 discussed above. Thus, the

limitations of Claim 19 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Claim 6 in Section XII.F. Accordingly, Claim 19 is obvious over *Ciezobka* alone for the reasons discussed above.

T. DEPENDENT CLAIM 20

241. Dependent Claim 20 depends from Claim 14. In addition to the disclosure of the limitations of Claim 14 discussed above, *Ciezobka* discloses the additional limitations of Claim 20:

- a. **20. The apparatus of claim 14, wherein, when the instructions are executed by the one or more processors, the following step is also executed: pumping the fluid into the manifold.**

242. Except for being an apparatus claim and depending from Claim 14, the limitations of Claim 20 are identical to those of Claim 7 discussed above. Thus, the limitations of Claim 20 are disclosed by *Ciezobka* as discussed here and for at least the same reasons as those discussed above regarding Claim 7 in Section XII.G. Accordingly, Claim 20 is obvious over *Ciezobka* alone for the reasons discussed above.

U. DEPENDENT CLAIM 21

243. Dependent Claim 21 depends from Claim 14. In addition to the disclosure of the limitations of Claim 14 discussed above, *Ciezobka* discloses the additional limitations of Claim 21:

- a. **21. The apparatus of claim 14, wherein, when the instructions are executed by the one or more processors, the following step is also executed: determining that the fluid communicated via the manifold has satisfied the one or more conditions.**

244. Except for being an apparatus claim and depending from Claim 14, the limitations of Claim 21 are identical to those of Claim 8 discussed above. Thus, the limitations of Claim 21 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Claim 8 in Section XII.H. Accordingly, Claim 21 is obvious over *Ciezobka* alone for the reasons discussed above.

V. DEPENDENT CLAIM 22

245. Dependent Claim 22 depends from Claim 21, which depends from Claim 14. In addition to the disclosure of the limitations of Claims 14 and 21 discussed above, *Ciezobka* discloses the additional limitations of Claim 22:

- a. **22. The apparatus of claim 21, wherein determining that the fluid communicated via the manifold has satisfied the one or more flow rate conditions comprises determining that a flow rate of the fluid is below an upper threshold, above a lower threshold, or both.**

246. Except for being an apparatus claim and depending from Claim 21, the limitations of Claim 22 are identical to those of Claim 9 discussed above. Thus, the limitations of Claim 22 are disclosed by *Ciezobka*, at least for the same reasons as those discussed above regarding Claim 9 in Section XII.I. Accordingly, Claim 22 is obvious over *Ciezobka* alone for the above reasons.

W. DEPENDENT CLAIM 23

247. Dependent Claim 23 depends from Claim 14. In addition to the disclosure of the limitations of Claim 14 discussed above, *Ciezobka* discloses the additional limitations of Claim 23:

- a. **23. The apparatus of claim 14, wherein the fluid communicated via the manifold is hydraulic fracturing fluid.**

248. Except for being an apparatus claim and depending from Claim 14, the limitations of Claim 23 are identical to those of Claim 10 discussed above. Thus, the limitations of Claim 23 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Claim 10 in Section XII.J. Accordingly, Claim 23 is obvious over *Ciezobka* alone for the reasons discussed above.

X. DEPENDENT CLAIM 24

249. Dependent Claim 24 depends from Claim 14. In addition to the disclosure of the limitations of Claim 14 discussed above, *Ciezobka* discloses the additional limitations of Claim 24:

- a. **24. The apparatus of claim 14, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.**

250. Except for being an apparatus claim and depending from Claim 14, the limitations of Claim 24 are identical to those of Claim 11 discussed above. Thus, the limitations of Claim 24 are disclosed by *Ciezobka* at least for the same reasons as

those discussed above regarding Claim 11 in Section XII.K. Accordingly, Claim 24 is obvious over *Ciezobka* alone for the reasons discussed above.

Y. DEPENDENT CLAIM 25

251. Dependent Claim 25 depends from Claim 14. In addition to the disclosure of the limitations of Claim 14 discussed above, *Ciezobka* discloses the additional limitations of Claim 25:

a. 25.1: “25. The apparatus of claim 14, wherein the second valve is associated with both the manifold and the second well; and”

252. Except for being an apparatus claim and depending from Claim 14, Limitation 25.1 is identical to Limitation 12.1 discussed above. Thus, Limitation 25.1 is disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding 12.1 in Section XII.L.a.

b. 25.2: “wherein communicating fluid to the second well via the second valve comprises communicating fluid to the second well via the manifold and the second valve.”

253. Except for being an apparatus claim and depending from Claim 14, Limitation 25.2 is identical to Limitation 12.2 discussed above. Thus, Limitation 25.2 is disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 12.2 in Section XII.L.b.

254. Accordingly, *Ciezobka* discloses the limitations of Claim 25, and thus, Claim 25 is obvious over *Ciezobka* alone for the above reasons.

Z. DEPENDENT CLAIM 26

255. Dependent Claim 26 depends from Claim 25, which depends from Claim 14. In addition to the disclosure of the limitations of Claims 14 and 25 discussed above, *Ciezobka* discloses the additional limitations of Claim 26:

- a. **26. The apparatus of claim 25, wherein the fluid communicated via the manifold is hydraulic fracturing fluid.”**

256. Except for being an apparatus claim and depending from Claims 25 and 14, the limitations of Claim 26 are identical to those of Claim 13 discussed above. Thus, Claim 26 is disclosed by *Ciezobka* at least for the same reasons discussed above regarding Claim 13 in Section XII.M. Thus, Claim 26 is obvious over *Ciezobka* alone for the above reasons.

AA. INDEPENDENT CLAIM 27

257. It is my opinion that *Ciezobka* anticipates, or at least renders obvious, Claim 27 of the '770 Patent. Details regarding the specific disclosures of *Ciezobka* are contained in the following subsections. To the extent the Board determines that *Ciezobka* does not explicitly disclose the limitations of Claim 27, a POSITA would have found the pumping and switching arrangement of Claim 27 to be obvious in light of the disclosure and teachings of *Ciezobka* alone.

a. **27.1: “1. A system, comprising: a first valve via which fluid is communicated from a manifold to a first well”**

258. *Ciezobka* discloses this limitation. Except for being rewritten as part of a system claim, the limitation is contained in Limitation 1.1. Thus, Limitation 27.1 is disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 1.1 in Section XII.A.a.

259. Accordingly, *Ciezobka* discloses Limitation 27.1.

b. **27.2: “a second valve via which fluid is adapted to be communicated to a second well; and”**

260. *Ciezobka* discloses this limitation. Except for being rewritten as part of a system claim, the limitation is contained in Limitation 1.3. Thus, Limitation 27.2 is disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 1.3 in Section XII.A.c.

261. Accordingly, *Ciezobka* discloses Limitation 27.2.

c. **27.3: “one or more controllers, configured to:**

262. *Ciezobka* discloses this limitation, or at least renders it obvious. *Ciezobka* discloses a switching arrangement with precise flow rates and time periods. For example, *Ciezobka* discloses that pulsed flowrates are “from 10% to nearly 100% lower”, “25% to 75% lower,” and “50% lower” than the primary flowrate.¹²¹ Further, *Ciezobka* discloses specific numerical flowrates for both the

¹²¹ See, e.g. Ex. 1036 at 4:3-15.

constant flow line and the variable flow lines “for example the constant flow line supplies a constant flow rate **92** of 50% of the total flow, equaling 45 bpm, and the variable flow line supplies a variable flow rate **94** of 50% of the total flow, equaling 45 bpm.”¹²²

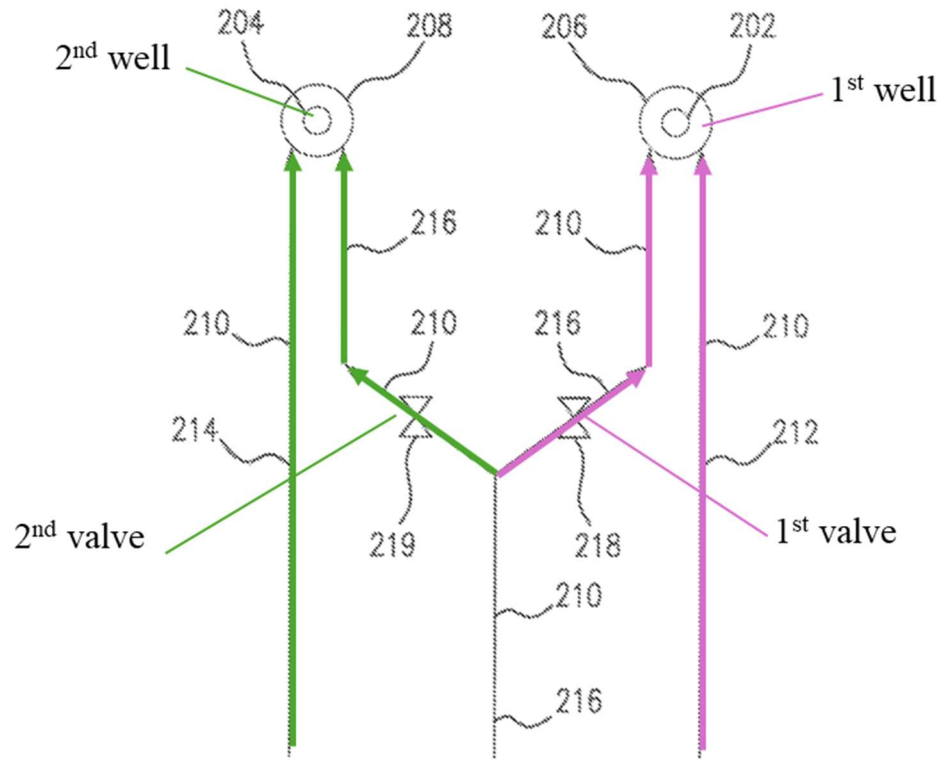


FIG. 6

263. Further, *Ciezobka* teaches switching of valves **218** and **219** to create the pulses. *Ciezobka* teaches that in a fracturing process, initially, both diverter valves **218** and **219** “are open allowing” fluid flow “to be provided to both of the wellheads

¹²² Ex. 1036 at at 10:31-34, see also 9:4-13.

202 and **204**.”¹²³ The second diverter valve **219** (e.g., second valve) is then closed for a “short period of time” while the first diverter valve **218** (e.g., first valve) remains open to provide decreased flow rate (shown as **232** in Fig. 7) to the second well **204** and increased flow rate (shown as **222** in Fig. 7) to the first well **202** for a “short period of time.”¹²⁴ The “short period of time” is disclosed by *Ciezobka* as “For example, the short period of time may range from 1 minute to 1 second. Preferably, the short period of time equals 10 seconds.”¹²⁵ A POSITA would have recognized, at the time of the ‘770 Patent, that such precise rate control such as 90 bpm or 45 bpm, or reducing flow rate by levels such as 25% lower, etc. would have used some type of controller. Further, a POSITA would have recognized that controlling pulse lengths from 1 minute to 1 second, and preferably 10 seconds, would have been implemented with some type of controller.

264. To the extent that *Ciezobka* does not specifically call out a “controller,” such as the generic controller claimed, it would have been obvious to a POSITA at the time of the ‘770 Patent to use a controller to control valve switching and flowrates, as such controllers were ubiquitous in hydraulic fracturing and flow control.¹²⁶

¹²³ Ex. 1036 at 12:8-10.

¹²⁴ Ex. 1036 at 12:8-11.

¹²⁵ Ex. 1036 at 12:11-12.

¹²⁶ See, e.g., Ex. 1020 at [0030]; Ex. 1021 at [0072],

265. Further, *Ciezobka* teaches using “a software toolbox” and AI tools for optimization and analysis of the fracturing operations in “real time.”¹²⁷ A POSITA would have readily recognized that such computing tools would have also obviously been used to perform the optimized fracturing operations, including using software instructions for opening and closing valves and controlling a pump rate.

266. Thus, *Ciezobka* discloses, or at least renders obvious, the limitations of 27.3.

d. **27.4: “open the second valve to thereby communicate fluid to the second well via the second valve; and”**

267. *Ciezobka* discloses this limitation. Except for being rewritten as part of a system claim, the limitation is contained in Limitation 1.3. Thus, Limitation 27.4 is disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 1.3 in Section XII.A.c.

268. Accordingly, *Ciezobka* discloses Limitation 27.4.

e. **27.5: “close the first valve after opening the second valve,”**

269. *Ciezobka* discloses this limitation. Except for being rewritten as part of a system claim, the limitation is contained in Limitation 1.4. Thus, Limitation 27.5 is disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 1.4 in Section XII.A.d.

¹²⁷ Ex. 1036 at 27:26-28:2.

270. Accordingly, *Ciezobka* discloses the limitations of 27.5.

- f. **27.6: “in response to: determining that the fluid communicated via the manifold has satisfied one or more conditions.”**

271. *Ciezobka* discloses this limitation. Except for being rewritten as part of a system claim, the limitation is contained in Limitation 1.2. Thus, Limitation 27.6 is disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 1.2 in Section XII.A.b. Thus, *Ciezobka* discloses Limitation 27.6.

272. Accordingly, Claim 27 is obvious over *Ciezobka* alone for the reasons discussed above.

BB. DEPENDENT CLAIM 28

273. Dependent Claim 28 depends from Claim 27. In addition to the disclosure of the limitations of Claim 27 discussed above, *Ciezobka* discloses the additional limitations of Claim 28:

- a. **28.1: “28. The system of claim 27, further comprising: a third valve via which fluid is communicated from the manifold to a third well;”**

274. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of 28.1 are substantially similar to those of Limitation 2.1 discussed above. Thus, the limitations of 28.1 are disclosed by *Ciezobka* at least for

the same reasons as those discussed above regarding Limitation 2.1 in Section XII.B.a.

b. **28.2: “a fourth valve via which the fluid is adapted to be communicated to a fourth well; and”**

275. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of 28.2 are contained in Limitation 2.3 discussed above. Thus, the limitations of 28.2 are disclosed, or at least rendered obvious by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 2.3 in Section XII.B.c.

c. **28.3: “the one or more controllers, configured to open the fourth valve to thereby communicate fluid to the fourth well via the fourth valve; and”**

276. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of 28.3 are contained in Limitation 2.3 discussed above. Thus, the limitations of 28.3 are disclosed, or at least rendered obvious by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 2.3 in Section XII.B.c.

d. **28.4: “close the third valve after opening the fourth valve,”**

277. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of 28.4 are contained in Limitation 2.4 discussed above. Thus, the limitations of 28.4 are disclosed, or at least rendered obvious by *Ciezobka*

at least for the same reasons as those discussed above regarding Limitation 2.4 in Section XII.B.d.

- e. **28.5: “in response to: determining that the fluid communicated via the manifold has satisfied the one or more conditions.”**

278. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of 28.5 are contained in Limitation 2.2 discussed above. Thus, the limitations of 28.5 are disclosed, or at least rendered obvious by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 2.2 in Section XII.B.b.

279. Accordingly, Claim 28 is obvious over *Ciezobka* alone for the above reasons.

CC. DEPENDENT CLAIM 29

280. Dependent Claim 29 depends from Claim 28, which depends from Claim 27. In addition to the disclosure of the limitations of Claims 27 and 28 discussed above, *Ciezobka* discloses the additional limitations of Claim 29:

- a. **29.1: “29. The system of claim 28, wherein the one or more controllers are further configured to: close the first valve after opening both the second valve and the fourth valve; and/or**

281. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of 29.1 are contained in Limitation 3.1 discussed above. Thus, the limitations of 29.1 are disclosed, or at least rendered obvious by *Ciezobka*

at least for the same reasons as those discussed above regarding Limitation 3.1 in Section XII.C.a.

b. **29.2: “close the third valve after opening both the second valve and the fourth valve.”**

282. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of 29.2 are contained in Limitation 3.2 discussed above. Thus, the limitations of 29.2 are disclosed, or at least rendered obvious by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 3.2 in Section XII.C.b.

283. Accordingly, Claim 29 is obvious over *Ciezobka* alone for the above reasons.

DD. DEPENDENT CLAIM 30

284. Dependent Claim 30 depends from Claim 27. In addition to the disclosure of the limitations of Claim 27 discussed above, *Ciezobka* discloses the limitations of Claim 30:

a. **30. The system of claim 27, wherein the one or more conditions include one or more flow rate conditions.**

285. Except for being rewritten as a system claim and depending from Claim 27, the limitations of Claim 30 are identical to those of Claim 4 discussed above. Thus, the limitations of Claim 30 are disclosed by *Ciezobka*, at least for the same

reasons as those discussed above regarding Claim 4 in Section XII.D. Accordingly, Claim 30 is obvious over *Ciezobka* alone for the above reasons.

EE. DEPENDENT CLAIM 31

286. Dependent Claim 31 depends from Claim 30, which depends from claim 27. In addition to the disclosure of the limitations of Claims 27 and 30 discussed above, *Ciezobka* discloses the additional limitations of Claim 31:

- a. **31. The system of claim 30, wherein the fluid communicated via the manifold has satisfied the one or more flow rate conditions when a flow rate of the fluid is below an upper threshold, above a lower threshold, or both.**

287. Except for being rewritten as a system claim and depending from Claim 30, the limitations of Claim 31 are identical to those of Claim 5 discussed above. Thus, the limitations of Claim 31 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Claim 5 in Section XII.E. Accordingly, Claim 31 is obvious over *Ciezobka* alone for the reasons discussed above.

FF. DEPENDENT CLAIM 32

288. Dependent Claim 32 depends from Claim 30, which depends from Claim 27. In addition to the disclosure of the limitations of Claims 27 and 30 discussed above, *Ciezobka* discloses the additional limitations of Claim 32:

- a. **32. The system of claim 30, wherein the fluid communicated via the manifold has not satisfied the one or more flow rate conditions when a flow rate of the fluid is above an upper threshold or below a lower threshold.**

289. Except for being rewritten as a system claim and depending from Claim 30, the limitations of Claim 32 are identical to those of Claim 6 discussed above. Thus, the limitations of Claim 32 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Claim 6 in Section XII.F. Accordingly, Claim 32 is obvious over *Ciezobka* alone for the reasons discussed above.

GG. DEPENDENT CLAIM 33

290. Dependent Claim 33 depends from Claim 27. In addition to the disclosure of the limitations of Claim 27 discussed above, *Ciezobka* discloses the additional limitations of Claim 33:

- a. **“33. The system of claim 27, further comprising the manifold.”**

291. *Ciezobka* discloses a manifold associated with the valves and wells. *Ciezobka* teaches, “[t]he manifold receives the fracturing fluid, with or without proppant, at a low pressure from the pre-blender or the slurry-blender and distributes the fluid and/or slurry to the high-pressure fracturing pumps. The manifold then receives the fluids at a high pressure from the high-pressure fracturing pumps and directs the fluid to a ground iron leading to the wellhead and wellbore.”¹²⁸

¹²⁸ Ex. 1036 at 3:10-14.

292. Accordingly, *Ciezobka* discloses the limitations of Claim 33. Thus, Claim 33 is obvious over *Ciezobka* alone for the above reasons.

HH. DEPENDENT CLAIM 34

293. Dependent Claim 34 depends from Claim 27. In addition to the disclosure of the limitations of Claim 27 discussed above, *Ciezobka* discloses the additional limitations of Claim 34:

a. 34.1: “34. The system of claim 27, further comprising one or more pumps;”

294. *Ciezobka* teaches, “[t]he manifold receives the fracturing fluid, with or without proppant, at a low pressure from the pre-blender or the slurry-blender and distributes the fluid and/or slurry to the high-pressure fracturing pumps. The manifold then receives the fluids at a high pressure from the high-pressure fracturing pumps and directs the fluid to a ground iron leading to the wellhead and wellbore.”¹²⁹ Accordingly, *Ciezobka* teaches a plurality of pumps, including “high-pressure fracturing pumps.”

295. Therefore, *Ciezobka* discloses one or more pumps as claimed by Limitation 34.1.a.

¹²⁹ *Id.*

- b. **34.2: “wherein the one or more controllers are further configured to cause the one or more pumps to pump the fluid into the manifold.”**

296. As discussed above, Ciezobka discloses, “The manifold then receives the fluids at a high pressure from the high-pressure fracturing pumps and directs the fluid to a ground iron leading to the wellhead and wellbore.”¹³⁰ Further, *Ciezobka* teaches using “a software toolbox” and AI tools for optimization and analysis of the fracturing operations in “real time.”¹³¹ A POSITA would have readily recognized that such computing tools, or any other suitable generic controller, would have also obviously been used to perform the optimized fracturing operations, including using software instructions for opening and closing valves and controlling a pump rate. Therefore, *Ciezobka* discloses, or at least renders obvious, the controllers configured to cause the one or more pumps to pump the fluid into the manifold, as in Limitation 34.2.

297. Accordingly, Claim 34 is obvious over *Ciezobka* alone for the above reasons.

¹³⁰ Ex. 1036 at 3:13-14.

¹³¹ Ex. 1036 at 27:26-28:2.

II. DEPENDENT CLAIM 35

298. Dependent Claim 35 depends from Claim 27. In addition to the disclosure of the limitations of Claim 27 discussed above, *Ciezobka* discloses the additional limitations of Claim 35:

- a. **35. The system of claim 27, wherein the fluid communicated via the manifold is hydraulic fracturing fluid.**

299. Except for being rewritten as a system claim and depending from Claim 27, the limitations of Claim 35 are identical to those of Claim 10 discussed above. Thus, the limitations of Claim 35 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Claim 10 in Section XII.J. Accordingly, Claim 35 obvious over *Ciezobka* alone for the reasons discussed above.

JJ. DEPENDENT CLAIM 36

300. Dependent Claim 36 depends from Claim 27. In addition to the disclosure of the limitations of Claim 27 discussed above, *Ciezobka* discloses the additional limitations of Claim 36:

- a. **36. The system of claim 27, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.**

301. Except for being rewritten as a system claim and depending from Claim 27, the limitations of Claim 36 are identical to those of Claim 11 discussed above. Thus, the limitations of Claim 36 are disclosed by *Ciezobka* at least for the same

reasons as those discussed above regarding Claim 11 in Section XII.K. Accordingly, Claim 37 is obvious over *Ciezobka* alone for the reasons discussed above.

KK. DEPENDENT CLAIM 37

302. Dependent Claim 37 depends from Claim 27. In addition to the disclosure of the limitations of Claim 27 discussed above, *Ciezobka* discloses the additional limitations of Claim 37:

- a. **37.1: “The system of claim 27, wherein the second valve is associated with both the manifold and the second well; and”**

303. Except for being rewritten as a system claim and depending from Claim 27, the limitations of 37.1 are identical to those of Limitation 12.1 discussed above. Thus, the limitations of Claim 37.1 are disclosed by *Ciezobka*, at least for the same reasons as those discussed above regarding Limitation 12.1 in Section XII.L.a.

- b. **37.2: “wherein communicating fluid to the second well via the second valve comprises communicating fluid to the second well via the manifold and the second valve”**

304. Except for being rewritten as a system claim and depending from Claim 27, the limitations of 37.2 are identical to those of Limitation 12.2 discussed above. Thus, the limitations of Claim 37.2 are disclosed by *Ciezobka*, at least for the same reasons as those discussed above regarding Limitation 12.2 in Section XII.L.b.

305. Accordingly, Claim 37 is obvious over *Ciezobka* alone for the above reasons.

LL. DEPENDENT CLAIM 38

306. Dependent Claim 38 depends from Claim 37, which depends from Claim 27. In addition to the disclosure of the limitations of Claims 27 and 37 discussed above, *Ciezobka* discloses the additional limitations of Claim 38:

- a. **“38. The system of claim 37, wherein the fluid communicated via the manifold is hydraulic fracturing fluid.”**

307. Except for being rewritten as a system claim and depending from Claim 37, the limitations of 38 are identical to those of Claim 13 discussed above. Thus, the limitations of Claim 38 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Claim 13 in Section XII.M. Accordingly, Claim 37 is obvious over *Ciezobka* alone for the reasons discussed above.

XIII. GROUND 3: OBVIOUS OVER THE COMBINATION OF CIEZOBKA AND MCNEEL

A. RATIONALE AND MOTIVATION FOR COMBINING CIEZOBKA WITH MCNEEL

308. A POSITA would have been motivated to combine *McNeel* with *Ciezobka*. *McNeel* is in the same field of endeavor of oil and gas well systems as *Ciezobka* (as well as the ‘770 Patent) and is directed to solving the same problem – controlling well operations, particularly fracturing operations. *Ciezobka* is directed toward “A hydraulic fracturing system and method for enhancing effective

permeability of earth formations to increase hydrocarbon production.”¹³² *McNeel* is directed “generally to well operations, and more particularly to methods and apparatuses for simultaneously treating multiple wells from a centralized location and simultaneously connecting multiple wells to a single manifold, so as to conserve labor, infrastructure, and environmental impact.”¹³³

309. Both *Ciezobka* and *McNeel* address the introduction of a fracturing fluid, including proppant, into wells to be fractured, the fluid being pressurized by one or more pressure pumps. *Ciezobka* teaches, “[t]he manifold receives the fracturing fluid, with or without proppant, at a low pressure from the pre-blender or the slurry-blender and distributes the fluid and/or slurry to the high-pressure fracturing pumps. The manifold then receives the fluids at a high pressure from the high-pressure fracturing pumps and directs the fluid to a ground iron leading to the wellhead and wellbore.”¹³⁴ *McNeel* similarly teaches “a well operations factory which manufactures and pumps a well treatment fluid, a first connection between a first well location and the factory, and a second connection between a second well location and the factory. The well treatment operations factory comprises a means for simultaneously flowing a first stimulation fluid to the first well location via the first connection and a second stimulation fluid to the second well location via the

¹³² Ex. 1036 at Abstract.

¹³³ Ex. 1037 at [0001].

¹³⁴ Ex. 1036 at 3:10-14.

second connection.”¹³⁵ Further, *McNeel* discloses that its system “can be used to stimulate wells simultaneously or singly.”¹³⁶

310. *Ciezobka* teaches that its process “variations may utilize multiple wells or multiple fluid flow lines to the wellhead or from one or more pumps.”¹³⁷ There are no limitations on the number of “multiple” wells or “one or more” pumps in *Ciezobka*. From this, a POSITA would have understood that *Ciezobka*’s process could be applied to two, three, four, or more wells.

311. *McNeel* explicitly teaches hydraulic fracturing operations at a third well and fourth well. *McNeel* teaches, regarding Fig. 2, “the means for simultaneously flowing treatment fluid is a central manifold 107. The central manifold 107 is connected to the pumping grid 111 and is operable to flow stimulation fluid, for example, to multiple wells at different pads simultaneously.”¹³⁸ *McNeel* further discloses, “The manifold 107 is operable to treat simultaneously two separate wells, for example, as shown in FIG. 2 via connections 204 and 205.”¹³⁹

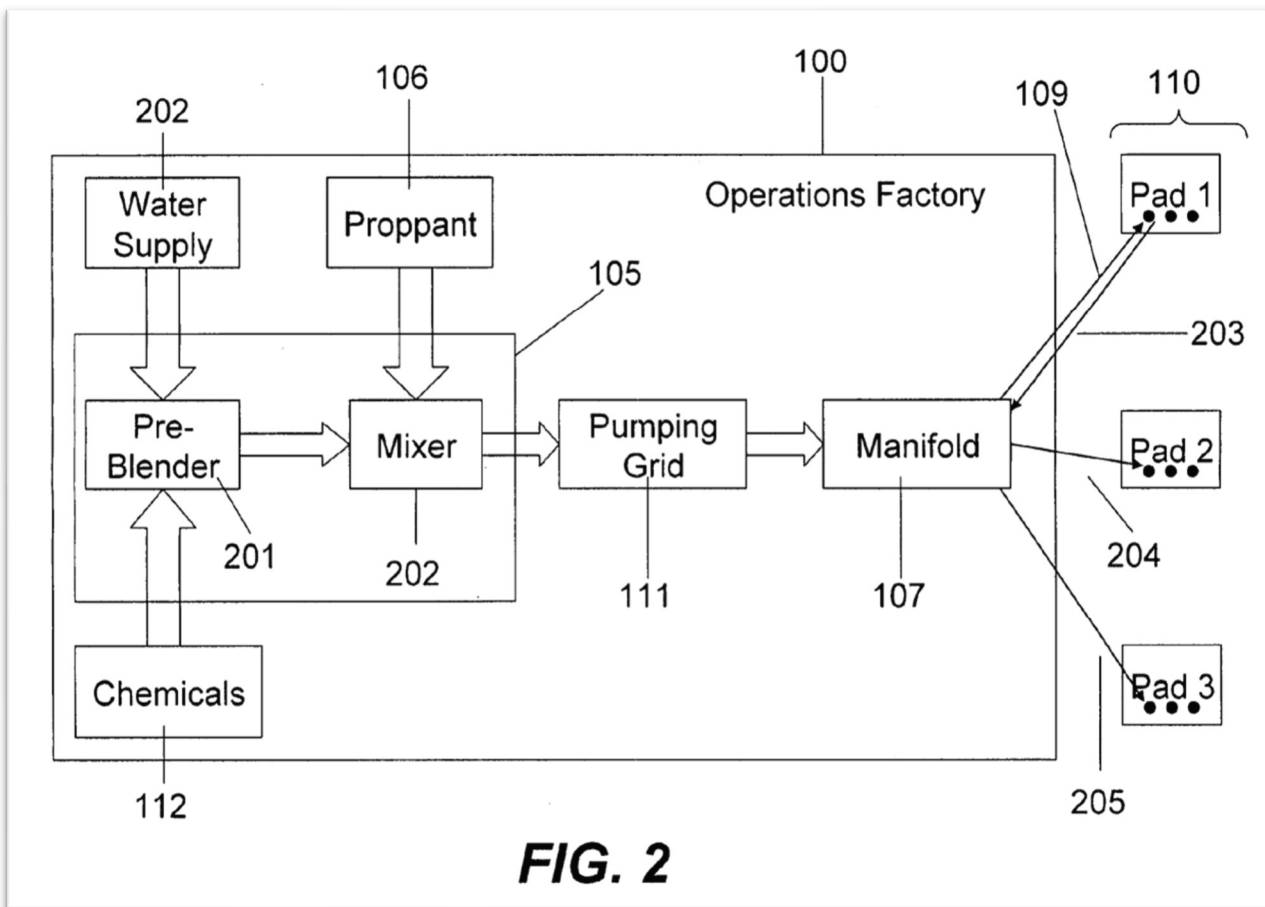
¹³⁵ Ex. 1037 at [0006].

¹³⁶ Ex. 1037 at [0025].

¹³⁷ Ex. 1036 at 28:22-23.

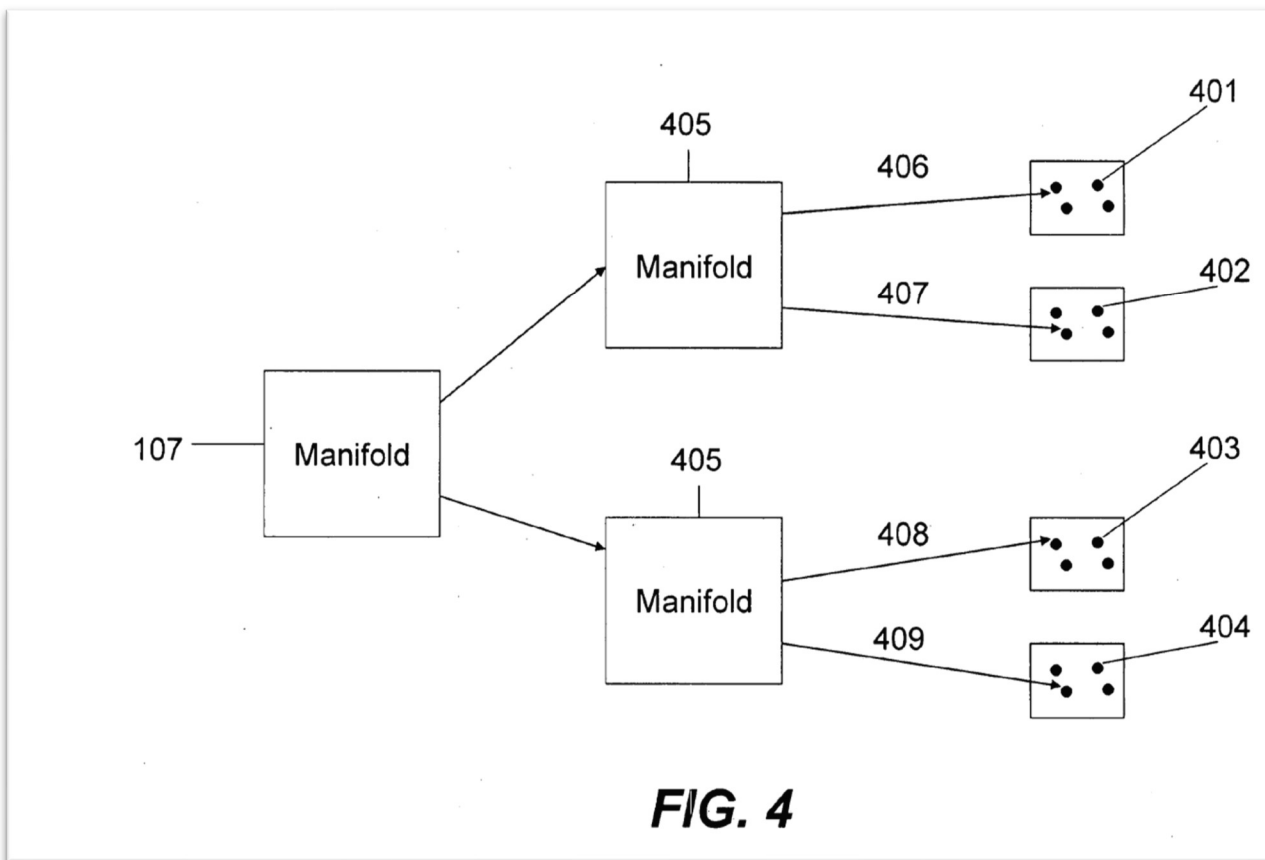
¹³⁸ Ex. 1037 at [0023].

¹³⁹ *Id.*



312. While Fig. 2 shows the fracturing of three wells via connections 203, 204, and 205, *McNeel* further makes it clear that the same process can be applied to even more wells. For example, “[i]n reference to FIG. 4, in one embodiment, the central manifold 107 can be connected to one or more additional manifolds 405. The additional manifolds are operable to connect to multiple well locations 401-404 and deliver well treatment fluids and receive production fluids via connections 406-409, respectively, in the same way as the central manifold 107 described above.”¹⁴⁰

¹⁴⁰ Ex. 1037 at [0024].



313. *McNeel* further explicitly discloses that, like *Ciezobka*, fracturing fluid is pumped to the wells (e.g., via a “pumping grid” as shown in Fig. 2) and that “each line can further include a pressure sensor and an additional valve.”¹⁴¹

314. A POSITA would have been motivated to include *McNeel*’s teachings of third and fourth wells to improve the *Ciezobka* system by gaining its benefits at more than one location (for more than two wells). For example, *Ciezobka* teaches its system “increase[s] hydrocarbon production, enhance[s] operation efficiency, ... open[s] perforations that are either unopened or not effective,” “as well as reducing

¹⁴¹ Ex. 1037 at [0008].

entry friction... during multi stage hydraulic fracturing.”¹⁴² *McNeel* has similar goals of efficiency such as “to conserve labor, infrastructure, and environmental impact.”¹⁴³ The combination of the teachings of both *Ciezobka* and *McNeel* allow a system that gains the efficiency benefits of both disclosures.

315. To the extent that *Ciezobka* does not already teach applying its pulse technique to a third and fourth well, a POSITA would be motivated to use connections to the third and fourth wells of *McNeel* into the fracturing system of *Ciezobka* at least for the reasons described above. A POSITA, therefore, would recognize that combining the teachings of *Ciezobka* and *McNeel* is simply applying the teachings of *McNeel* regarding a third and fourth well to the disclosure of *Ciezobka*, which is ready for improvement (i.e., applying teachings to a third and fourth well.) Further, a POSITA would recognize that the combination of *Ciezobka* and *McNeel* is the use of a known technique (fracture flow to a third and fourth well) to the known method of *Ciezobka* and used in the same way to improve fracturing efficiencies. A POSITA would, therefore, have had a reasonable expectation of success in combining *Ciezobka* with *McNeel* for the same reasons.

¹⁴² Ex. 1036 at–Abstract and 1:16-17.

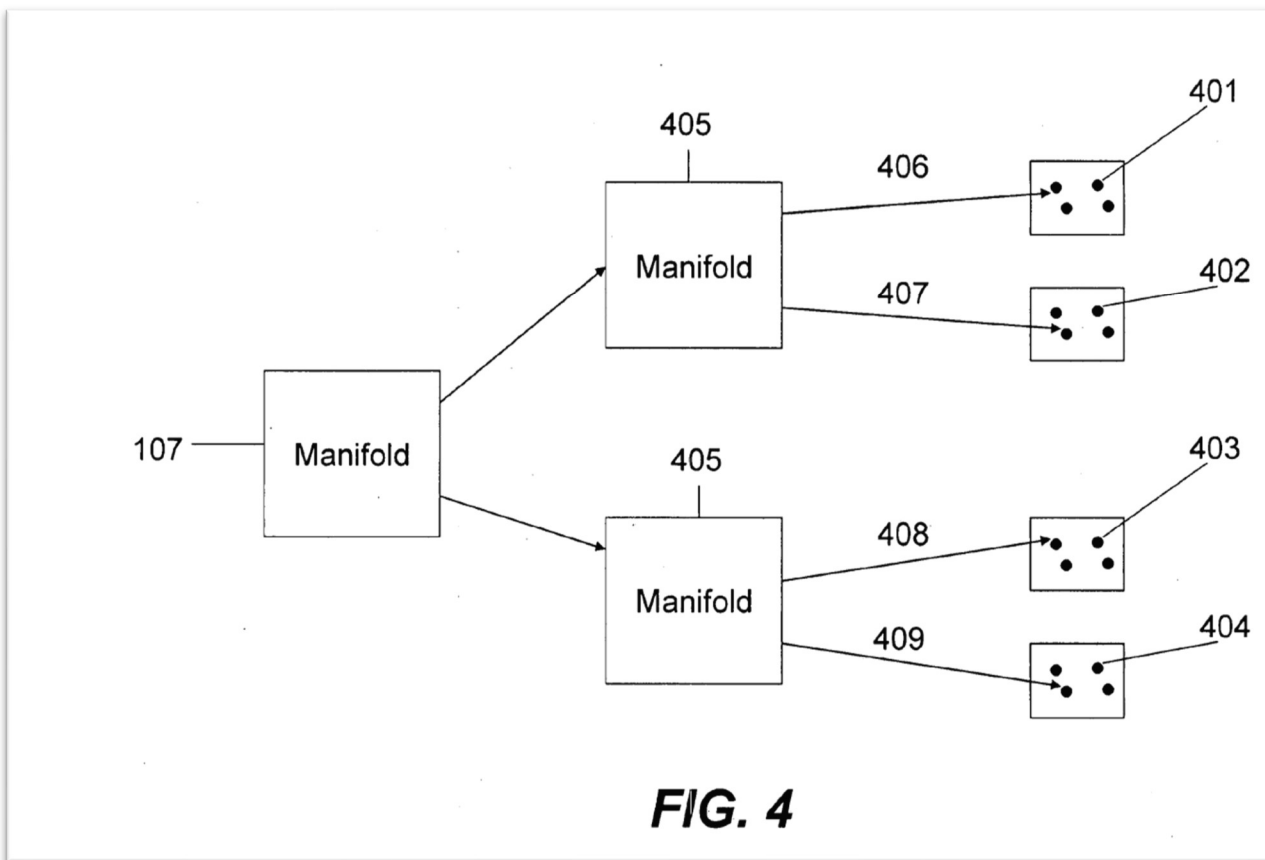
¹⁴³ Ex. 1037 at [0001].

B. DEPENDENT CLAIM 2

316. Dependent Claim 2 depends from Claim 1. Further, Claim 2 claims limitations already analyzed as part of Claim 1 but applied to a third and fourth well, as opposed to the first and second wells of Claim 15. As discussed above regarding Grounds 1-2, *Ciezobka* discloses, or at least suggests, applying its pulsed hydraulic fracturing system to “multiple wells,” which would include a third and fourth well.

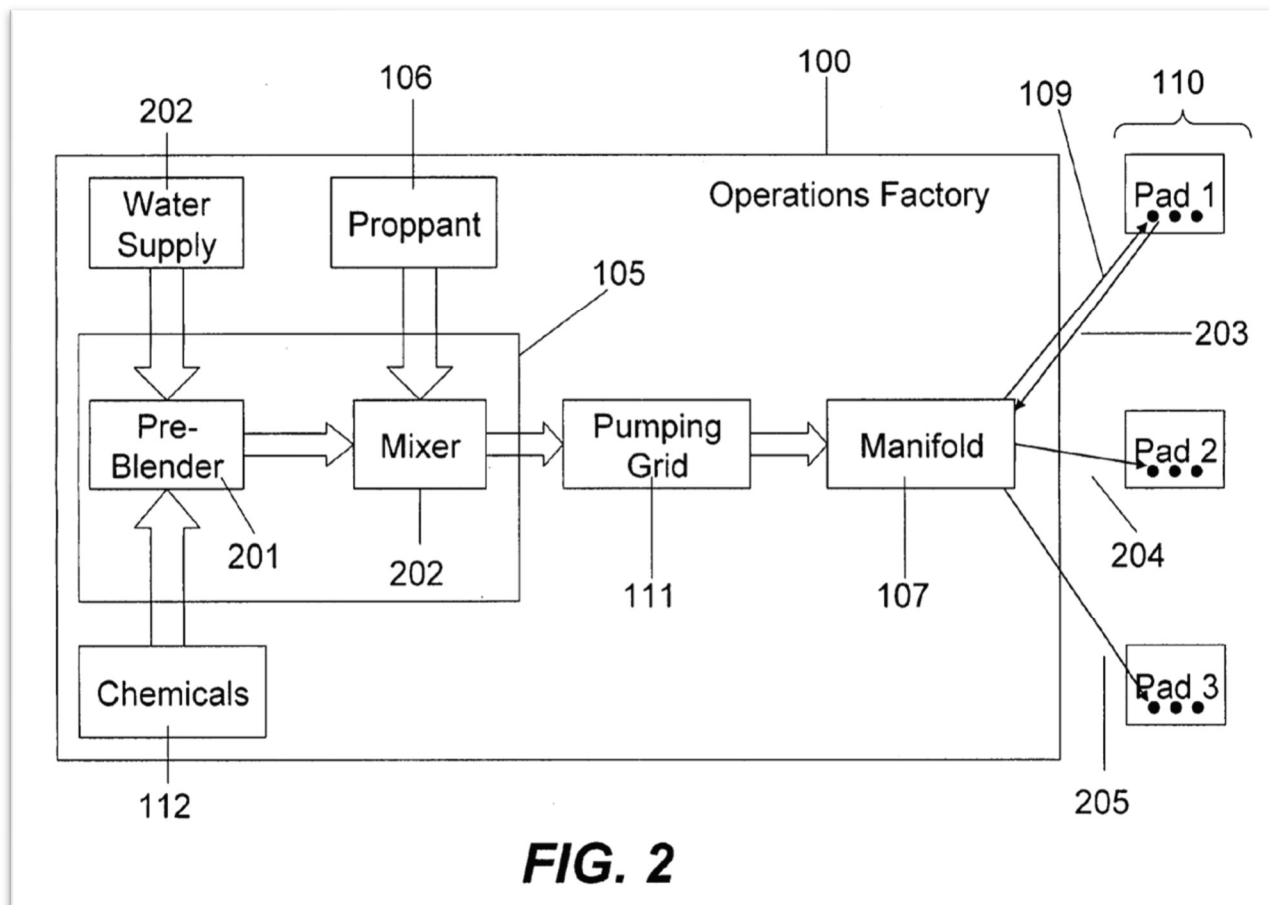
317. To the extent that *Ciezobka* does not explicitly disclose a third and fourth well, *McNeel* provides that in its fracturing operation, “the central manifold 107 can be connected to one or more additional manifolds 405. The additional manifolds are operable to connect to multiple well locations 401-404 and deliver well treatment fluids and receive production fluids via connections 406-409, respectively, in the same way as the central manifold 107 described above”.¹⁴⁴

¹⁴⁴ Ex. 1037 at [0024].



318. Manifold 107 is taught by *McNeel* as being used to “treat simultaneously two separate wells, for example, as shown in FIG. 2 via connections 204 and 205.”¹⁴⁵

¹⁴⁵ Ex. 1037 at [0023].



319. Accordingly, the multiple manifolds of Fig. 4 are used for the same purpose as manifold 107 in Figure 2, that is, to treat multiple wells simultaneously. In the case of Fig. 4, at least four wells are explicitly represented.

- a. **2.1: “2. The method of claim 1, further comprising: communicating fluid to a third well via the manifold and a third valve, the third valve being associated with both the manifold and the third well; and”**

320. As discussed above regarding Grounds 1-2, *Ciezobka* discloses valves associated with wells that are operated to allow fluid to pump (i.e., communicate) into the wells and conduct hydraulic fracturing. Further, as discussed above, *McNeel*

explicitly discloses applying hydraulic fracturing techniques to a third and fourth well. Accordingly, a POSITA would have understood that the combination of *McNeel* and *Ciezobka* teaches a third and fourth well and third and fourth valves associated with the third and fourth wells. Further still, *Ciezobka* teaches communicating fluid to a first well via a first valve and the manifold. Similarly, the combination of *Ciezobka* and *McNeel* makes it obvious to communicate fluid to a third well via a third valve and the manifold. Thus, the combination of *Ciezobka* and *McNeel* renders Limitation 2.1 obvious.

321. Accordingly, *Ciezobka* and *McNeel* disclose, or at least render obvious, the limitations of 2.1.

b. **2.2: “in response to determining that the fluid communicated via the manifold has satisfied the one or more conditions:”**

322. As discussed above regarding Grounds 1-2, *Ciezobka* discloses valves associated with wells that are operated to allow fluid to pump (i.e., communicate) into the wells and conduct hydraulic fracturing. Further, as discussed above, *McNeel* explicitly discloses applying hydraulic fracturing techniques to a third and fourth well by operating associated valves. Accordingly, a POSITA would have understood that the combination of *McNeel* and *Ciezobka* teaches a third and fourth well and third and fourth valves associated with the third and fourth wells. Further still, as discussed above regarding Grounds 1-2, *Ciezobka* discloses determining the fluid

communicated by the manifold has satisfied one or more conditions. Thus, the combination of *Ciezobka* and *McNeel* renders Limitation 2.2 obvious.

c. **2.3: “opening a fourth valve; communicating fluid to a fourth well via the fourth valve; and**

323. As discussed above regarding Grounds 1-2, *Ciezobka* discloses valves associated with wells that are operated to allow fluid to pump (i.e., communicate) into the wells and conduct hydraulic fracturing. Further, as discussed above, *McNeel* explicitly discloses applying hydraulic fracturing techniques to a third and fourth well by operating associated valves to allow fluid flow thereto.¹⁴⁶ Accordingly, a POSITA would have understood that the combination of *McNeel* and *Ciezobka* teaches a third and fourth well and third and fourth valves associated with the third and fourth wells. *Ciezobka* teaches opening a second valve and communicating fluid to a second well via a second valve. Similarly, the combination of *Ciezobka* and *McNeel* makes it obvious to open a fourth valve and communicate fluid to a fourth well via a fourth valve using the same fracturing methods disclosed by *Ciezobka*. Thus, the combination of *Ciezobka* and *McNeel* renders Limitation 2.3 obvious.

d. **2.4: “closing the third valve after opening the fourth valve.”**

324. As discussed above regarding Grounds 1-2, *Ciezobka* discloses valves associated with wells that are operated to allow fluid to pump (i.e., communicate)

¹⁴⁶ Ex. 1037 at [0025]-[0026].

into the wells and conduct hydraulic fracturing. Further, as discussed above, *McNeel* explicitly discloses applying hydraulic fracturing techniques to a third and fourth well. Accordingly, a POSITA would have understood that the combination of *McNeel* and *Ciezobka* teaches a third and fourth well and third and fourth valves associated with the third and fourth wells. Further still, *Ciezobka* teaches closing a first valve after opening a second valve. Similarly, the combination of *Ciezobka* and *McNeel* makes it obvious to close the third valve after opening the fourth one. Thus, the combination of *Ciezobka* and *McNeel* renders Limitation 2.4 obvious.

325. Thus, while *Ciezobka* teaches methods for delivering pulses of fracturing fluid to multiple wells using an overlapping valve sequence, *McNeel* teaches manifolds and associated valves that are configured to selectively deliver fracturing fluid to one or more wells, simultaneously or singly, including first, second, third, and fourth wells. Additionally, *McNeel*'s manifolds and associated valves are configured to allow different flow rates to be provided to selected wells, as desired.¹⁴⁷ Thus, a POSITA would have found it obvious to use *McNeel*'s manifold systems in the *Ciezobka*'s system with the predictable results of *McNeel*'s manifolds being able to deliver fluid to selected first-fourth wells according to *Ciezobka*'s pulsed fracturing methods.

¹⁴⁷ *Id.*

326. As the combination of *Ciezobka* and *McNeel* render each and every limitation of Claim 2 obvious, Claim 2 is obvious over *Ciezobka* in view of *McNeel*.

C. DEPENDENT CLAIM 3

327. Dependent Claim 3 depends from Claim 2, which depends from Claim 1. In addition to the disclosure of the limitations of Claims 1 and 2 discussed above, *Ciezobka* renders the additional limitations of Claim 3 obvious:

a. 3.1: “3. The method of claim 2, wherein: the first valve is closed after opening both the second valve and the fourth valve; and/or”

328. As discussed above regarding Grounds 1-2, *Ciezobka* discloses valves associated with wells operated to allow fluid to pump (i.e., communicate) into the wells and conduct hydraulic fracturing. Further, as discussed above, *McNeel* explicitly discloses applying hydraulic fracturing techniques to a third and fourth well. Accordingly, a POSITA would have understood that the combination of *McNeel* and *Ciezobka* teaches a third and fourth well and third and fourth valves associated with the third and fourth wells. *McNeel* further discloses “methods and apparatuses for simultaneously treating multiple wells from a centralized location and simultaneously connecting multiple wells to a single manifold.”¹⁴⁸

329. Based on the teaching of *McNeel* that wells can be fractured simultaneously, a POSITA would have found it obvious to, for example, create a

¹⁴⁸ Ex. 1037 at [0001].

pulse in the first and third wells simultaneously using associated valves to take advantage of the efficiency taught by *Ciezobka* and *McNeel*. Similarly, a POSITA would have found it obvious to, for example, create a pulse in the second and fourth wells simultaneously using associated valves to take advantage of the efficiencies of *Ciezobka*.

330. As discussed above regarding Limitation 1.4, *Ciezobka* discloses closing the first valve after the second valve is opened. In a method where wells 2 and 4 are on the same pad and receive treatment “simultaneously,” as taught or suggested by *Ciezobka*, the second and fourth valves would be opened and closed simultaneously, and the first valve would be closed after the second and fourth valves are opened to take advantage of the creation of zipper fractures, which were known.¹⁴⁹

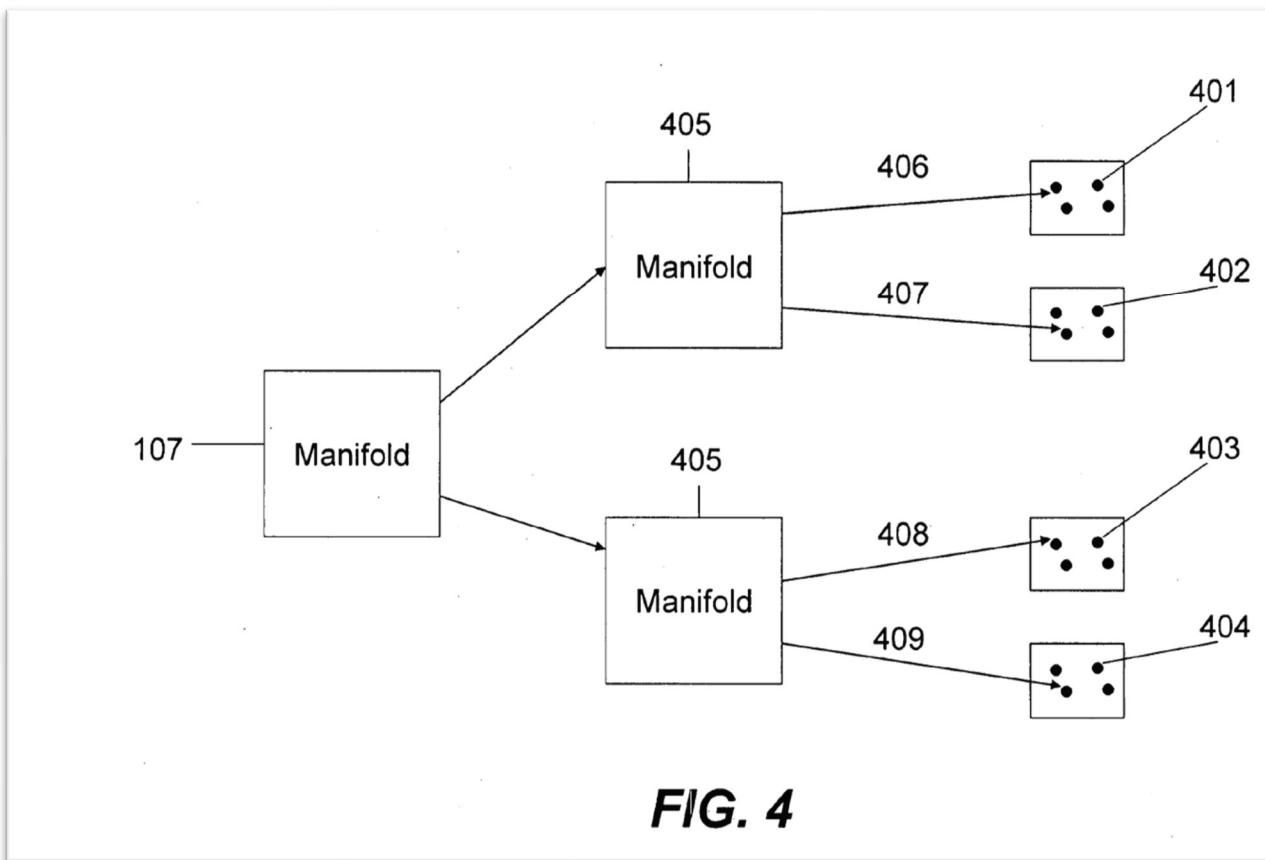
331. Further, as shown in Fig. 4 of *McNeel*, reproduced below, *McNeel* teaches that additional manifolds **405** can be connected to a central manifold **107**, where “[t]he additional manifolds are operable to connect to multiple well locations **401-404** and deliver well treatment fluids” via flowlines **406-409**.¹⁵⁰ It would have been obvious to use the fracturing systems/methods described by *Ciezobka* in Figs. 6-7 in the systems of *McNeel*, where *Ciezobka*’s sets of first and second wells and

¹⁴⁹ See Sections X.D-X.F.

¹⁵⁰ Ex. 1037 at [0024].

associated valves may be connected to *McNeel's* additional manifolds **405** and/or central manifold **107** to receive high pressure fracturing fluids from connected pumps, as *Ciezobka* teaches that its systems/methods in Figs. 6-7 can be connected to a known system “for providing pressure flow rate to the wellheads,” and because *Ciezobka* explicitly envisions its application to “multiple wells.”¹⁵¹ A POSITA would have found this to be a simple combination of known systems with predictable results of improved fracturing efficiency. Additionally, with two sets of *Ciezobka's* systems/methods of Figs. 6-7 connected to a central manifold, as taught by *McNeel*, a POSITA would have found it obvious to equally apply *Ciezobka's* overlapping valve sequencing to provide alternating fluid pulses to four wells. In applying *Ciezobka's* overlapping valve sequences to provide alternating fluid pulses to two pairs of wells in *McNeel's* system, it would have been nearly inevitable that, at some point in the “simultaneous” fracturing operation, a valve to one well (e.g., a first well) would be closed after valves to other wells (e.g., a second and fourth well) are opened.

¹⁵¹ Ex. 1036 at 11:28-30 and 28:22-25.



332. Further, as it is known to use multiple fracturing “fleets” to perform fracturing operations at multiple wellpads at the same time, it would be obvious, while performing the valve switching, pulse generating techniques of *Ciezobka* at both wellpads at the same time. In such a case, it would be nearly inevitable that, at some point in the “simultaneous” fracturing operation at multiple pads, the first valve would be closed after the second valve is opened (as specifically disclosed by *Ciezobka*) and after the fourth valve is opened.

333. For example, Fig. 7, showing the switching operation and corresponding flowrates of a first [annotated in pink] and second well [annotated in

green], is shown below, along with a second Fig. 7 annotated to show the switching operation and corresponding flowrates of the third [annotated in green] and fourth [annotated in blue] well occurring at the same time, using, for example, a different fracturing fleet. Accordingly, the flow rates would line up temporally, as shown.

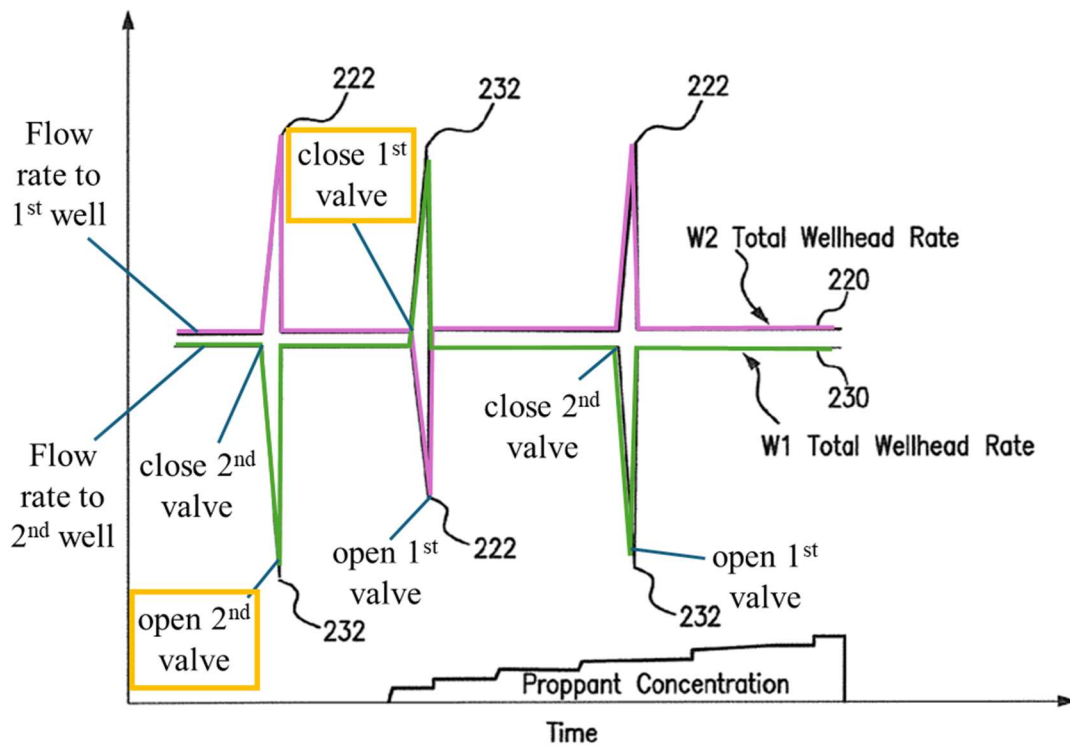


FIG. 7
(Annotated)

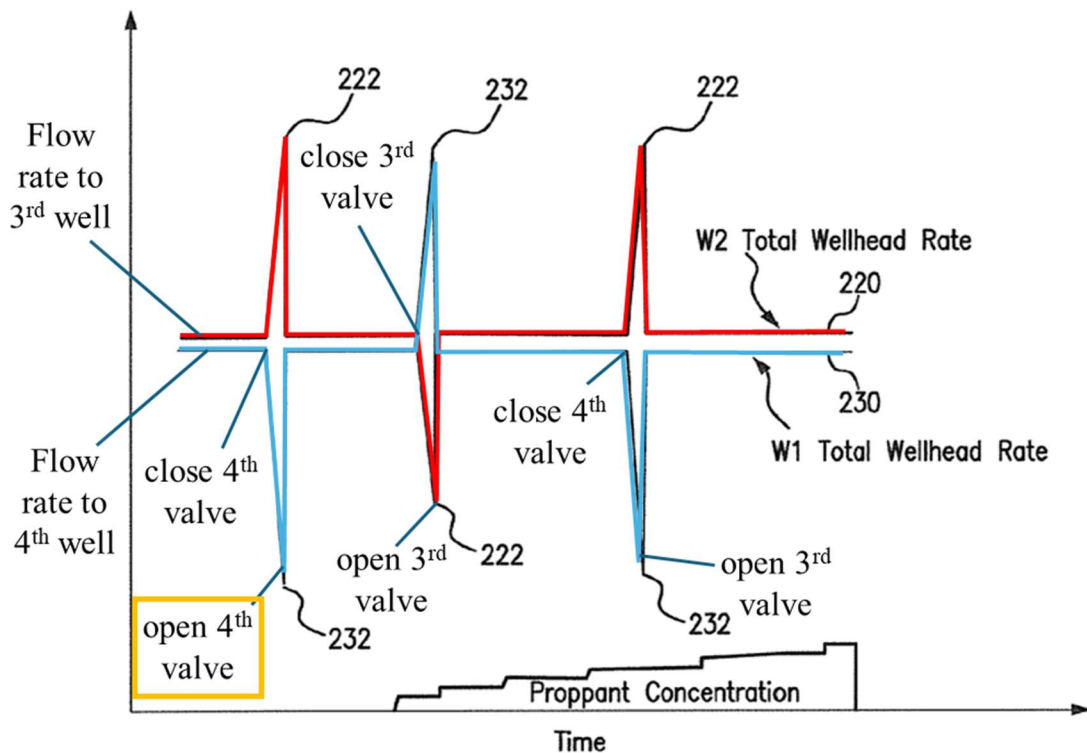


FIG. 7
(Annotated)

334. As seen in the above Figures, the first valve would be closed after the second valve is opened and the fourth valve is opened (events annotated in orange).

335. Additionally, Limitation 3.1 is the first prong in an “and/or” Claim. Thus, because Limitation 3.1 is disclosed or at least rendered obvious by *Ciezobka* with *McNeel*, Claim 3 as a whole is at least rendered obvious by *Ciezobka*. Further, as discussed below, the combination of *Ciezobka* and *McNeel* also renders obvious the second prong of the “and/or” statement contained in Claim Limitation 3.2.

b. **3.2: “the third valve is closed after opening both the second valve and the fourth valve.”**

336. For the same reasons discussed above regarding Limitation 3.1, *Ciezobka* and *McNeel* render obvious simultaneous treatment of the second and fourth wells. Further, for the same reasons, the combination of *Ciezobka* and *McNeel* teaches or at least renders obvious simultaneous treatment of the first and third well. In a method where wells 1 and 3 are “simultaneously treated” and switch with wells 2 and 4 according to the method of *Ciezobka* combined with *McNeel*, the second and fourth valves would be opened and closed simultaneously, and the first and third valves would be closed simultaneously, and after the second and fourth valves are opened.

337. Accordingly, Claim 3 is obvious over *Ciezobka* alone for the above reasons.

D. INDEPENDENT CLAIM 14

338. It is my opinion that Claim 14 of the '770 Patent would have been obvious based on the teachings of *Ciezobka*. To the extent that the generic computer claimed in Claim 14 is not rendered obvious by *Ciezobka* alone, *McNeel* provides additional teaching, making using a computer to control the valves obvious.

- a. 14.1: “An apparatus comprising: a non-transitory computer readable medium; and a plurality of instructions stored on the non-transitory computer readable medium and executable by one or more processors, wherein, when the instructions are executed by the one or more processors, the following steps are executed:

14.2: “communicating fluid to a first well via a manifold and a first valve, the first valve being associated with both the manifold and the first well; and”

14.3: “in response to determining that the fluid communicated via the manifold has satisfied one or more conditions:”

14.4: “opening a second valve; communicating fluid to a second well via the second valve; and”

14.5: “closing the first valve after opening the second valve.”

339. As discussed above regarding Grounds 1 & 2, *Ciezobka* discloses, or at least renders obvious, the use of a generic computer to control the switching of valves. *Ciezobka* discloses using “a software toolbox which incorporates all of the data handling and data analysis elements for real time application in the field during hydraulic fracturing operations.”¹⁵² A POSITA would have understood that the description of using the software toolbox “real time in the field” necessitates a generic computing device, such as described in Limitation 14.1, to be “in the field” at the location of the hydraulic fracturing. Further, A POSITA would have also recognized that using the computer for “all of the data handling and data analysis

¹⁵² Ex. 1036 at 27:26-28.

elements” requires the computer to be connected to the system of *Ciezobka* in such a way that all flow rate measurements, pressure measurements, proppant concentrations, etc. are fed into the computer for “real time application in the field.”

340. To the extent that *Ciezobka* does not explicitly disclose using the computer used for “data handing and data analysis elements” for “real time in the field” control of the valves, *McNeel* teaches such an arrangement. *McNeel* teaches the use of valves, along with sensors, to control the fracturing operations. Further, *McNeel* teaches that “[t]hese valves may be either plug valves or check valves and can be manually or electronically monitored and controlled.”¹⁵³ *McNeel* also teaches that such manifolds and associated valves “are controlled, coordinated, and monitored by a central control system.”¹⁵⁴ “The central control system may use all of the sensor data from all units and the drive signals from their individual subcontrollers to determine subsystem trajectories.”¹⁵⁵ A POSITA would have immediately recognized that “electronically controlled” valves would have used a computer to control the valves, particularly at the time of the ’770 Patent (2017-2019). Such computer control systems had been used in fracturing operations for decades by the time of the ’770 Patent.¹⁵⁶ To the extent that using a computer, as

¹⁵³ Ex. 1037 at [0025] and [0026].

¹⁵⁴ Ex. 1037 at [0029].

¹⁵⁵ *Id.*

¹⁵⁶ See, e.g., Ex. 1020 at [0030]; Ex. 1021 at [0072].

claimed in Claim 14, to control the valve switching is not explicitly disclosed by *McNeel* or *Ciezobka*, it would have been obvious to a POSITA at the time of the ‘770 Patent application to use a computer control system for improved valve control.

341. Accordingly, the combination of *Ciezobka* and *McNeel* renders obvious Limitation 14.1. Limitations 14.2-14.5 are identical to Limitations 1.1-1.4 and are disclosed and/or rendered obvious by *Ciezobka* for at least the same reasons provided in Section XII.A. Thus, Claim 14 is obvious over *Ciezobka* in view of *McNeel* for the reasons provided above.

E. DEPENDENT CLAIMS 15–26

342. The limitations of claims 15-26 are disclosed or rendered obvious by *Ciezobka* alone for the reasons discussed in Grounds 1-2. For the same reasons, the claims are obvious over the combination of *Ciezobka* and *McNeel*.

F. INDEPENDENT CLAIM 27

- a. **27.1: “1. A system, comprising: a first valve via which fluid is communicated from a manifold to a first well”**
- 27.2: “a second valve via which fluid is adapted to be communicated to a second well; and”**
- 27.3: “one or more controllers, configured to:”**
- 27.4: “open the second valve to thereby communicate fluid to the second well via the second valve; and”**
- 27.5: “close the first valve after opening the second valve,”**
- 27.6: “in response to: determining that the fluid communicated via the manifold has satisfied one or more conditions.”**

343. As discussed above regarding Grounds 1 & 2, *Ciezobka* discloses, or at least renders obvious, the use of a generic computer to control the switching of valves. To the extent that *Ciezobka* does not explicitly disclose using the computer used for “data handing and data analysis elements” for “real time in the field” control of the valves, *McNeel* teaches such an arrangement. *McNeel* teaches the use of valves, along with sensors, to control the fracturing operations. Further, *McNeel* teaches that “[t]hese valves may be either plug valves or check valves and can be manually or electronically monitored and controlled.”¹⁵⁷ *McNeel* also teaches that such manifolds and associated valves “are controlled, coordinated, and monitored

¹⁵⁷ Ex. 1037 at [0025] see also [0026].

by a central control system.”¹⁵⁸ “The central control system may use all of the sensor data from all units and the drive signals from their individual subcontrollers to determine subsystem trajectories.”¹⁵⁹ A POSITA would have immediately recognized that “electronically controlled” valves would have used a “controller” to control the valves, particularly at the time of the ‘770 Patent (2017-2019). Such computer control systems had been used in fracturing operations for decades by the time of the ‘770 Patent.¹⁶⁰

344. Further, it would have been obvious to use software instructions for controlling the fracturing system, including opening and closing valves using an overlapping valve sequence to selectively deliver fluid pulses to multiple wells, according to *Ciezobka’s* systems/methods, on the “central control system” of *McNeel* (or any other suitable generic controller) in order to apply *Ciezobka’s* fracturing methods in “real time.”¹⁶¹ Application of *Ciezobka’s* methods using *McNeel’s* controller/control system would have involved a simple application of a known technique using a known system with the predictable results of improved control. Thus, Limitation 27.3 would have been obvious by the combination of *Ciezobka* and *McNeel*.

¹⁵⁸ Ex. 1037 at [0029].

¹⁵⁹ *Id.*

¹⁶⁰ See, e.g., Ex. 1020 at [0030]; Ex. 1021 at [0072].

¹⁶¹ Ex. 1036 at 27:27-28.

345. Limitations 27.1-27.2 and 27.4-27.6 are identical to or contained in Limitations 1.1-1.4 and are disclosed and/or rendered obvious by *Ciezobka* for at least the same reasons provided in Section XII.A. Accordingly, Claim 27 is obvious over the combination of *Ciezobka* and *McNeel* for the reasons provided above.

G. DEPENDENT CLAIM 28

346. Dependent Claim 28 depends from Claim 27. In addition to the disclosure of the limitations of Claim 27 discussed above, *Ciezobka* discloses the additional limitations of Claim 28:

- a. **28.1: “28. The system of claim 27, further comprising: a third valve via which fluid is communicated from the manifold to a third well;”**

347. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of 28.1 are substantially similar to those of Limitation 2.1 discussed above. Thus, the limitations of 28.1 are disclosed by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 2.1 in Section XII.B.a.

- b. **28.2: “a fourth valve via which the fluid is adapted to be communicated to a fourth well; and”**

348. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of 28.2 are contained in Limitation 2.3 discussed above. Thus, the limitations of 28.2 are disclosed, or at least rendered obvious by *Ciezobka*

at least for the same reasons as those discussed above regarding Limitation 2.3 in Section XII.B.c.

- c. **28.3: “the one or more controllers, configured to: open the fourth valve to thereby communicate fluid to the fourth well via the fourth valve; and”**

349. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of 28.3 are contained in Limitation 2.3 discussed above. Thus, the limitations of 28.3 are disclosed, or at least rendered obvious by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 2.3 in Section XII.B.c.

- d. **28.4: “close the third valve after opening the fourth valve,”**

350. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of 28.4 are contained in Limitation 2.4 discussed above. Thus, the limitations of 28.4 are disclosed, or at least rendered obvious by *Ciezobka* at least for the same reasons as those discussed above regarding Limitation 2.4 in Section XII.B.d.

- e. **28.5: “in response to: determining that the fluid communicated via the manifold has satisfied the one or more conditions.”**

351. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of 28.5 are contained in Limitation 2.2 discussed above. Thus, the limitations of 28.5 are disclosed, or at least rendered obvious by *Ciezobka*

at least for the same reasons as those discussed above regarding Limitation 2.2 in Section XII.B.b.

352. Accordingly, Claim 28 is obvious over *Ciezobka* alone for the above reasons.

H. DEPENDENT CLAIMS 29 – 38.

353. Except for being rewritten as part of a system claim and depending from Claim 27, the limitations of Claim 29 are the same as Claim 3, discussed above in Section XIII.C. Thus, the limitations of Claim 29 are disclosed, or at least rendered obvious by *Ciezobka* and *McNeel* at least for the same reasons as those discussed above regarding Claim 3 in Section XIII.C. Accordingly, Claim 29 is rendered obvious by *Ciezobka* and *McNeel* for the reasons provided above. Additionally, the limitations of claims 30-38 are disclosed or rendered obvious by *Ciezobka* alone for the reasons discussed in Grounds 1-2 in Section XII. Accordingly, for the same reasons, Claims 30-38 are obvious over the combination of *Ciezobka* and *McNeel*.

XIV. SECONDARY CONSIDERATIONS

354. I have not seen any evidence of secondary considerations related to the '770 Patent. Should the Patent Owner put forth any alleged evidence of secondary considerations in this proceeding or any related proceeding, I reserve the right to consider such evidence, to consider whether any such evidence has a nexus to any claims of the Challenged Patent, and to update my analysis.

XV. CONCLUSION

355. Based on my education, experience, and expertise, it is my opinion that all of the Challenged Claims are anticipated and/or obvious in view of *Ciezobka* and/or *McNeel* for the reasons discussed above.

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 1, 2024.



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 Organizations, Culture & Ethics: Group or Horizontal Interactions, Marcus O. Durham and Robert A Durham, ISBN 978-1466250338, 2011

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"Grounding Systems Interaction," Robert A. Durham and Marcus O. Durham, *Proceedings of 33rd Annual Frontiers in Power Conference*, OSU, Stillwater, OK, October 2000.

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"Can Electrical Insulation and Conductor Performance Be Predicted?" Marcus O. Durham and Robert A. Durham, *Proceedings of Production Operations Symposium*, SPE 52161, Oklahoma City, OK, March 1999

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"Remote Transmitter and Distributed Control Grounding and System Protection," Robert A. Durham and Marcus O. Durham, *Proceedings of 27th Annual Frontiers in Power Conference*, OSU, Stillwater, OK, October 1994.

Robert A Durham, PhD, PE
Expert Witness
Previous Four Years from February 14, 2023

Attorney	Case	Location	Issue	
Carr & Carr	Bales v. Amp Electric et al	Delaware County, OK	Fire	Depo
Denton Law	Robbins v. Madewell	Mayes County, OK	Fire / injury	Trial
Baker Botts	IPR 2023-00558	USPTA PTAB	Intellectual Property	Depo
Haynes Boone	Nabors v. Helmerich & Payne et al	Northern District, TX	Intellectual Property	Trial
McDermott Will & Emery LLP	Halliburton V. U.S. Well Services	Western District, TX	Intellectual Property	Trial
Jones, Oten & Jewell	Davis v. Tapp	Garfield County, OK	Fire / Injury	Trial
Haynes & Boone	Nabors Driling v. Helmerich & Payne et al	Northern District, TX	Intellectual Property	Depo
Mattingly Law	Fulton v. Aviagen et al	Muskogee County, OK	Building Codes	Trial
Baker Botts	US Well Services v. Halliburton	Western District, TX	Intellectual Property	Depo
Kelly, Morgan	Montanez v. Deepwell Energy Svcs	Ector County, TX	Flash Fire / Injury	Depo
Baker Botts	IPR 2021-01316	USPTO PTAB	Intellectual Property	Depo
Baker Botts	IPR 2021-01238	USPTO PTAB	Intellectual Property	Depo
Baker Botts	IPR 2021-01315	USPTO PTAB	Intellectual Property	Depo
Baker Botts	IPR 2021-01065	USPTO PTAB	Intellectual Property	Depo
Clancy & Thompson	Borth v. Phillips & Sons Trucking et al	Canadian County, OK	Injury	Depo
Baker Botts	IPR 2021-01034	USPTO PTAB	Intellectual Property	Depo
Baker Botts	IPR 2021-01033	USPTO PTAB	Intellectual Property	Depo
Baker Botts	IPR 2021-01032	USPTO PTAB	Intellectual Property	Depo

Stephen Jones	Davis v. Tapp	Garfield County	Fire / Injury	Depo
Kelly, Morgan	Calvillo v. On Point	Travis County, TX	Flash Fire / Injury	Depo
Hartline Barger	Ramirez v. Home Depot	Southern District, TX	Electrical Failure / Fire	Depo
Mcafee & Taft	Hale v. Southeast Colorado Power Association	Baca County, CO	Electrical Failure / Fire	Depo
Hartline Barger	Siqueros v. Templo Monte Horeb et al	El Paso County, TX	Injury	Depo
Naman, Howell	Lentz v Brenntag Pacific et al	Upton County, TX	Flash Fire / Injury	Depo
Craft Law Firm	Cason v. Cimarex et al	Victoria County, TX	Flash Fire / Injury	Depo
Naman, Howell	Lentz v Brenntag Pacific et al	Upton County, TX	Flash Fire / Injury	Depo