

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

WEATHERFORD U.S., L.P.,
Petitioner,

v.

HALLIBURTON ENERGY SERVICES, INC.,
Patent Owner.

Case IPR2024-00990
Patent No. 11,333,007

DECLARATION OF DR. ROBERT A. DURHAM

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I, Robert Durham, hereby declare as follows:

I. INTRODUCTION & QUALIFICATIONS

1. I have been retained on behalf of Halliburton Energy Services, Inc. (“Halliburton”) to provide my opinions regarding Weatherford U.S., L.P.’s Petition for *Inter Partes* Review of Claims 1-23 of U.S. Patent No. 11,333,007 (“the ’007 Patent”). I submit this declaration based on my personal knowledge and in support of Halliburton’s Patent Owner Response.

2. In formulating my opinions, I have relied upon my knowledge, training, and experience in the relevant art. My qualifications are stated more fully in my curriculum vitae, which has been included as Ex. 2003. My CV also lists publications on which I am a named author and identifies parties on behalf of whom I have previously provided expert testimony within the past four years. Here, I provide a brief summary of my qualifications.

3. I am a consulting engineer with experience in a number of technical areas. I have oil and gas industry expertise from drilling and completion to downstream. As a consultant, I have worked with oil field production companies, refining and chemical plants, equipment manufacturers, and technology development companies for over twenty years. My work relates to the subject matter of the U.S. Pat. No. 11,333,007 (“the ’007 Patent”), which I describe below in Section VI (“Overview of the ’007 Patent”).

Ex. 2002 p. 5

4. 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.

5. I have also served in leadership positions in the Petroleum and Chemical Industry Committee (PCIC) of the Institute of Electrical and Electronics Engineers (IEEE) for nearly twenty years. IEEE is the world's largest technical professional association. The PCIC is the premier forum for the exchange of electrical applications technology related to the petroleum and chemical industry. From 2005 to 2012, I served as Secretary, Vice Chair, and ultimately chair of the Production Subcommittee of the PCIC. The Production Subcommittee is the primary method for PCIC members to communicate technical papers related to drilling, wellhead, and facilities operations of oil and gas wells. In 2013, I was appointed as Vice-Chair of the Standards Subcommittee of the PCIC, a role which transitioned to Chair in 2014. I served as Chair until 2022. The Standards Subcommittee of the PCIC is the Sponsor of IEEE standards relating equipment operations in the Oil and Gas Industry. The PCIC Standards Subcommittee sponsors nearly 50 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.

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

7. I have worked directly in the 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.

8. After a brief stint as Vice President for EDG Power Group, responsible for Engineering and Project Management of generation and co-generation facilities across the U.S., I transitioned to the role of consulting engineer. In that role, I have served as a consulting engineer in designing, constructing, and analyzing all kinds of 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.

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

10. I have been familiar with oil and gas drilling, fracturing (fracking), completion, production, midstream, and downstream operations for over twenty years. I am familiar with sand control technologies, including sand screens and gravel packs. I have specified and used sand control devices in production wells, particularly in loosely consolidated sand formations. Additionally, I was familiar with sand control devices when employed at New Dominion, LLC. I have studied gravel pack technologies in a consulting role, even before this engagement, and have testified regarding such technologies

11. I have been familiar with the Occupational Safety and Health Administration (“OSHA”) and its responsibilities at oil and gas locations. I have consulted and investigated incidents on multiple oil and gas sites where OSHA has also performed investigations about injuries and fatalities that have occurred at oil

and gas locations, including drilling, fracturing and completion operations. As Principal Scientist of THEWAY Labs, part of my responsibilities include overseeing the Health Safety and Environmental (HSE) program at THEWAY Labs, including establishing policies and procedures commensurate with OSHA requirements at all locations, including requirements for oil and gas sites.

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

13. 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 '007 Patent and have been an expert in this field since before the '007 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 '007 Patent at the time of filing.

II. TASK SUMMARY AND MATERIALS REVIEWED

14. I have been asked to review the Petition for *Inter Partes* Review of Claims 1-23 of the '007 Patent (the "Challenged Patent") along with the associated Patent, File History, alleged Prior Art and other associated exhibits and provide my opinions regarding the Petition. In forming my opinions, I have reviewed the

materials cited in the List of Exhibits and the materials cited throughout my declaration.

III. LIST OF EXHIBITS

Exhibit No.	Description
1001	U.S. Patent No. 11,333,007 (“’007 Patent”)
1002	File History for U.S. Patent No. 11,333,007
1003	Declaration of Michael R. Chambers Sr. (“Chambers Decl.”)
1004	CV of Michael R. Chambers Sr.
1005	U.S. Patent No. 9,797,226 (“Yeh”)
1006	IPTC 12549 (“Yeh2”)
1007	U.S. Patent No. 4,945,991 (“Jones”)
1008	U.S. Patent No. 5,113,935 (“Jones2”)
1009	L.G. Jones et al., <i>Alternate Path Gravel Packing</i> , Society of Petroleum Engineers, SPE 22796 (Oct. 1991)
1010	U.S. Patent No. 7,661,476
1011	<i>ExxonMobil Awards Alternate Path Technology License to Weatherford</i> , ExxonMobil Press Release (Aug. 27, 2013)
1012	U.S. Patent No. 5,588,487
1013	G. Hurst et al., <i>Alternate Path Completions: A Critical Review and Lessons Learned From Case Histories With Recommended Practices for Deepwater Applications</i> , Society of Petroleum Engineers, SPE 86532 (Feb. 2004) (“Hurst”)
1014	K.W. Lagrone et al., <i>A New Development in Completion Methods The Limited Entry Technique</i> , Society of Petroleum Engineers, SPE 530 (July 1963) (“Lagrone”)
1015	M.T. Hecker et al., <i>Extending Openhole Gravel Packing Capability: Initial Field Installation of Internal Shunt Alternate Path Technology</i> , Society of Petroleum Engineers, SPE 135102 (Sept. 2010) (“Hecker”)

1016	A. Bonner et al., <i>Design and Validation of an Improved Shunt Tube System</i> , Society of Petroleum Engineers, SPE-169440-MS (2014) (“Bonner”)
1017	API Technical Report 5C3, published in December 2008 with an Addendum in October 2015 (excerpts)
1018	ASTM A554-16: Standard Specification for Welded Stainless Steel Mechanical Tubing (2016) (excerpts)
1019	Declaration of Christine Diedrich of the Society of Petroleum Engineers
1020	Complaint for Patent Infringement, <i>Halliburton Energy Servs. v. Weatherford U.S. L.P.</i> , Case No. 24-cv-00090 (W.D. La. Jan. 22, 2024)
1021	U.S. District Courts – Combined Civil and Criminal Federal Court Management Statistics (March 31, 2023), available at https://www.uscourts.gov/statistics-reports/federal-court-management-statistics-march-2023
1022	Shahryar Saebi, <i>The Evolution of Completion Designs Using Alternate Path (Shunt-Tubes) Technology</i> , Society of Petroleum Engineers SPE 155129 (Mar. 2012)
1023	U.S. Patent No. 5,476,143
1024	U.S. Patent No. 7,938,184
1025	Larry G. Myers et al., <i>Case History in Achieving High Rate Producers in Sub Sea Gravel Packed Completions</i> , Society of Petroleum Engineers, SPE 39433 (Feb. 1998)
1026	Raymond Tibbles, et al., <i>Design and Execution of a 3000-ft Horizontal Gravel-Packed Completion (A Kazakhstan Case History)</i> , Society of Petroleum Engineers, SPE 64410 (Oct. 2000)
1027	M.D. Barry et al., <i>Openhole Gravel Packing With Zonal Isolation</i> , Society of Petroleum Engineers, SPE 110460 (Nov. 2007)
1028	U.S. Patent No. 5,890,533
1029	ASTM A500/A500M-13: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes (2013) (excerpts)
1030	U.S. Patent No. 4,629,218
1031	Declaration of Stephen McNamee

1032	Fischer Stainless Steel Tubing - Part Number List
1033	L.G. Jones et al., <i>Gravel Packing Horizontal Wellbores with Leak-Off Using Shunts</i> , Society of Petroleum Engineers, SPE 38640 (Oct. 1997)
1034	D.W. Bryant & L.G. Jones, <i>Completion and Production Results from Alternate-Path Gravel-Packed Wells</i> , SPE Drilling & Completion, SPE 27359 (Sept. 1995)
1035	U.S. Patent No. 6,588,506
1036	Halliburton Cementing Tables (1979) (excerpts)
1037	Introduction to Otis Multi-Position Gravel Pack System, Otis Engineering Corporation, Technical Manual 2004/88 (excerpts)
1038	Johnson Oil and Gas Well Screens Catalog (1991) (excerpts)
1039	U.S. Patent No. 2,905,245
1040	U.S. Patent No. 8,839,861
1041	U.S. Patent No. 5,842,516
2001	Deposition Transcript of Dr. Michael R. Chambers re: IPR2024-00990 (February 21, 2025)
2002	Declaration of Robert A. Durham
2003	Curriculum Vitae of Robert A. Durham
2004	Second Declaration of Robert A. Durham
2005	Provisional Application No. 62/688,813
2006	Bourgoyne, Adam T., Jr., Keith K. Millheim, Martin E. Chenevert, and F.S. Young, Jr., <i>Applied Drilling Engineering</i> , Society of Petroleum Engineers (1986).
2007	Staff of Royal Dutch / Shell Group of Companies, <i>The Petroleum Handbook</i> , (1983).
2008	Rahman, S. S. and G. V. Chilingarian, <i>Casing design-theory and practice</i> (1995).
2009	IEEE RP 1017, "IEEE Recommended Practice for Field Testing Electric Submersible Pump Cable" (2004).
2010	Conaway, Charles F, <i>The Petroleum Industry: A Nontechnical Guide</i> . Pennwell Books (1999).

Ex. 2002 p. 12

2011	Braek, A. M., R. A. Almehaideb, and R. Hughes, <i>Application of Eos to Optimize the Design of an Early Production Scheme of an Onshore Oil Field in Abu Dhabi</i> , Abu Dhabi International Petroleum Exhibition and Conference (1998).
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IV. SUMMARY OF CONCLUSIONS

15. Based upon my review of the Petition and materials identified above, it is my opinion that the *Yeh* fails to disclose or render obvious all limitations of claims 1 – 10, with or without *Yeh2*. It is my further opinion that *Yeh/Yeh2*, with or without *Jones2*, fails to disclose or render obvious all limitations of Claims 14 – 20.

16. Further, it is my opinion that the *Yeh/Jones* combination fails to disclose or render obvious Claims 21 – 22. Also, the combination of *Yeh, Jones and Yeh2* fails to disclose or render obvious all the limitations of Claim 23.

V. LEGAL STANDARDS

A. LEVEL OF ORDINARY SKILL IN THE ART

17. 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.

18. I have been instructed by counsel that the person of ordinary skill in the art (“**POSITA**”) is a hypothetical person who is presumed to know the relevant prior art. I understand that the actual inventor’s skill is not determinative of the level of

ordinary skill. I further understand that the factors that may be considered in determining the level of skill include the types of problems encountered in the art, prior art solutions to those problems, rapidity with which innovations are made, sophistication of the technology, and educational level of active workers in the field. I understand that not all such factors may be present in every case, and one or more of them may predominate.

B. LEGAL STANDARD FOR CLAIM CONSTRUCTION

19. 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.

20. 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.

21. 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.

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

23. 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.

24. 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

25. 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.

D. OBVIOUSNESS

26. 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 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).

27. 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.

28. 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.

29. 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;

Ex. 2002 p. 17

- 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.

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

31. 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;

Ex. 2002 p. 18

- 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.

32. 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. DEPENDENT CLAIMS AND ANTECEDENT BASIS

33. I understand that dependent claims contain a reference to a previous claim in the same application, specify a further limitation of the subject matter claimed, and include all the limitations of the previous claim. I understand that a dependent claim incorporates by reference all the limitations of the claim to which it refers.

34. I understand that a claim may make reference to a preceding claim to define a limitation. I understand that an earlier recitation or claim limitation in a claim, or in a preceding claim to which the claim makes reference, may provide antecedent basis for a later recitation or claim limitation in the claim.

F. PRIORITY DATE

35. 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.

36. I understand that it is not enough for a patent to merely claim the benefit of an earlier-filed application, but that additional criteria must be met. In particular, the prior application itself must describe the claimed invention, and must do so in sufficient detail that one skilled in the art can clearly conclude that the inventor invented the claimed invention as of the filing date sought. First, I understand that a priority-date analysis is on a claim-by-claim basis. Second, I understand that, in order for a patent claim to be entitled to the filing date of an earlier patent application, a “Section 112 analysis” must be conducted. I am informed that a “Section 112” analysis encompasses looking to the earlier patent application, and ascertaining whether that earlier patent application meets both the written-description and enablement requirements as of the filing date of the earlier application. I understand that it is not enough that the claim would have been obvious from the earlier application, but that application itself must describe the claimed invention.

37. I understand that in order to satisfy the written description requirement the earlier application must reasonably convey to those skilled in the art that the

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

38. 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.

VI. OVERVIEW OF THE '007 PATENT

A. PATENT SPECIFICATION AND CLAIMS

39. The '007 Patent, entitled “Multiple Shunt Pressure Assembly for Gravel Packing,” was issued by the USPTO on May 17, 2022.¹ The '007 Patent relates to fracturing operations in the oil and gas industry and, in particular, discloses “shunt tube systems utilized in the sand screen assemblies” for “wellbore gravel

¹ Ex. 1001 ('007 Patent) at (45).

packing.”² The patent explains that gravel packing in an oil or gas well may be used to prevent formation sand from being “swept into the flow path of the production fluid” during production.³ Problems that may arise during gravel packing are in “incomplete packing,” or the “formation of sand bridges” in the gravel pack. These two problems are related to “leak-off” in the gravel pack, or “premature loss of the [gravel] carrier fluid into the formation”.⁴ The ’007 Patent explains that “shunt tubes” in a sand screen structure may “operate[] to permit the inflowing packing sand/gel slurry to bypass any sand bridges” and complete the gravel pack.⁵ Another problem described by the ’007 Patent was “since shunt tube assemblies for an entire lower production assembly are selected based on the highest operating pressure expected to be required across the entire length of the gravel packing interval, individual sand screen assemblies in a lower production assemblies have become increasingly heavier.”⁶

40. The ’007 Patent also explains that “where production zones are elongated,” multiple “lower completion assemblies” may be needed to form a string from the production zone’s “upstream end to the downstream end,” and “relatively

² Ex. 1001 (’007 Patent) 1:15-20.

³ Ex. 1001 (’007 Patent) 1:24-47.

⁴ Ex. 1001 (’007 Patent) 1:44-53.

⁵ Ex. 1001 (’007 Patent) 1:54-67.

⁶ Ex. 1001 (’007 Patent) 9:20-25.

high pressures must be applied to the carrier fluid.”⁷ The ’007 Patent notes that historically, “each individual lower completion assembly” is “designed to withstand the high delivery pressures at the upstream end” of the string.⁸ The ’007 Patent addresses problems with gravel packing by designing the lower sections of the sand screen assembly “to allow a larger volume of fluid to flow therethrough than that of the first [upper] sand screen assembly 202 by adjusting cross-sectional flow areas, location and number of nozzles. In this regard, the geometries of the shunt tube assemblies 220 of the first sand screen assembly 202 may be selected to have a higher operating pressure than the shunt tube assemblies 220 of the second sandscreen assembly 204.”⁹ This allows for longer assemblies, reduces weight and addresses problems with leakoff in the higher pressure (upper) portions of the assembly.

B. PRIORITY DATE

41. PCT Patent Application No. PCT/US2019/024626 leading to the ’007 Patent was filed on March 28, 2019.¹⁰ The ’007 Patent claimed priority to provisional application No. 62/688,813 filed on June 22, 2018.¹¹ Petitioner applies the

⁷ Ex. 1001 (’007 Patent) 2:1-9.

⁸ Ex. 1001 (’007 Patent) 2:9-14.

⁹ Ex. 1001 (’007 Patent) 9:39-45.

¹⁰ Ex. 1001 (’007 Patent) Cover

¹¹ Ex. 1001 (’007 Patent) Cover

provisional filing date of June 22, 2018 as the priority date.¹² Patent Owner does not dispute this priority date, and I use this priority date for purposes of this declaration.¹³

C. PROSECUTION HISTORY

42. The Examiner issued an Office Action on July 6, 2021, rejecting all claims under 35 U.S.C. §103 and §112.¹⁴ The Examiner rejected claims 1-23 as obvious.¹⁵ In a response dated October 6, 2021, Applicant argued against these rejections and amended the claims, arguing that the combination does not teach changing characteristics of the shunt tube assemblies along the length of a production zone.¹⁶

43. The Examiner issued another Office Action on October 21, 2021, allowing claims 1-7, 9-15, and 17-24, and rejecting claim 8 under 35 U.S.C. §112. In a response dated December 8, 2021, Applicant amended claim 8 to address the §112 rejection.¹⁷ A Notice of Allowability was issued on January 21, 2022.¹⁸

VII. OVERVIEW OF PRINCIPAL CITED REFERENCES

¹² Petition 30, 31.

¹³ Petition at 10, 30 - 31.

¹⁴ Ex. 1002, 262-284.

¹⁵ Ex. 1002 at 269-284

¹⁶ Ex. 1002 at 583-592.

¹⁷ Ex. 1002 at 608 – 615.

¹⁸ Ex. 1002 at 622 – 624.

A. YEH (EX. 1005)

I. Status & Disclosure of Yeh

44. *Yeh* is a United States Patent issued to *Charles S. Yeh et al.* granted on October 24, 2017. The application that led to *Yeh* (Appl. No. 13/990,804) was filed on November 17, 2011 and claims priority to two provisional applications, though Petitioner does not rely on the provisional filing dates.¹⁹ The title of *Yeh* is “Crossover Joint for Connecting Eccentric Flow Paths to Concentric Flow Paths.”

45. As the title of *Yeh* suggests, *Yeh* is directed to a “crossover tool” that couples two wellbore tools (e.g. sand screens, packers) where “radial center of the primary flow path in the first wellbore tool is offset from a radial center of the primary flow path in the second wellbore tool.”²⁰ *Yeh* describes the primary problem purportedly solved as “a need exists for an improved sand control system utilizing a crossover joint for connecting an eccentric sand screen with a concentric packer, or vice versa.”²¹ *Yeh* describes several considerations in designing the crossover joint, which include minimizing curvature, providing mechanical integrity, limiting “outer diameter” of the tool, and “maximizing inner diameter of the primary flow path.”²² *Yeh* teaches the use of the crossover tool primarily in a gravel pack environment

¹⁹ Provisional application No. 61/424,427, filed on Dec. 17, 2010, provisional application No. 61/499,865, filed on Jun. 22, 2011.

²⁰ Ex. 1005 (*Yeh*) at Abstract.

²¹ Ex. 1005 (*Yeh*) 4:12 – 14.

²² Ex. 1005 (*Yeh*) 26:57-64, 28:25-30.

where concentric and eccentric sand screens are connected with each other and with concentric and eccentric packers.²³

46. *Yeh* provides several examples of the use of this crossover tool, with the preferred embodiment being eccentric screen → crossover tool → concentric packer.²⁴ This is the embodiment relied on in the Petition. *Yeh* does not purport to improve on existing sand screens, but rather focuses on connecting sand screens together, and connecting sand screens to packers.²⁵ *Yeh* teaches using more readily available, lower friction and less expensive eccentric screens downstream, instead of more expensive, less available, higher friction, more complex concentric screens, may “reduce the overall cost of completion.” Ex. 1006, 30:20-33.

B. YEH2 (EX. 1006)

1. Status & Disclosure of Yeh2

47. *Yeh2* is a paper presented at the International Petroleum Technology Conference held December 3 – 5, 2008. *Yeh2* was assigned paper number IPTC 12549 and is titled “Unlocking the Limits of Extreme Length in Alternate Path

²³ see, e.g., Ex. 1005 (*Yeh*) 29:58 – 30:46

²⁴ Ex. 1005 (*Yeh*), 30:13-39.

²⁵ See, e.g., Ex. 1005 (*Yeh*) 3:23 – 24 (“It is known to use rectangular shunt tubes that are eccentrically attached to the outside of a sand screen.”; see also, e.g., 3:24 – 51 describing a known “Alternate Path sand screen having concentric internal shunt tubes.”)

Gravel Packing”.²⁶ *Yeh2* describes a concentric sand screen for use in a gravel pack application “over much longer production intervals (~5,000 ft)”, longer than the then known lengths “up to 2,800 ft”.²⁷ *Yeh2* primarily accomplishes this by using internal, closed-end shunt tubes in a 6x3 configuration and “shunt manifolds,” which “incorporates a continuous non-ported shunt tube to transport the slurry and a non-continuous, ported packing tube on each joint used to discharge the slurry.”²⁸ *Yeh2* does not describe shunt tube wall thickness or describe any approach for modifying shunt tube wall thickness over the length of the production interval. *Yeh2* instead teaches to rate shunt tubes to withstand the highest burst pressure at the heel.²⁹

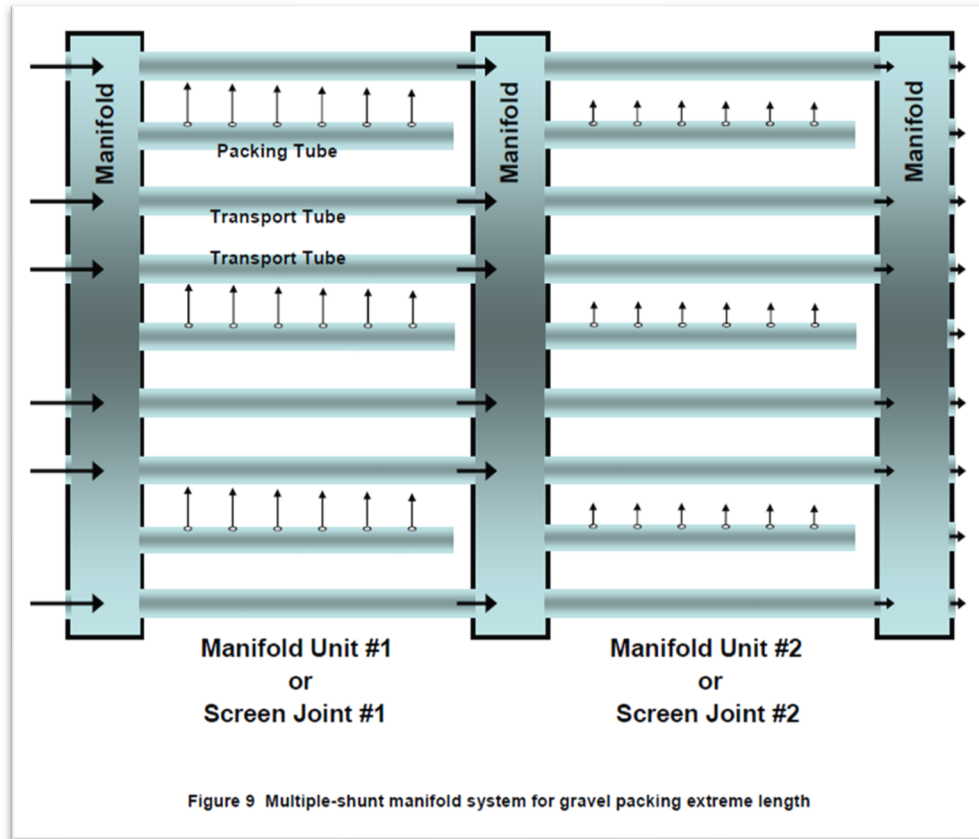
48. Fig. 9 of *Yeh2* shows this manifold unit assembly, while Fig. 10 shows the concentric sand screen with internal shunt tubes described by *Yeh2*.

²⁶ Ex. 1006 (*Yeh2*) pg 1.

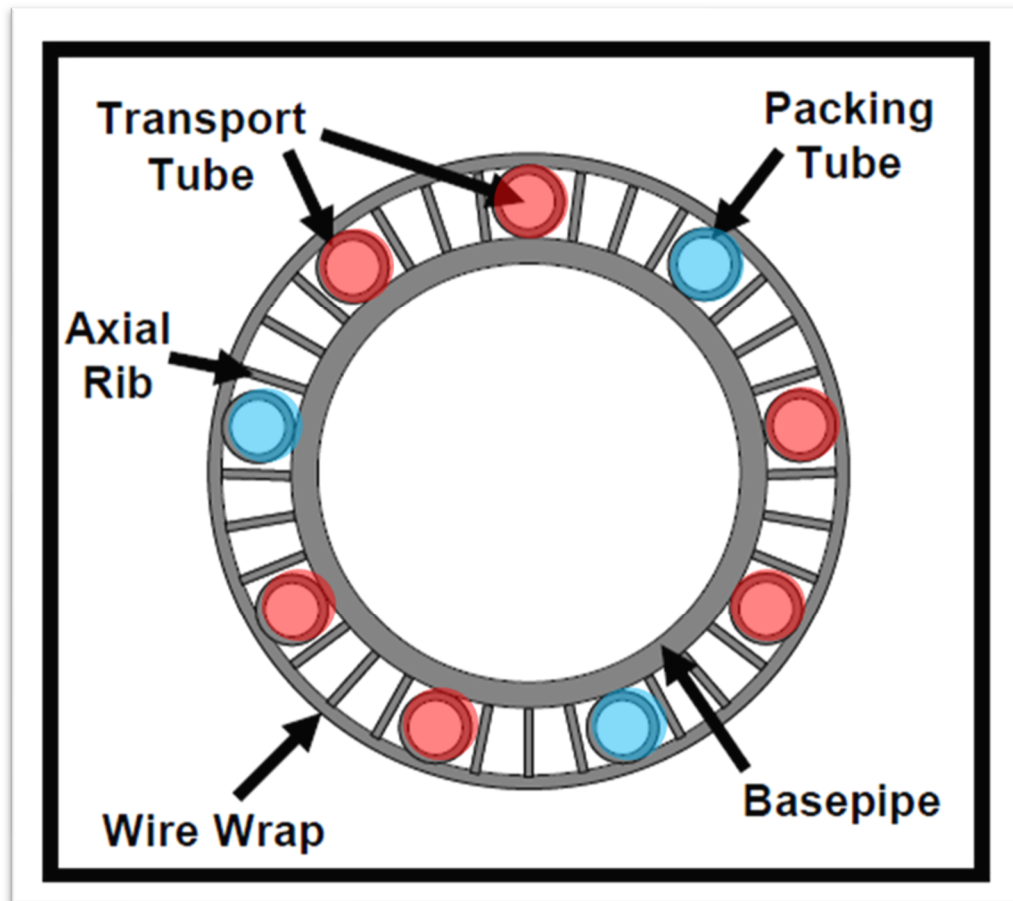
²⁷ Ex. 1006 (*Yeh2*) pg 1.

²⁸ Ex. 1006 (*Yeh2*) pg 3.

²⁹ Ex. 1006 (*Yeh2*) pg 5.



Ex 1006 (Yeh2) Figure 9



Ex. 1006 (Yeh2) Fig. 10 (annotated)

C. JONES (EX. 1007)

1. Status & Disclosure of Jones

49. *Jones* is a United States Patent issued to *Lloyd Jones* granted on August 7, 1990. The application that led to *Jones* (Appl. No. 397,217) was filed on August 23, 1989.³⁰ The title of *Jones* is “Method for Gravel Packing Wells.”

50. *Jones* describes an early example of a gravel pack system with “one or more conduits [] positioned coaxially adjacent the exterior of the sand screen with

³⁰ Ex. 1007 (*Jones*) Cover.

openings to provide fluid communication between the conduit and a substantial portion of the annulus between the borehole casing and the sand screen.”³¹ In this arrangement, a gravel slurry is pumped into the annulus to create a gravel pack and “[i]f injection of the slurry of gravel forms a gravel bridge in any portion of the annulus being packed thereby plugging the annulus between the casing and the sand screen, the slurry of gravel will continue to flow down the conduit and into the annulus below the gravel bridge thereby completely packing the annulus between the sand screen and the borehole casing.”³² *Jones* teaches that it is applicable “to placing gravel packs in an open-hole wellbore adjacent to a substantial portion of an unconsolidated or poorly consolidated subterranean oil or gas reservoir.”³³ *Jones* explains that the shunt tubes “may be made of any pressure-resistant material,” such as “stainless steel.”³⁴

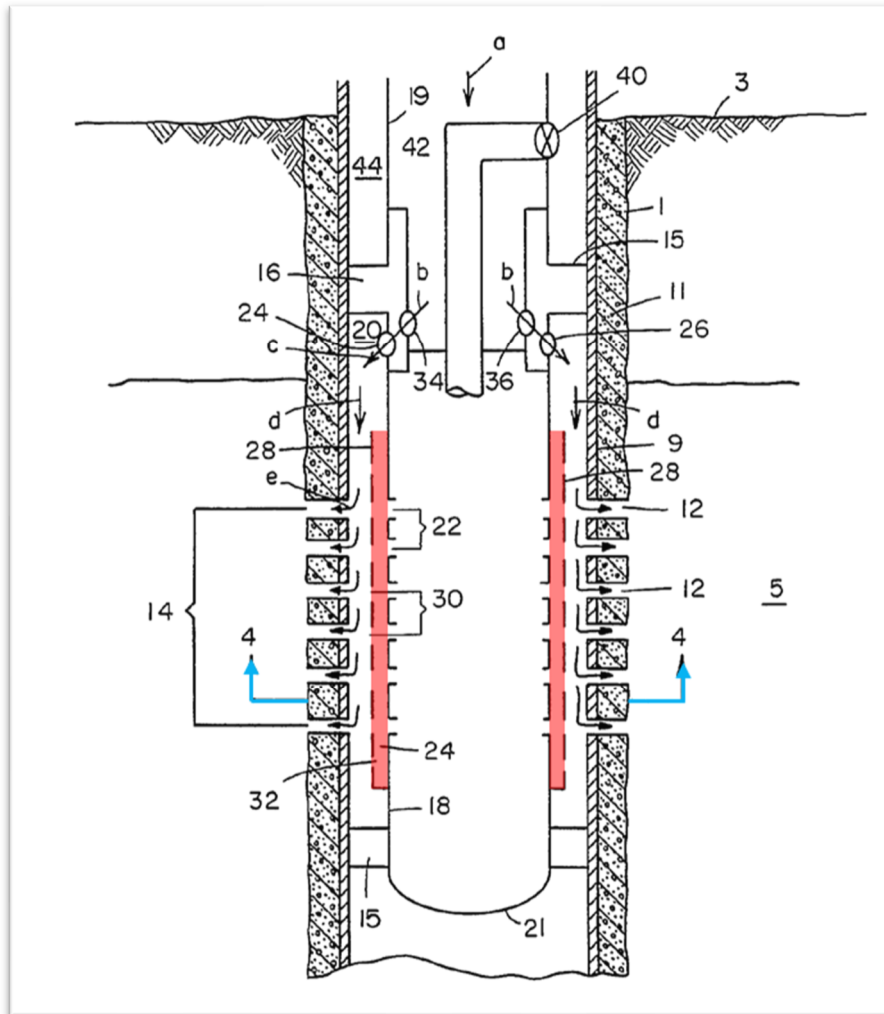
51. *Jones* discloses two round “conduits 28” (annotated in red) located on the outside of the sand screen, which are shown in Fig. 1 of *Jones*.

³¹ Ex. 1007 (*Jones*) at Abstract.

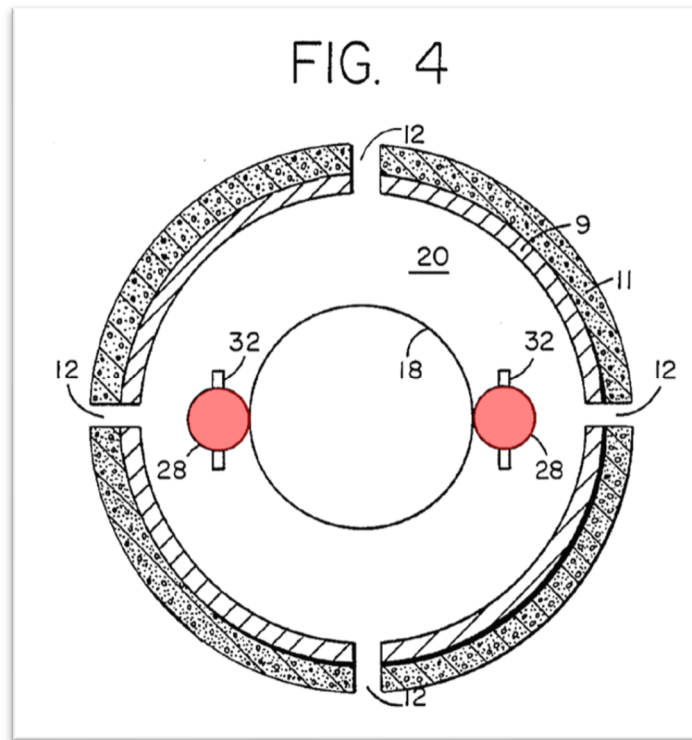
³² Ex. 1007 (*Jones*) at Abstract.

³³ Ex. 1007 (*Jones*) at Abstract.

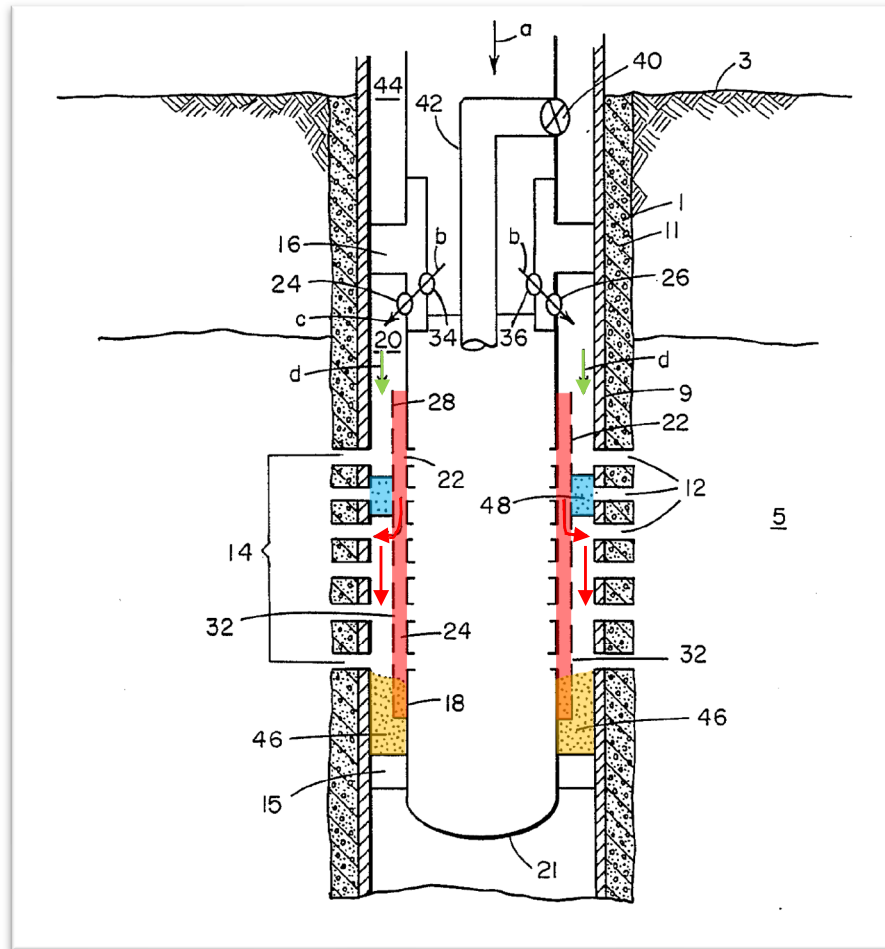
³⁴ Ex. 1007 (*Jones*) 4:11 – 13.

Ex. 1007 (*Jones*) Fig. 1 (annotated)

52. Fig. 4 of Jones shows a cross-sectional view of the sand screen assembly, including conduits 28, taken along line 4-4 (annotated in blue) of Fig. 1.

Ex. 1007 (*Jones*) Fig. 4

53. As shown in Fig. 3 of *Jones*, a gravel slurry is pumped into the annulus (green arrows), forming a gravel pack (annotated in orange), for example, starting at the bottom of the well bore and filling upward. If a sand bridge (annotated in blue) forms before the gravel pack is complete, conduits 28 (annotated in red) allow the gravel slurry to flow past the sand bridge and into the annulus below the bridge (red arrows).



Ex. 1007 (*Jones*) Fig 3 (annotated)

D. *JONES2* (EX. 1008)

1. Status & Disclosure of Jones2

54. *Jones2* is a United States Patent issued to *Lloyd Jones* granted on May 19, 1992. The application that led to *Jones2* (Appl. No. 694,163) was filed on May 1, 1991.³⁵ The title of *Jones2* is “Gravel Packing of Wells.”

³⁵ Ex. 1008 (*Jones2*) Cover.

55. *Jones2*, like *Jones*, describes an “[a]pparatus for gravel packing a wellbore interval having shunt means (i.e. conduits) on the external surface of a sand screen.”³⁶ However, unlike *Jones*, which only taught 2 round conduits (i.e., shunt tubes) on the outside of the sand screen, *Jones2* describes “a variety of differently configured, perforated conduits and/or arrangements of these conduits.”³⁷

VIII. LEVEL OF ORDINARY SKILL IN THE ART

56. Petitioners assert that a POSITA “would have had a B.S. degree in mechanical or petroleum engineering or a similar technical discipline, with at least five years of experience in oil or gas well drilling, completion, and/or subsurface production operations or in technical support of such operations including at least some experience in unconsolidated formations utilizing sand control methods and means. Also, additional education in a relevant technical discipline could compensate for less experience in the relevant field, and vice versa.”³⁸

57. I possess not only the education requirements of POSITA’s definition but also the field experience. Not only is my education in a similar technical discipline to that of Petitioner’s definition, but I also have additional education beyond a bachelor’s degree. Further, I have over twenty years of experience in oil

³⁶ Ex. 1008 (*Jones2*) at Abstract

³⁷ Ex. 1008 (*Jones2*) at Abstract

³⁸ Petition at 31-32

and gas drilling, completion and subsurface production operations, including experience in unconsolidated formations using sand control.

58. For purposes of this declaration, I have applied the level of skill proposed by Petitioner's expert. Ex. 1003, §VI.

IX. TECHNOLOGY BACKGROUND AND STATE OF THE ART

59. 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 particularly in the field of fluid handling during the various stages of drilling, completion, and production. The principles discussed in the subsections below would have been known to a POSITA in the June 2018 timeframe.

60. I understand that it is important, when viewing the State of the Art and the background technology known to a POSITA, to rely on those materials which would have been known to a POSITA at the time of the filing of the '007 Patent. Reliance on materials published or made publicly available after the filing of the '007 Patent (with the exception of publications specifically documenting the history of an industry) does not show what would have been known to a POSITA in the relevant timeframe.

61. Oil and gas exploration and production operations depend on identifying, locating and collecting hydrocarbon (i.e., oil and gas (natural gas)) reserves for sale, use as a fuel, for lubrication, or for the development of chemicals,

pharmaceuticals and plastics used in modern society. 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 the invention of the roller cone drill bit in 1908 by Howard Hughes. 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 drill mud serves the dual purpose of lubricating and cooling the bit teeth and grinding surfaces, as well as carrying detritus 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.³⁹

62. Traditional well drilling techniques, including both cable tool and rotary, focused on attempting to keep wells vertical, and maintain a “straight hole” in order to reach the target formation at a known location. However, this means that the hydrocarbon bearing formation is only exposed to the wellbore for only the vertical depth of the formation at the wellbore location which is often only tens of feet. Further, surface drilling locations must be directly above the target formations limiting access to those formations which are located under geographical features

³⁹ See generally Ex. 2.
at pp. 97-127.

(such as lakes, mountains, oceans), buildings or other environs which would prevent, or make difficult, the location of a traditional drilling pad.⁴⁰

63. Directional drilling is a technique for accessing hydrocarbon bearing formations (oil and gas formations) that are not located immediately beneath the surface location. Some tool or process is used to cause the well bore to deviate from the vertical in order to reach previously inaccessible formation locations, to expose more of the hydrocarbon bearing formation to the well bore, or to drill several wells from a single surface location, such as an offshore platform or a land-based drilling pad.⁴¹

64. According to *Bourgoyne*, “[d]irectional drilling is the process of directing the well-bore along some trajectory to a predetermined target. Deviation control is the process of keeping the wellbore contained within some prescribed limits relative to inclination angle, horizontal excursion from the vertical, or both.”⁴²

65. Directional drilled wells usually involve a vertical section of the well that is reached using conventional, rotary drilling techniques. Once the kick point is reached, “some method must be used to force the bit in the desired direction.” Regardless of what tool is used to cause the deviation “the principles for determining

⁴⁰ See generally Ex. 2010 at pp. 97-127.

⁴¹ See generally Ex. 2010 at pp. 97-127.

⁴² Ex. 2006 at § 8.6.

the total angle change, dogleg severity, new inclination angle, direction and tool-face setting are all the same.”⁴³

A. WELL COMPLETION

1. Casing and Cementing

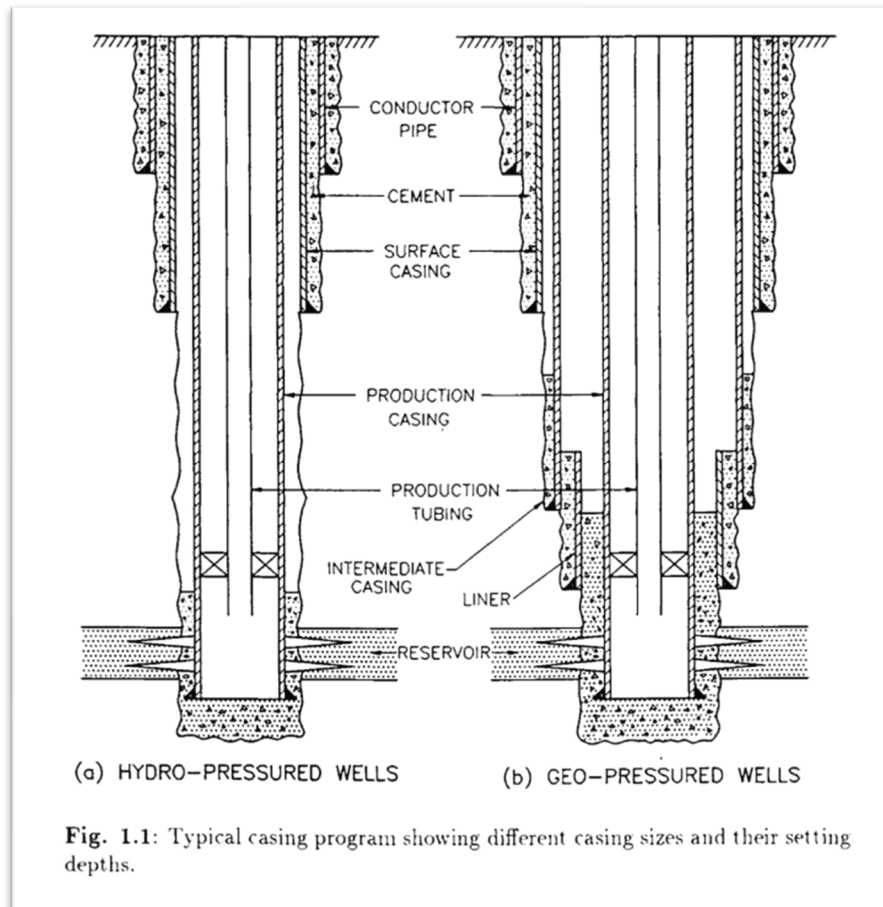
66. Once a wellbore has been drilled, casing is added to the wellbore. Casing is a series of tubular structures (pipes) inserted into the well that are used to isolate the wellbore from the surrounding geological formations. Casing provides several functions in the wellbore, as explained by Rahman in 1995:⁴⁴

1. Keeping the hole open by preventing the weak formations from collapsing, i.e., caving of the hole.
2. Serving as a high strength flow conduit to surface for both drilling and production fluids.
3. Protecting the freshwater-bearing formations from contamination by drilling and production fluids.
4. Providing a suitable support for wellhead equipment and blowout preventers for controlling subsurface pressure, and for the installation of tubing and subsurface equipment.
5. Providing safe passage for running wireline equipment.
6. Allowing isolated communication with selectively perforated formation(s) of interest.

⁴³ Ex. 2006 at § 8.6.

⁴⁴ Ex. 2008 at p. 1.

67. There are several different strings of tubular structures inserted into a well that, as a group, are referred to as casing. These are demonstrated in Fig. 1.1 from Rahman:⁴⁵



68. The conductor pipe is the topmost, and outermost, layer of the casing string. It is set first and is designed to hold back the loosely consolidated surface formations (such as topsoil) and prevent them from caving into the hole. The next layer is the surface casing. The surface casing's primary role is to isolate relatively

⁴⁵ Ex. 2008 at p. 2.

shallow freshwater formations from the wellbore and prevent them from being contaminated by drilling / completion fluids or from produced fluids. The surface casing extends from the surface to a solid consolidated formation (typically a limestone) and provides a seal between that formation and the surface, isolating the shallow water and loosely consolidate formations from the wellbore. As shown in Fig. 1.1, both the surface casing and the conductor pipe are cemented into the wellbore all the way to the surface.⁴⁶

69. In many wells, some of the overburden formations (formations above the target formation) have properties which prevent proper drilling to continue. In some cases, these non-producing formations are loosely consolidated and tend to cave-in the hole. In other formations, saltwater or other fluids can penetrate the well or the natural fractures and properties in the overburden formation absorb the drilling fluid, resulting in lost circulation. These formations are isolated from the wellbore by the use of strings of “intermediate casing.” Each string of intermediate casing is cemented at the bottom of the string to prevent migration of well fluids up the annulus of the casing (between the casing and the formation).⁴⁷

70. Once the target formation has been reached, a string of production casing is run, and is the final string of “casing.” This casing is cemented above and

⁴⁶ Ex. 2008 at pp. 1-6.

⁴⁷ Ex. 2008 at pp. 1-6.

below the target formation to prevent the migration of the hydrocarbons out of the target formation to other formations surrounding it. Further, additional cement can be pumped above the target formation to provide additional mechanical support for the casing string. In some modern wells, cement is run all the way to the surface. The production casing is designed to withstand the maximum pressure of the treatment (i.e. hydraulic fracturing), or the maximum shut-in pressure of the well, whichever is greater. In many cases liners (tubular sections which are hung from previous casing sections and do not reach the surface. Once the production casing is set, well treatment operations, including perforating and hydraulic fracturing, can begin.⁴⁸

2. Sand Control

71. In some formations, the components of the formation can be loosely consolidated, that is there are a small amount of binding materials (e.g. clay, silt, etc.). *Priester* identifies two sand formations with this material, “in areas such as the San Joaquin Valley in California and the Gulf Coast area of Louisiana, producing sands are frequently encountered that contain little or no binding material.”⁴⁹ Other formations such as the Austin Chalk in south central Texas and the Red Fork sand around Glenpool, OK are examples of unconsolidated formations. In these

⁴⁸ Ex. 2008 at pp. 1-6.

⁴⁹ Ex. 1039 (*Priester*) 1:46 – 50.

unconsolidated formations, the formation particles (sand in particular) flows into the wellbore through the perforations in the casing, or through the open hole. The sand can cause numerous problems including, for example:⁵⁰

- Damage to downhole equipment (e.g. pumps)
- Erosion of piping / valves
- Accumulation in surface equipment (tanks, separators)
- Accumulation (plugging) in the wellbore

72. In order to control the flow of these particles (e.g. sand) into the wellbore, sand screens have long been used. These screens typically have specially shaped and spaced wire wrapped around and welded to a series of ribs (support rods). The spacing between the wire wraps is designed to allow fluids into the wellbore, while preventing the flow of fine sand particles.⁵¹ Some available sand screens had an annulus between the production tubing (inner tubing) and an outer jacket that were “pre-packed” with sand particles larger than the fines in the formation. These pre-packed sand particles created a tortuous path for flow with allowed fluid to flow through the pores, but blocked formation fines from flowing into the production

⁵⁰ See, e.g., Ex. 1007 (*Jones*) 1:18 – 28.

⁵¹ See, e.g., Ex. 1038 generally.

tubing.⁵² However, both of these solutions tended to decrease the productivity of the well, and were not always successful in prevent fines from entering the tubing.⁵³

73. Another option, used since at least the 1950s, involves pumping a gravel (larger sand particles) laden slurry into the well and surrounding the annulus between the casing (or open hole formation) and the well piping (liner or production tubing) with a “pack” of gravel. *Priester* provides one early example of this method. *Priester* describes “carrier fluid, including the widely graded sand particles, is then injected [red arrows] , as shown in Fig. 1, through tubing 13 [highlighted in red] and flows downwardly to the control ports 17 [highlighted in blue].”⁵⁴ The slurry then flows out the control ports (blue arrows) and into “the annular space between the perforations 21 in liner 20 (annotated in magenta) and the underreamed part of borehole 11 (outlined in green). This flow scheme is indicated by flow arrows (green arrows)”⁵⁵ *Priester* further teaches that “particles in a thoroughly-mixed state are then deposited as pack 45 [annotated in orange] between liner 20 and the well bore wall of unconsolidated formation 10 by the fluid carrier flowing back to the surface

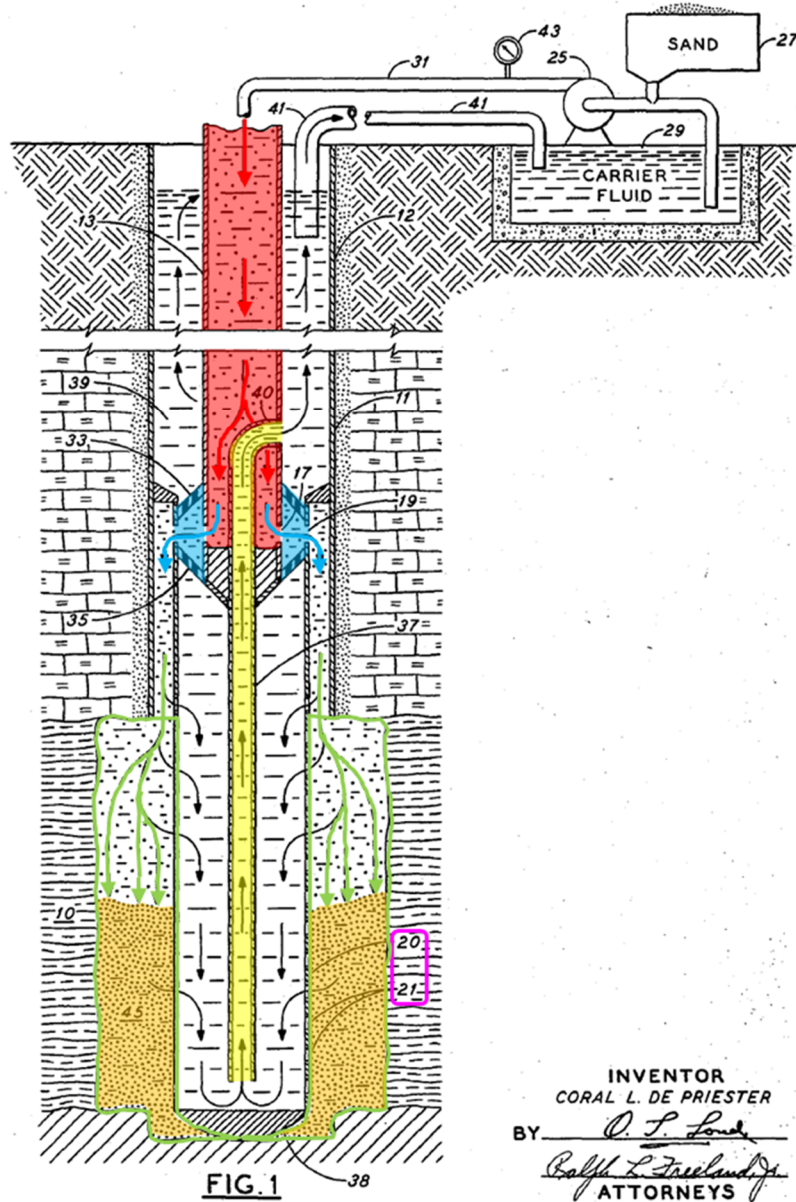
⁵² See, e.g., Ex. 1038 pg 6.

⁵³ Ex. 1039 (*Priester*) 1:63 – 2:50.

⁵⁴ Ex. 1039 (*Priester*) 5:36 – 40.

⁵⁵ Ex. 1039 (*Priester*) 5:47 – 49.

through perforations 21 and into the lower end of tail pipe 37 [highlighted in yellow].”⁵⁶



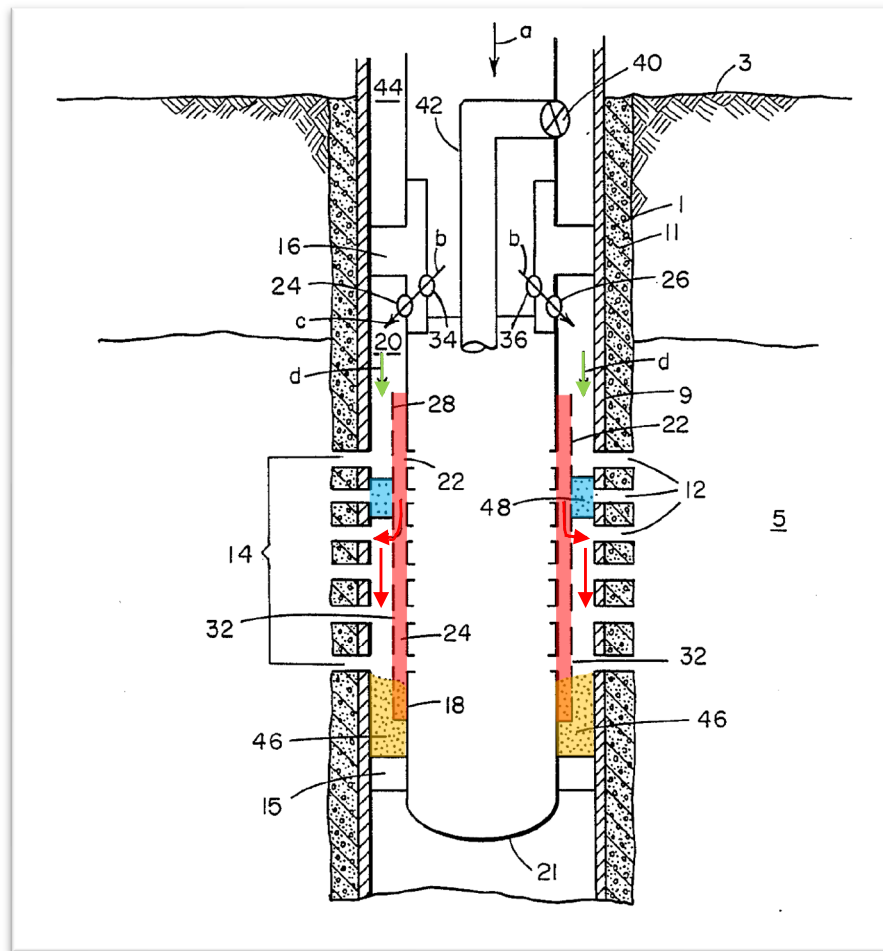
Ex. 1039 (*Priester*) Fig. 1 (annotated)

⁵⁶ Ex. 1039 (*Priester*) 5:50 – 54.

74. *Priester* further discloses that “[d]esirably pack 45 is made as solid as possible so that the granular particles force themselves into binding engagement with the particles of the formation.”⁵⁷ This tightly packed gravel (i.e. gravel pack) then allows fluid flow into the production system while keeping sand particles from the formation out.

75. However, as disclosed in Fig. 3 of *Jones*, a gravel slurry is pumped into the annulus (green arrows), forming a gravel pack (annotated in orange), for example, starting at the bottom of the well bore and filling upward. If a sand bridge (annotated in blue) forms before the gravel pack is complete, conduits 28 (annotated in red) allow the gravel slurry to flow past the sand bridge and into the annulus below the bridge (red arrows).

⁵⁷ Ex. 1039 (*Priester*) 5:73 – 75.



Ex. 1007 (*Jones*) Fig 3 (annotated)

76. This is an early example of the “shunt tube” gravel packing system improved upon by the '007 Patent.

B. OIL AND GAS PRODUCTION

77. The goal of the exploration, drilling, and completion is to produce economically acceptable quantities of hydrocarbons (oil and gas) for collection and sale. After the well has been stimulated (fractured), the fracturing equipment is moved to the next location to be fractured. The well is then turned over to production

Ex. 2002 p. 46

and production equipment, such as production tubing, downhole pumps, permanent collection tanks, etc. are brought in and installed at the site. Production tubing is run inside the casing to create a conduit for production fluids to flow from the bottom of the well to the wellhead located at the surface. As discussed below, production fluids contain three phases – solids (e.g., sand) from the formation, liquids (e.g., hydrocarbons (oil) and saltwater), and gaseous natural gas.⁵⁸ Oil and gas production from a well at the time of the '007 Patent commonly lasted more than ten years, sometimes up to 30 years, with proper maintenance.

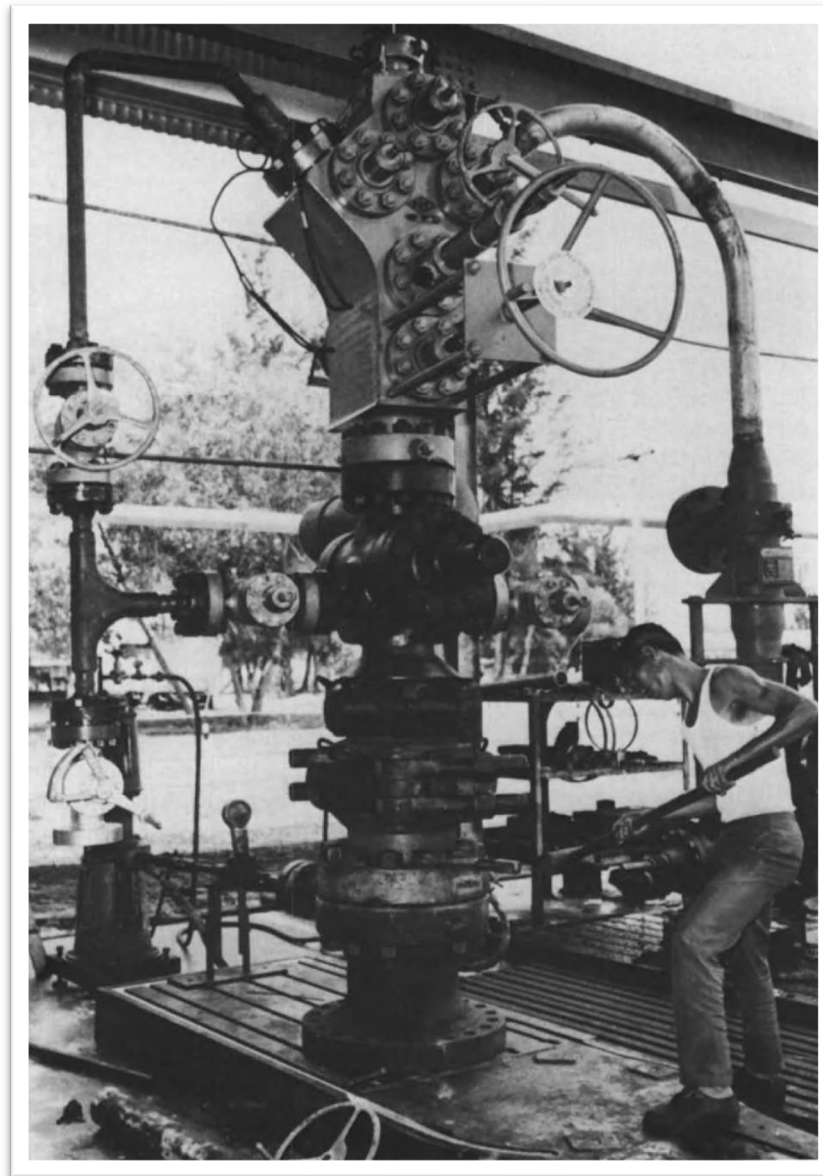
i. Collection Equipment

78. In a new field, wells are often overpressured, with enough bottomhole pressure to overcome the fluid head of the well. As a result, oil and gas (and often water) flow to the surface without additional assistance. In such locations, oil flowed to tanks and gas flowed to a pipeline (if present) for sale or to a flare, if a gas gathering system was not available.⁵⁹ These wells were controlled by “Christmas Trees” located at the wellhead that contain a series of valves used for shut-in and pressure control. A picture of a Christmas Tree is shown below. In overpressured fields, the only power consumption are very small (~10 hp) transfer pumps or

⁵⁸ Natural gas is composed of methane, along with other gaseous hydrocarbons, along with varying amounts of other gases such as helium and hydrogen.

⁵⁹ Ex. 2007 at p. 115.

chemical injection pumps. In locations where multiple wells flow into a single storage or treatment facility, collection manifolds are used to commingle production fluids into a single pipeline for delivery to the storage or treatment location.⁶⁰



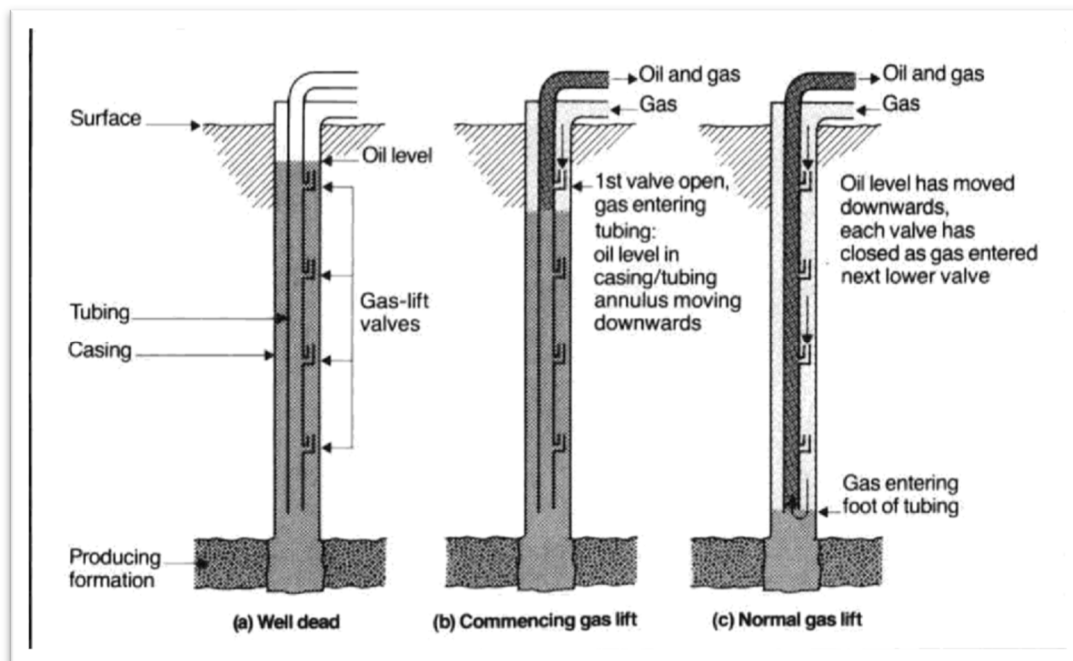
Off-shore Christmas Tree⁶¹

⁶⁰ See, e.g., Ex. 2011 at p. 2.

⁶¹ Ex. 2007 at p. 116.

79. In fields where wells are underpressured (i.e., not enough bottomhole pressure to raise liquids to the surface), some type of artificial lift operation was used to produce the hydrocarbon liquids in commercially viable quantities. Such artificial lift technologies included gas lift, ball and valve pumping and electrical submersible pumping. Gas lift involves injecting quantities of gas (which at the time had significantly less value than the hydrocarbon liquids) back into the well in order to increase pressure in the annulus (i.e., the space between the production tubing and the casing) and force oil into the tubing. This technology involved natural gas driven compressors to increase the pressure of the gas and a series of sequenced opening valves in the production string. Power consumption ranged from tens of hp per well and was provided by a portion of the produced gas. Other power consumptions are transfer pumps and chemical pumps as with overpressured fields. The figure below shows basic gas lift valve operation.⁶²

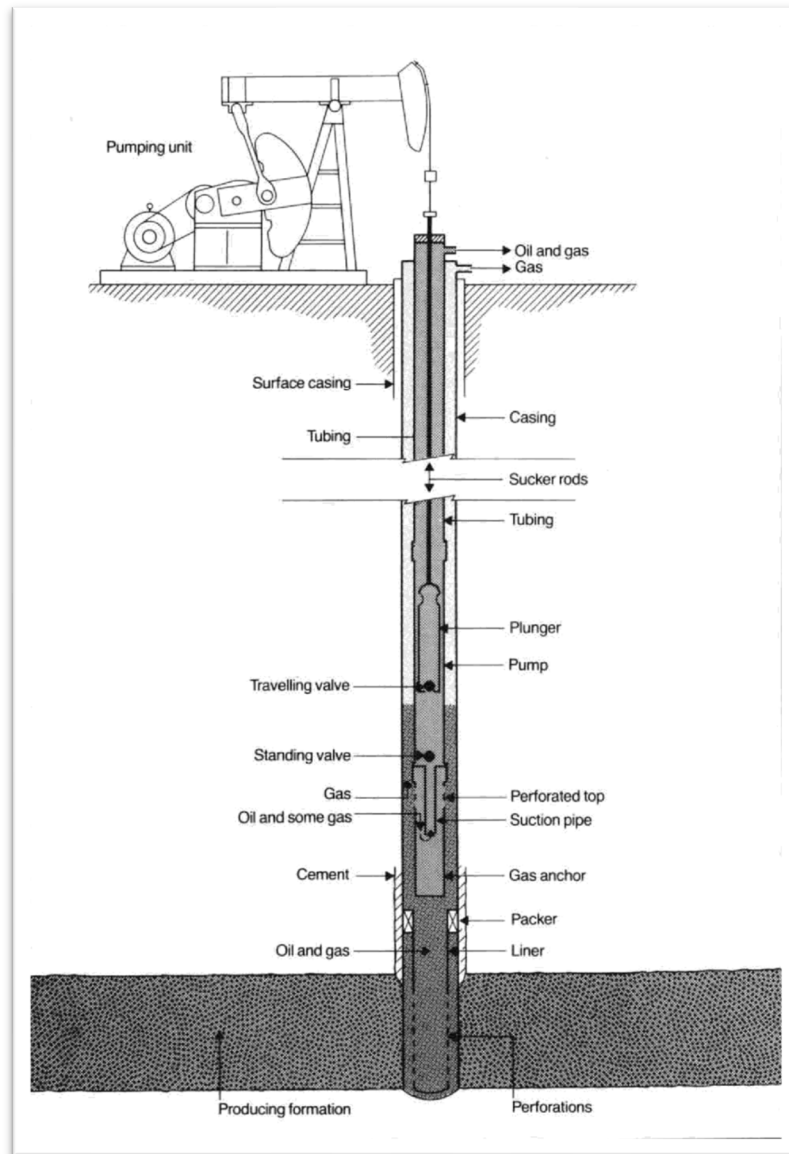
⁶² See, e.g., Ex. 2007 at pp. 115-119.

Gas Lift Valve Operation⁶³

80. As shown in the figure below, ball and valve pumping involved a downhole pump with two sets of balls and valves, standing valve and traveling valve. The pump operated vertically. As the pump was separated (e.g. traveling valve moving upward), the standing valve would open allowing hydrocarbons to flow into the barrel of the pump. As the pump was closed (e.g., traveling valve moving downward), the travelling valve would open and hydrocarbon fluids would move upward into the production tubing. The movement of the pump was controlled by a surface pumping unit, often the ubiquitous “pump jack” visually associated with oil and gas fields. A picture of pump jacks in operation is shown below. These pumping

⁶³ Ex. 2007 at p. 118.

units were run by small (tens of Hp) electric motors or natural gas engines, along with the transfer and chemical pumps mentioned above.⁶⁴



Ball and Valve Pumping Installation⁶⁵

⁶⁴ Ex. 2007 at pp. 119-122.

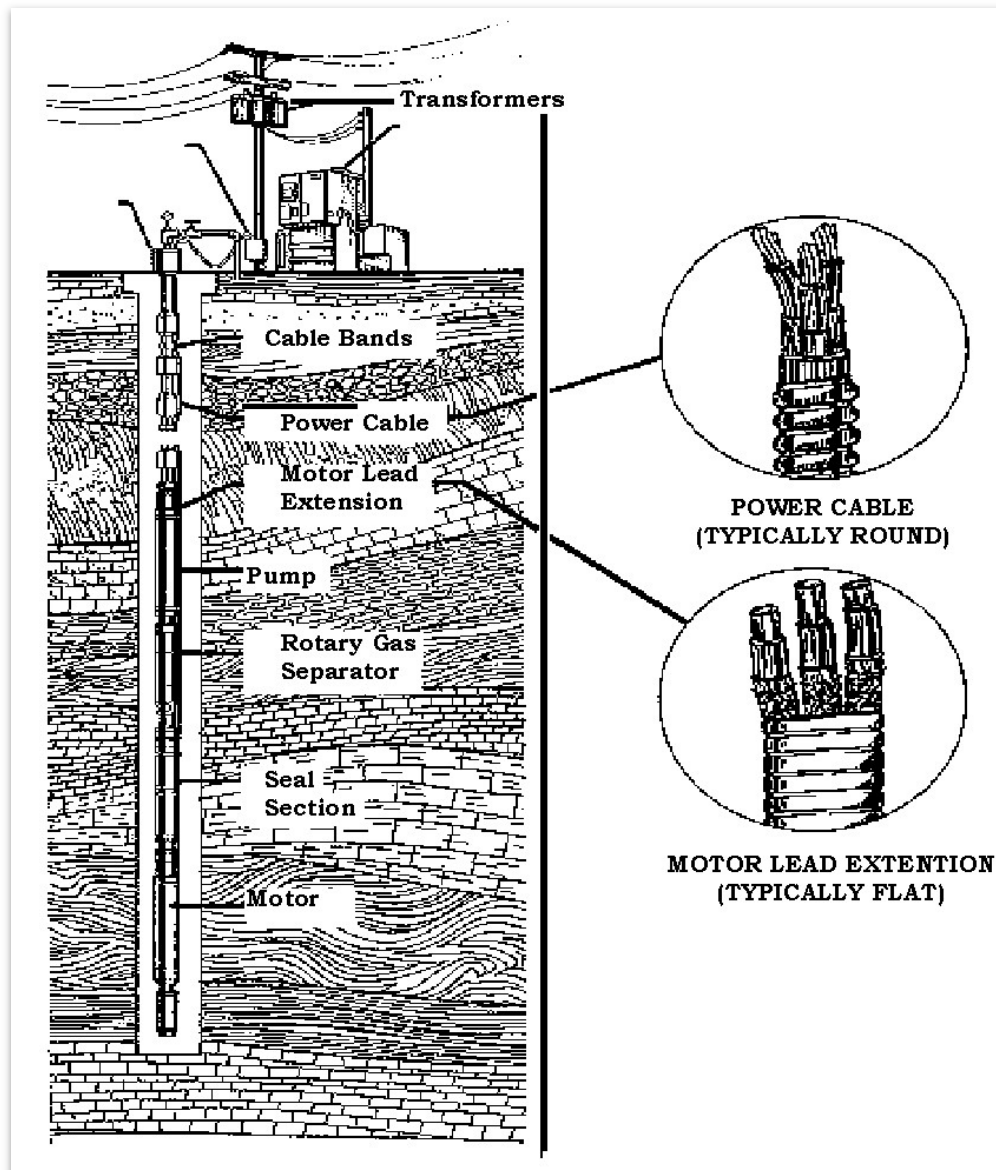
⁶⁵ Ex. 2007 at p. 120.



Pump Jacks in Operation⁶⁶

81. The third primary technology used for artificial lift (e.g. pumping) recovery operations were electric submersible pumps (“ESP”). An ESP is simply a centrifugal pump comprised of multiple centrifugal impellers which are small enough to fit into the wellbore. ESPs were often ~4.5” in diameter and 20-30 feet long. ESPs often operated at medium voltage (~2.3kv – 5kV) and typically consumed a couple of hundred Hp per well. ESP installations required much more extensive electric service equipment.

⁶⁶ Ex. 2007 at p. 121.

ESP Installation⁶⁷

82. It is these downhole pumps that are most susceptible to damage from fines intrusion into the hydrocarbon fluid stream and the wellbore.

⁶⁷ Ex. 2009 at p. 3.

X. CLAIM CONSTRUCTION

83. It is my opinion that a POSITA would understand all the claim terms to have their plain and ordinary meaning, and I have applied the plain and ordinary meaning, in the context of the '007 Patent, for all claim terms.

XI. YEH IN VIEW OF YEH2 DOES NOT RENDER CLAIMS 1-10 OBVIOUS

84. After review of the evidence submitted in support of the Petition, including the Prior Art relied on and the declaration of Mr. Chambers, it is my opinion that the combination of *Yeh* and *Yeh2* does not render claims 1 – 10 of the '007 Patent obvious. There are claim elements missing from the combination that Mr. Chambers and Petition do not show are obvious in light of the combination.

A. INDEPENDENT CLAIM 1

85. Claim 1 contains the following limitations, which have been subdivided in the same manner that Mr. Chambers and Petitioner subdivided them:

1[preamble]: 1. “A completion assembly for deployment in a wellbore, the completion assembly comprising:”

1[A]: a first sand screen assembly comprising a base pipe having perforations therein and extending between a first end and a second ends, a sand screen disposed around a portion of the base pipe, and a shunt tube assembly disposed outwardly of the sand screen, the shunt tube assembly having a transport tube and a packing tube, where each of the tubes has a passageway defined therein, the packing tube further including a plurality of nozzles spaced apart from each other, wherein each of the tubes and each nozzle has a cross-sectional flow area;

1[B]: a second sand screen assembly comprising a base pipe having perforations therein and extending between a first end and a second ends, a

sand screen disposed around a portion of the base pipe, and a shunt tube assembly disposed outwardly of the sand screen, the shunt tube assembly having a transport tube and a packing tube, the packing tube including a plurality of nozzles spaced apart from each other, wherein each of the tubes and each nozzle has a cross-sectional flow area;”

1[C]: a source of pressurized working fluid fluidly coupled to an upstream end of the transport tube of the first sand screen assembly;”

1[D]: wherein the first and second sand screen assemblies are arranged end to end relative to one another so that the base pipes are in fluid communication with one another and the transport tubes are in fluid communication with one another such that the transport tube of the second sand screen assembly is fluidly coupled to the source of pressurized working fluid downstream of the transport tube of the first sand screen assembly; and”

1[E]: wherein the transport tube of the first sand screen assembly has a first wall thickness and the transport tube of the second sand screen assembly has a second wall thickness, the first wall thickness being greater than the second wall thickness.”

1. Neither *Yeh* nor *Yeh2* suggest changing to a thicker wall in the upstream (first) sand screen assembly transport tube.

86. Petitioner and Mr. Chambers focus not on the particular configuration of the invention of the '007 Patent but instead attempt to characterize the '007 Patent as merely repeating elements of *Yeh* and *Yeh2* with no significant changes. This analysis is incorrect. Neither Petitioner nor Mr. Chambers point to any part of *Yeh* or *Yeh2* where the wall thickness of the first (upstream) sand screen assembly shunt tubes is thicker than those of the lower because they cannot. In fact, as discussed below, a POSITA would have understood that the wall thickness in *Yeh*'s first sand screen assembly shunt tubes was *thinner* than that of the lower. Petitioner's (and Mr. Chambers') analysis appears to be that “different sizes, and wall thickness, of

tubes were known; therefore, it would have been obvious to include these different wall thicknesses in a gravel pack system.” Or, in other words, it would just be common sense to modify the sand screen assemblies of *Yeh/Yeh2* to meet the claim limitations. It is my understanding that this is not a proper obviousness analysis. It is my understanding that an obviousness analysis focuses not on the entire realm of possibilities (what *could* have been done by a POSITA), but rather on specific teachings in the art and how a POSITA would have been motivated to combine those teachings (what *would* have been done by a POSITA). The Petition and Mr. Chambers’ declaration are devoid of any showing in the combined references of limitation 1[E] “wherein the transport tube of the first sand screen assembly has a first wall thickness and the transport tube of the second sand screen assembly has a second wall thickness, the first wall thickness being greater than the second wall thickness.” Further, there simply is no direct analysis or rationale as to *why* a POSITA would have applied general industry tubing (such as that shown in Ex. 1031) into the specific space-constrained and limited environment of a gravel packing screen.

87. In fact, such a system with thicker walls in the upper transport tubes flew in the face of conventional thinking at the time of the ’007 Patent. It is only with the roadmap provided by the ’007 Patent that Petitioner and Mr. Chambers look at the gravel pack assembly in hindsight and state that such a configuration would

have been obvious to a POSITA. Thicker wall thicknesses in the upper assembly would not have been based on *Yeh*, *Yeh2* or any of the other references discussing the “alternative path” sand screen assemblies that Mr. Chambers relies on. In fact, these references as a whole teach against such a configuration and display the conventional wisdom that the ’007 Patent upended.

88. Petitioner and Mr. Chambers point to one embodiment of *Yeh* (and none of *Yeh2*) to suggest that “a higher-pressure shunt tube assembly necessitated greater wall thickness.”⁶⁸

In order to maintain the mechanical integrity (that is, to stay within the burst, bending, and collapse ratings) of the secondary flow paths, a certain surrounding wall thickness is required. This, in turn, limits the inside diameter of the crossover joint.⁶⁹

89. However, the section does not discuss wall thickness of the sand screen assemblies at all, but rather the crossover joint (or tool) that is the focus of *Yeh*. Mr. Chambers agreed.⁷⁰ *Yeh* makes this statement about wall thickness describing its crossover tool (crossover joint) and appropriate rates of curvature for the crossover joint, as illustrated in Figs. 10-11.⁷¹ *Yeh* explains that minimizing curvature in the crossover joint is preferred to “ease downhole tool pass-through, reduce torque and

⁶⁸ Petition at 41-42 referencing Ex. 1005 (*Yeh*) 28:10 – 24. See also Ex. 1003 ¶291.

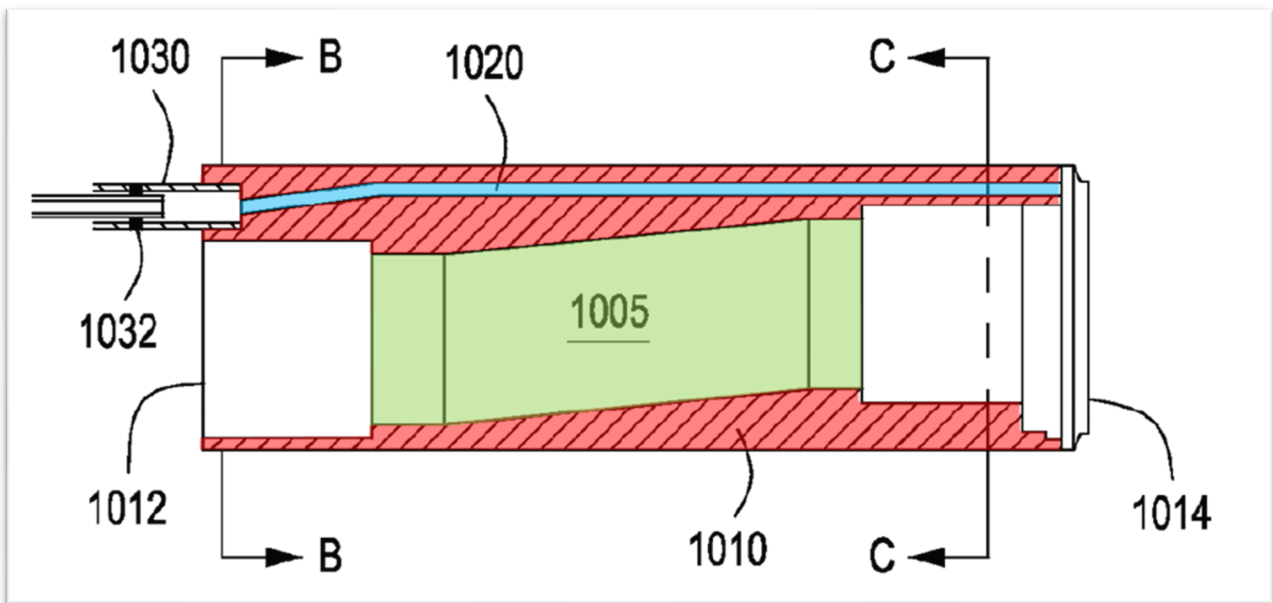
⁶⁹ Ex. 1005 (*Yeh*), 28:20-24

⁷⁰ Exhibit 2002 (Chambers Deposition) 24:5-14.

⁷¹ Ex. 1005 (*Yeh*), 25:41-55, 26:57-28:8.

drag, minimize erosion by particle flow, and minimize flow friction.”⁷² *Yeh* further describes that one “way to mitigate the curvature impact on the primary flow path is to increase the internal diameter of the crossover joint.”⁷³ Increasing the diameter of the primary flow path 1005 (highlighted in green below) “eases the run of other downhole tools through the curved crossover joint.”⁷⁴

90. *Yeh* also describes its “crossover tool” as having a “wall 1010” that defines a primary flow path (highlighted in red below).⁷⁵ And Figure 10 shows that wall 1010 contains *Yeh*’s secondary flow path 1020 (highlighted in blue below).



Ex. 1005 (*Yeh*) Fig. 10A (annotated)

⁷² 26:61-64.

⁷³ Ex. 1005 (*Yeh*), 28:5-8.

⁷⁴ Ex. 1005 (*Yeh*), 28:5-8.

⁷⁵ Ex. 1005 (*Yeh*), 25:41-55, Fig. 10.

91. Only after this explanation—teaching a POSITA to minimize crossover curvature and increase the internal diameter of the primary flow path—does *Yeh* state that “a certain surrounding wall thickness is required.”⁷⁶ When *Yeh* explains that “a certain surrounding wall thickness is required,” *Yeh* refers to wall 1010 of the crossover joint, not wall thickness of the transport tubes in the secondary flow path. *Yeh* explains that wall 1010 requires a certain thickness in order to place a limit on its teaching to increase the internal diameter (and curvature) of the crossover joint’s primary flow path. *Yeh* makes this abundantly clear in the sentence following sentence: “[t]his, in turn, limits the inside diameter of the crossover joint.”⁷⁷ In sum, *Yeh* is disclosing to maximize the primary flow path, but to leave enough room for secondary flow paths. If anything, a POSITA would read this disclosure of *Yeh* as teaching to limit space for shunt tubes because the primary flow path (including in the crossover joint) requires a maximized inner diameter to run tools downhole and perform effective pumping operations by minimizing torque, drag, erosion, and friction.⁷⁸ Accordingly, *Yeh* is not addressing the uniform wall thickness of the shunt tubes, but the variable wall thickness of the crossover joint.

92. In addition to *Yeh*’s teaching of maximizing the diameter of the primary flow path, *Yeh* also teaches constraining the outer diameter of the tool. *Yeh* teaches

⁷⁶ Ex. 1005, 28:5-24.

⁷⁷ Ex. 1005 (*Yeh*), 28:23-24.

⁷⁸ Ex. 1005, 26:61-64.

that the crossover tool should have “an overall outer diameter that is less than or equal to the diameters of the adjacent wellbore tools.”⁷⁹ Accordingly, the shunt tubes of *Yeh* must fit in the space constrained by limiting the O.D. and maximizing the I.D. of the primary flow path. *Yeh* does not provide direction on shunt tube design other than to maintain “mechanical integrity,” and *Yeh* makes clear that this mechanical integrity must be achieved in limited space.

2. *Yeh* offers a different solution than the '007 Patent

93. Petitioner points to a different embodiment of *Yeh* that teaches placing concentric screens in the higher pressure portion of the sand screen assembly and eccentric screens in the lower pressure section, because “known concentric screens are capable of gravel packing 5,000 feet, compared to 3,000 feet with the commercial eccentric screens.”⁸⁰ Thus, Petitioner and Mr. Chambers are relying on the teachings of using “higher pressure” concentric screens and “lower pressure” eccentric screens to support their contention.⁸¹

94. It was well known at the time of the '007 Patent, and before, that the pressure rating of the sand screen assembly limited the effective length of such an assembly used in a gravel pack completion, particularly for an eccentric configuration that was generally in use at the time. As *Yeh* teaches, there were two

⁷⁹ Ex. 1005, 28:25-30.

⁸⁰ Petition at 41 referencing Ex. 1005 (*Yeh*) 30:16 – 20, see also Ex. 1003 ¶292.

⁸¹ Ex. 2001 (Chambers Deposition) 25:2-26:1.

primary configurations of gravel pack assemblies by the time of *Yeh*. Each configuration comprised a base pipe (for pumping slurry down the well above the crossover tool, for retrieving slurry fluid during a circulating gravel pack, and for receiving well fluids during production), packing tubes (for distributing gravel into the annulus surrounding the well) and transport tubes (for carrying slurry downhole to the next set of packing tubes. In an eccentric design, such as that shown in Fig. 8A of *Yeh*, the packing tubes 832A (highlighted in blue) and the transport tubes 830A (highlighted in red) were offset (eccentric)⁸² to the base pipe (annotated in green).⁸³ In an eccentric design, the shunt tubes (packing and transport tubes) are typically rectangular so as to increase the available internal flow path (and reduce friction) while maintaining an overall smaller diameter of the tool as a whole.⁸⁴ As *Yeh* teaches, “[t]he eccentric layout reduces the overall diametrical size of the tool compared to if the equivalent shunt tubes were attached concentrically.”⁸⁵ Further, *Yeh* teaches that the use of eccentric designs would “reduce the overall friction” of the gravel pack system, allowing for longer lengths.⁸⁶

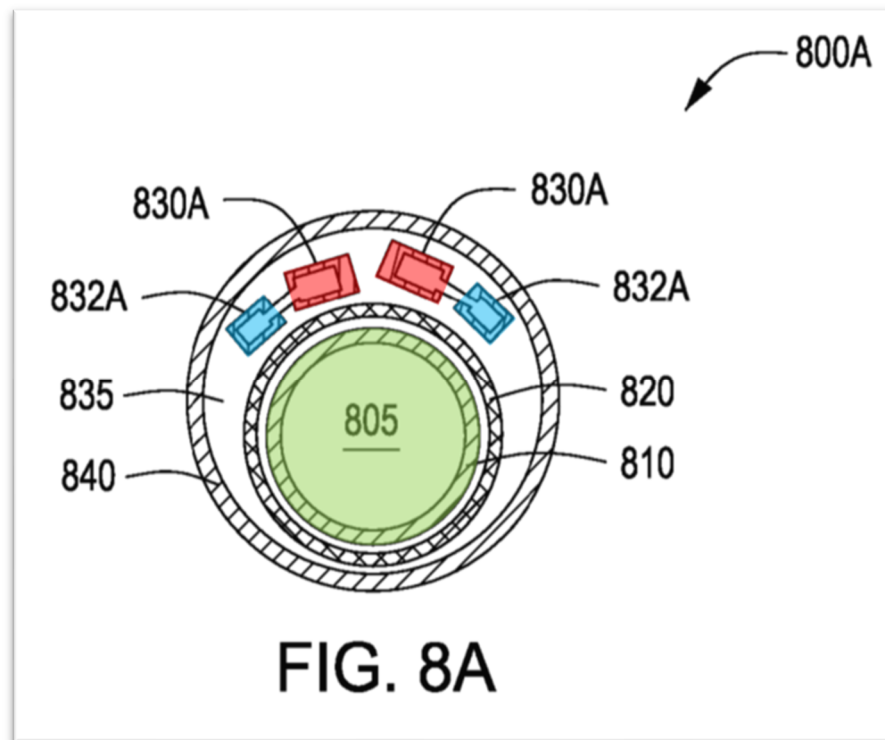
⁸² By eccentric I mean that the axis of the group of shunt tubes (packing and transport) is different than the axis of the base pipe.

⁸³ See, e.g., Ex. 1005 (*Yeh*) 24: 15 – 29.

⁸⁴ Eccentric designs with round shunt tubes were known, but the 2x2 rectangular configuration shown in Fig. 8A was typical and commonplace. See, for example, Ex. 1003 (*Chambers Declaration*) ¶111.

⁸⁵ Ex. 1005 (*Yeh*) 2:30 – 33.

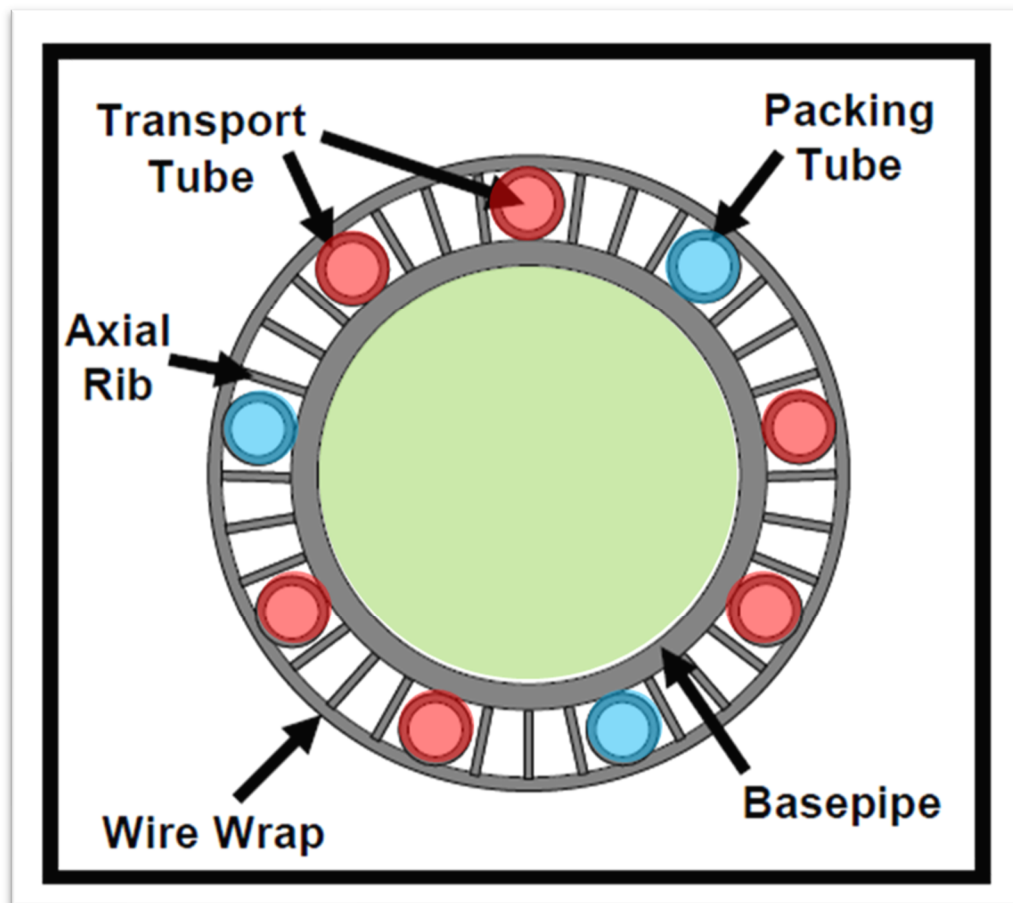
⁸⁶ See Ex. 1005 (*Yeh*) 24:57 – 59.



Ex. 1005 (Yeh) Fig. 8A (annotated)

95. In a concentric design, as shown, for example, in Fig. 10 of *Yeh2*, the axis of the group of transport tubes (highlighted in red) and the group of packing tubes (highlighted in blue) corresponds with the axis of the base pipe (annotated in green).⁸⁷

⁸⁷ See *e.g.*, Ex. 1005 (*Yeh*) 16:54 – 17:6



Ex. 1006 (Yeh2) Fig. 10 (annotated)

96. Though eccentric screen systems have lower overall friction and smaller overall tool size than concentric designs, at the time of *Yeh* (and before the '007 Patent), eccentric screens had a problem. It was widely known that the pressure rating of eccentric screens prior to the '007 Patent was limited to 3,000 PSI, which in turn limited the overall gravel pack length to around 3,200 feet.⁸⁸ Mr. Chambers

⁸⁸ See, e.g., *Yeh* 30: 15 – 20; see also Ex. 1015 (*Hecker*) at Abstract, Ex. 1026 (*Tibbles*) pg. 3; Ex. 1027 (*Barry*) pg 2.

agreed with this.⁸⁹ This was because “shunt tubes are typically formed from thin-walled” steel “in order to keep the outer effective diameter of tool 20 small enough to allow the tool to be readily lowered into casing 13.”⁹⁰ Even with some increased wall thickness, the working pressure rating of these eccentric designs was still limited to 3,000 PSI, limiting the overall length of the sand screen assembly.

97. Round shunt tubes, on the other hand, had a higher burst pressure rating, could be rated above 5,000 PSI, and could extend the gravel pack lengths to around 5,000 ft.⁹¹ Mr. Chambers agreed with this as well.⁹² *Yeh* teaches using a crossover tool to convert between an upstream high-pressure concentric design to a lower pressure eccentric design, in order to take advantage of the known benefits of each design in a gravel pack application.⁹³ Mr. Chambers claims that “a POSITA would understand that the tubing wall thickness in the eccentric screens would be less than the tubing wall thickness in the concentric screens due to the lower pressure requirement and the well understood direct proportionality between tubing wall

⁸⁹ Ex. 2001 (Chambers Deposition) 22:10-24; 23:18-24:4; 31:22-32:11; 43:22-44:12.

⁹⁰ Ex. 1041 (*Jones*) 3:54 – 58.

⁹¹ Ex. 1005 (*Yeh*) 30:15 – 20; Ex. 1006 (*Yeh2*) ppg 4, 5, Figures 3 -7, 9, 10, 13; Ex. 1010 (476 *Yeh*) 9:41 – 44; Ex. 1027 (*SPE* 110460) pg 2 – 3; Ex. 1024 (*YEH* 184) 10:66 – 11: 4; Ex. 1028 (*Jones* 533) 22:1 – 7; 2:35 – 40).

⁹² Ex. 2001 (Chambers Deposition) 23:11-17; 46:7-15.

⁹³ *e.g.*, higher pressure in concentric screens and lower cost, more readily available and lower friction in eccentric screens.

thickness and burst pressure as explained in API TR 5C3.”⁹⁴ This is an incorrect understanding of what *Yeh* teaches. The increase in pressure for concentric designs did not come from increased thickness of the tube walls, but from the geometry (round vs. rectangular) of the transport tubes. In fact, as discussed further below, concentric shunt tubes known at the time, with a pressure rating of 5,000 PSI, had thinner shunt tube walls than eccentric designs with a 3,200 PSI rating.

98. It was the conventional wisdom at the time of the '007 Patent that increasing tube thickness would lead to two undesirable outcomes:⁹⁵

- decrease the cross-sectional area of the shunt tubes, leading to undesirable higher friction, which would limit the available length for gravel pack by increasing pump demands.
- Increase the tool size (or reduce the size of the base pipe), leading to the inability to lower the tool into the hole *or* increase in friction in the base pipe, leading to higher pumping demands and increased friction during the production phase.

99. This is why, as *Yeh* and *Yeh2* teach, the solution to increase gravel pack length was to use concentric designs (with more shunt tubes located around the base

⁹⁴ Ex. 1003 (*Chambers Declaration*) ¶295.

⁹⁵ Ex. 1010 (476 *Yeh*) 24:14 – 20; Ex. 1013 (*SPE 86532*) pg 3.

Ex. 2002 p. 65

pipe to reduce friction and have a higher pressure rating due to the round configuration) in the higher pressure portion of the gravel pack system (towards the heel) and use the lower pressure rating (and reduced friction) eccentric design in the lower pressure portions of the gravel pack system (towards the toe).⁹⁶ There is simply no discussion or suggestion in *Yeh* or *Yeh2* (or any of Mr. Chambers' references) of increasing wall thickness in different portions of the gravel pack system to enable the existing system designs to increase pressure (and gravel pack lengths). It is simply not there.

100. In contrast to the claim by Petitioner and Mr. Chambers, the references instead show that the conventional wisdom was that wall thickness, and associated pressure ratings, were limited for each design of sand screen (due to the physical constraints of the system), and this limited eccentric designs to 3,200 PSI. The thinking at the time of the '007 Patent (as displayed by *Yeh* and *Yeh2*) was that it was only with the use of concentric designs (with round shunt tubes) that pressure ratings could be raised and lengths extended. It was the '007 Patent that changed this thinking, and Mr. Chambers' and Petitioner's attempts to read the divergent teachings of *Yeh*, *Yeh2* (and the rest of Mr. Chambers' references) onto the limitations of the '007 Patent rests on hindsight.

⁹⁶ Ex. 1005 (*Yeh*) 30: 15 – 26;

101. *Yeh2*, which also teaches a concentric screen, directed a POSITA to achieve higher pressure ratings by changing numerous design parameters other than shunt tube wall thickness. *Yeh2* taught to use concentric screens at higher pressures and “extreme lengths,” such as those described in *Yeh*.⁹⁷ And reading *Yeh2*’s description of its concentric screen design, a POSITA would have understood that the concentric screen achieved those higher pressures and extreme lengths by:

- Reducing tube cross section;⁹⁸
- Changing tube shape, from rectangular to round;⁹⁹
- Increasing the number of transport tubes, from two to six;¹⁰⁰
- Increasing the number of packing tubes, from two to three;¹⁰¹
- Using manifolds;¹⁰²
- Using closed-ended packing tubes.¹⁰³

102. Despite Mr. Chambers’ contentions, a POSITA would not have thinned the walls of the second (downstream) transport tubes based on the teachings of *Yeh*

⁹⁷ Ex. 1006 (*Yeh2*), 3, 5.

⁹⁸ Ex. 1006 (*Yeh2*), p.4 (noting tube size of “16 mm ID”)

⁹⁹ Ex. 1006 (*Yeh2*), p.4 (“Round shunt tubes were chosen to increase . . . pressure integrity”).

¹⁰⁰ Ex. 1006 (*Yeh2*), p.4.

¹⁰¹ Ex. 1006 (*Yeh2*), p.4.

¹⁰² Ex. 1006 (*Yeh2*), p.4.

¹⁰³ Ex. 1006 (*Yeh2*), p.4; *See also*, Figs. 9-10; Ex. 1003 (*Chambers Declaration*), ¶¶133-38, 160 (describing greater burst strength of round tubes).

and *Yeh*². Mr. Chambers, for example, contends that a POSITA would have thinned the walls of the downstream transport tubes instead of “increasing outside diameter” of the tubes, in order to maintain the OD of the entire tool.¹⁰⁴ However, Mr. Chambers ignores the fact that the rectangular transport tubes already used on eccentric screens had a larger cross-sectional area than did round transport tubes used in concentric screens. The larger CSA was the reason that eccentric screens had lower friction. Further, the larger CSA contributed to the lower pressure rating of these eccentric screens.¹⁰⁵ Further still, the rectangular tube shape allowed for a greater CSA without impacting tool size.¹⁰⁶

103. As discussed above, the embodiment in *Yeh* that Petitioner uses to show “high pressure” transport tubes in the first sand screen and “low pressure” transport tubes in the second sand screen is the concentric → crossover → eccentric configuration. In this configuration, the rectangular tubes in the eccentric sand screen already provide a lower friction and larger CSA in the same tool size, while using thicker transport tube walls. In other words, the eccentric screens already had the advantages that Mr. Chambers claims would have motivated a POSITA to reduce wall thickness in the downstream sand screens. Reducing the wall thickness in the

¹⁰⁴ Ex. 1003 (*Chambers Declaration*) ¶295.

¹⁰⁵ See Ex. 1003 (*Chambers Declaration*) ¶162; Ex. 1005 (*Yeh*) 25:54 – 56; Ex. 1015 pg 3.

¹⁰⁶ See Ex. 103 (*Chambers Declaration*) ¶101, 103, 129, 160 – 162.

downstream screens would further limit the use of the eccentric screens, as it would have reduced the pressure rating of those screens, and would have required the use of longer concentric screens, which Yeh teaches were less readily available, higher friction, and more costly. Accordingly, a POSITA would not have reduced the thickness of the downstream eccentric sand screen transport tube walls based on the teachings of *Yeh* and *Yeh2*.

104. As discussed above, Mr. Chambers states, without any support, that “a POSITA would understand that the tubing wall thickness in the eccentric screens would be less than the tubing wall thickness in the concentric screens due to the lower pressure requirement”.¹⁰⁷ However, this statement is not only unsupported and conclusory, it ignores the clear teachings of *Yeh*, *Yeh2* and the other references (as well as basic stress analysis) that round tubes have a higher pressure rating due to their shape (stresses are distributed evenly in all directions), not because of a change in thickness. Mr. Chambers cites to this engineering fact in one part of his declaration but ignores it in the analysis of 1[E].¹⁰⁸

3. ***Yeh* and *Yeh2* both teach away from having a thicker transport tube wall in the first (upstream) sand screen assembly**

105. Mr. Chambers’ statement that the concentric transport tube with a higher pressure has a thicker wall is contradicted by Mr. Chambers’ own testimony.

¹⁰⁷ Ex. 1003 (*Chambers Declaration*) ¶295

¹⁰⁸ See, e.g., Ex. 1003 (*Chambers Declaration*) ¶436 quoting Ex. 1028 2:1-7.

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In ¶331, when discussing Claim 5, Mr. Chambers proposes two different wall thicknesses, which he suggests would have been appropriate for rectangular shunt tubes (eccentric screens): 0.134” and 0.095”. In the same location, Mr. Chambers proposes two different wall thicknesses, which he suggests would have been appropriate for round shunt tubes (concentric screens): 0.095” and 0.075”. Regardless of which combination of eccentric and concentric shunt tubes is used, the thickness of the first (upstream, concentric) shunt tube is equal to or less than that of the second (downstream, eccentric) shunt tube. This is the exact opposite of the language in 1[E]. It appears that Mr. Chambers’ position changes depending on which Claim he is examining. However, as Claim 5 depends from (and would be contained within the scope of) Claim 1, the analysis should be consistent. By using an inconsistent and contradictory analysis, Mr. Chambers shows that his analysis is based merely on hindsight using the ’007 Patent as a roadmap.

106. Lest Mr. Chambers claim that these are just examples in his declaration, and not taught by *Yeh*, this understanding of round tube walls used in concentric design of being thinner than (or at most equal to) that of rectangular tubes used in eccentric designs is taught in Mr. Chambers’ other references. For example, Mr. Chambers references Hurst to teach that the wall for rectangular tubes in an eccentric screen was 0.095” (~2.4 mm).¹⁰⁹ Further, Mr. Chambers references Barry to describe

¹⁰⁹ Ex. 1003 ¶162 referencing Ex. 1013 at 2.

Ex. 2002 p. 70

round tubes for use with a concentric design had a wall thickness of 2 mm (0.078”).¹¹⁰ The teachings of wall thickness in Mr. Chambers declaration, whether or not he is presenting his own examples or using other references, show that the upstream (round tubes) wall thicknesses, described in *Yeh* as higher pressure, were thinner than (and even in Mr. Chamber’s hypothetical examples, at most equal to) the thickness of the downstream (rectangular tubes). Mr. Chambers agreed with this in his deposition.¹¹¹ This is because, contrary to Mr. Chambers’ claims in his analysis of 1[E], the strength comes from the more even distribution of stress in the round tubes as opposed to the rectangular tubes, and not a change to a thicker wall.¹¹²

107. Mr. Chambers’ conclusory statements do not overcome these adverse teachings of the *Yeh* system (as described in multiple references). Mr. Chambers states that “shunt tubes started out using a 1/16” (0.0625”) wall thickness.”¹¹³ Mr. Chambers then points to a general industry reference (Ex. 1018, 1031) to show that different size tubes and different wall thickness tubes were generally known.¹¹⁴ However, there is no reference to increasing wall thickness in a sand screen assembly

¹¹⁰ Ex. 1003 ¶162 referencing Ex. 1027 at 1, 3; The calculation is $(OD-ID)/2$, as Mr. Chambers states in ¶162, so a round tube with a 20mm OD and a 16mm ID yields $(20-16)/2 = 2$ mm.

¹¹¹ Ex. 2001 (Chambers Deposition) 56:6-24

¹¹² See, e.g., Ex. 1003 (*Chambers Declaration*) ¶436 quoting Ex. 1028 2:1-7.

¹¹³ Ex. 1003 ¶182.

¹¹⁴ Ex. 1003 (*Chambers Declaration*) 183w

in order to increase pressure rating in one section versus another. Furthermore, neither Mr. Chambers nor the Petition provide a rationale for *why* a POSITA *would* have used general purpose tubes in a gravel pack screen system of *Yeh/Yeh2*. Any such rationale would contradict the teachings of *Yeh* and *Yeh2*. A POSITA reading those references (and the other references describing the alternative path packing system) would not come away with the idea that changing wall thickness would solve the problems addressed by the '007 Patent, and thus a POSITA would not have been motivated to look at these general industry references.¹¹⁵ A POSITA reading the teachings of *Yeh* and *Yeh2* (and the other references) would rather come away with the idea that the solution to higher pressures was using a larger number of smaller, round shunt tubes. It was the '007 patent that demonstrated the idea that increasing wall thickness, even in eccentric screens, would overcome the constraints of a gravel pack system.

108. As discussed above, *Yeh2*, which also is directed to concentric screens, taught a POSITA to achieve higher pressure ratings by changing numerous design

¹¹⁵ As one example of Mr. Chambers' reliance on general industry reference with little to no applicability to the specifics of gravel pack, Mr. Chambers references ASTM A554-16 which is applicable for tubing "for use in ornamental, structural, exhaust, and other applications where appearance, mechanical properties, or corrosion resistance is needed." (Section 1.1). ASTM A554-16 is not applicable to pressurized piping as would be necessary in a sand screen shunt tube assembly. "ornamental" tubing has no applicability to pressurized assemblies that can have in excess of 5,000 PSI of pressure.

parameters other than shunt tube wall thickness. *Yeh2* taught a POSITA to use concentric screens at higher pressures and “extreme lengths,” such as those described in *Yeh*.¹¹⁶ And reading *Yeh2*’s description of its concentric screen design, a POSITA would have understood that the concentric screen achieved those higher pressures and extreme lengths by:

- Reducing tube cross section¹¹⁷;
- Changing tube shape, from rectangular to round¹¹⁸
- Increasing the number of transport tubes, from two to six;¹¹⁹
- Increasing the number of packing tubes, from two to three;¹²⁰
- Using manifolds;¹²¹
- Using closed-ended packing tubes .¹²²

109. None of these design factors relates to shunt tube wall thickness and there is no teaching in *Yeh2* that does.

¹¹⁶ Ex. 1006 (*Yeh2*) , 3, 5.

¹¹⁷ Ex. 1006 (*Yeh2*), p.4 (“noting tube size of “16 mm ID”

¹¹⁸ Ex. 1006 (*Yeh2*),p.4 (“Round shunt tubes were chosen to increase . . . pressure integrity”)

¹¹⁹ Ex. 1006 (*Yeh2*), p.4

¹²⁰ Ex. 1006 (*Yeh2*), p.4

¹²¹ Ex. 1006 (*Yeh2*), p.4

¹²² Ex. 1006 (*Yeh2*), p.4; see also 1006 (*Yeh2*), Figs. 9-10; Ex. 1003, ¶¶ 133-38, 160 (describing greater burst strength of round tubes);

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110. Further, a decision to increase wall thickness cannot be made in a vacuum. *Yeh2* teaches that design decisions “may be limited by wellbore dimensions, friction loss, manufacturing complexity, and overall cost.”¹²³ To this I would add that changing the wall thickness of the upper concentric transport tubes to be greater than the lower eccentric transport tubes would mean that the base pipe in the concentric arrangement would have to shrink, or the overall tool size would have to increase, or there would have been a reduction in cross sectional area (CSA) of the upper tubes. None of these would have been a desirable outcome to a POSITA. Further, I would contend that such a decision would be influenced by a variety of factors including:

- Presence of or adding Manifolds;
- Existing wall thickness;
- Material;
- Welding ability, corrosion/erosion resistance;
- Open-ended and closed-ended tubes;
- Nozzle size;
- Nozzle spacing;
- Nozzle distance from manifold;

¹²³ Ex. 1006 *Yeh2* pg 5.

- Jumpers (crossover tool) and pressure rating;
- Reducing leakoff;
- Rheology of the slurry.

111. Mr. Chambers, in his deposition testimony, conflicted with his declaration and agreed that making changes in the design of the shunt tubes was not a simple change, but rather constrained by the limitations of the environment.¹²⁴

112. Further still, neither the Petition nor Mr. Chambers offer a reason that a POSITA would have been motivated to increase the transport tube wall thickness of the upstream concentric screen to exceed that of tubes in the downstream eccentric screen, as limitation 1[E] claims. Mr. Chambers' references, including *Yeh* already teaches concentric screens rated to 6,500 PSI, more than twice the 3,000 psi rating of eccentric screens, extending gravel packing length by 50%.¹²⁵ Further, some concentric screens had been tested to 10,000 psi.¹²⁶ Petitioner offers no reason for a POSITA to push pressure above 10,000 psi by increasing wall thickness, particularly when doing so would contradict the space-constraint teachings of *Yeh* for secondary flow paths. Further still, Mr. Chambers calculates that round tubes at the sizes commonly used in concentric screens could support burst pressures of 14,700 psi

¹²⁴ Ex. 2001 (Chambers Deposition) 58:19-59:10; 59:19-60:12.

¹²⁵ Ex. 1007 (*Jones*), 28:17-20; Ex.1015 (*Hecker*), pp.1 (describing eccentric screen "maximum shunt system working pressure of 3,000 psi"), 3

¹²⁶ Ex. 1015, p.3; Ex. 1003, ¶237; Ex. 2001, 48:4-8.

without exceeding the 0.095-inch wall thickness common in eccentric tubes.¹²⁷ Mr. Chambers does not explain why a person of skill would pursue a pressure rating exceeding 15,000 psi, when obtaining that rating requires ignoring the teachings of *Yeh* of restricting the OD of the tool while maximizing the ID of the primary flow path.

113. Nor do Mr. Chambers or the Petition address how a POSITA would have balanced increasing shunt tube wall thickness with other design considerations in concentric screens. Both routes to increased shunt tube wall thickness in a concentric screen require changes that the art teaches against. Increasing tube thickness without any change to outer diameter would restrict the flow path of the shunt tubes, increasing friction pressure drop and requiring a higher pressure rating for the same packable length. Further, increasing tube thickness by maintaining the cross sectional area (CSA) of the shunt tube and increasing outer diameter, requires a smaller diameter in the primary flow path—which *Yeh* teaches should be maximized—or a larger outer diameter of the tool—which *Yeh* explains (and Petitioner’s expert admits) is limited by adjacent tools in the wellbore.¹²⁸

¹²⁷ See Ex. 1003, ¶¶162 (noting wall thickness of 0.095 inches for rectangular tubes commonly used in eccentric screens), 184 (calculating burst pressure up to 14,700 psi for round tube with 0.095-inch wall thickness).

¹²⁸ Ex. 1005, 28:5-8, 28:25-30; Ex. 1003, ¶295 (stating a POSITA would avoid “increasing outside diameter” because it “would require a greater tool size”).

114. In fact, the Petition's and Mr. Chambers' claim that it would have been simple to implement general industry tube configurations into a gravel pack assembly fails basic logical analysis. If, as Mr. Chambers claims, it was a simple matter of increasing wall thickness to increase pressure rating of the system, there would have been no need for the relatively complex systems of *Yeh* and *Yeh2*, adding more shunt tubes and manifolds and mixing eccentric and concentric screens to increase overall length and decrease friction.

115. Although *Yeh* and *Yeh2* solve a similar problem to that of the '007 Patent (extending lengths of gravel pack), the '007 Patent provides a solution that is different. There is no teaching or suggestion in *Yeh*, with or without *Yeh2*, of increasing wall thickness in the first (upper) shunt tube assembly as compared to the second (lower) shunt tube assembly. In fact, there are teachings away from such a configuration as Mr. Chambers (and Petitioner's) own art teach a POSITA to obtain higher pressures using concentric screens which were known to have thinner walls than eccentric screens. The Petition, even accepting the analysis in Mr. Chambers' declaration, fails to show that such a configuration would have been obvious to a POSITA based on *Yeh*, with or without *Yeh2*.

B. CLAIM 2

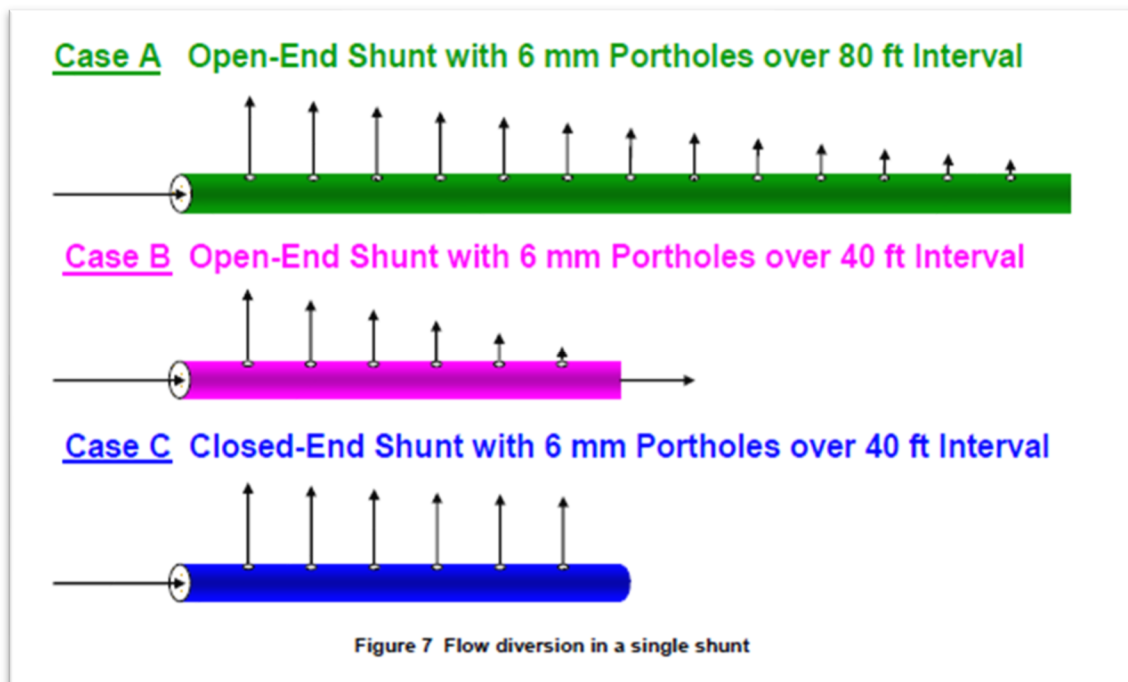
Claim 2: "The completion assembly of claim 1, wherein a cross-sectional flow area of the packing tube nozzle opening in the first sand screen assembly is less than a cross-sectional flow area of the packing tube nozzle opening in the second sand screen assembly."

Ex. 2002 p. 77

116. Claim 2 depends from Claim 1. As Claim 1 would not have been obvious to a POSITA based on the disclosures of *Yeh* and *Yeh2*, Claim 2 would not have been obvious to a POSITA based on the teachings of *Yeh* and *Yeh2*.

117. Further, Mr. Chambers, and Petitioner, rely on hindsight to read the limitations of Claim 2 into *Yeh* and *Yeh2*. A careful reading of both references shows that there simply is no discussion about changing the cross-sectional flow area of the nozzles in different portions of the assembly in either reference. *Yeh* does not discuss nozzle cross section at all.¹²⁹ As discussed above, it was known that the internal pressure in the sand screen assembly decreases along the length of the assembly. The same phenomenon occurs along the length of any particular shunt tube. This also means that the pressure differential between the internal pressure of the shunt tubes and the external pressure (provided by the formation) also decreases. This combination leads to decreased flow in downhole nozzles compared to upstream nozzles, as shown in *Yeh2* Fig. 7, Case A and Case B.

¹²⁹ See generally Ex. 1005 (*Yeh*).

Ex. 1006 (*Yeh2*) Fig. 7

118. The '007 Patent addresses this problem, at least in part, by modifying the nozzle size along the length of the assembly so that there is a smaller restriction for slurry to exit the nozzles as the pressure decreases. *Yeh* and *Yeh2* handle the problem in a different way. As seen above in Fig. 7 Case C, *Yeh2* addresses this problem of lower pressure resulting in lower flow not by modifying the nozzle size (all nozzles in all cases are 6mm, or just under $\frac{1}{4}$ "), but by using a closed-end shunt. Petitioner's expert agreed.¹³⁰ As *Yeh2* discloses, "the increase in pressure at the closed-end and the flow out of the last porthole is a result of the Bernoulli Effect."¹³¹

¹³⁰ Ex. 2001 (Chambers Deposition) 37:15-38:14.

¹³¹ Ex. 1006 (*Yeh2*) pg. 4

In effect, the closed-end shunt slows the slurry as it passes by the last several nozzles. Bernoulli's Principle teaches that faster flowing fluid has a lower pressure; so by slowing the fluid as it passes the nozzles (by using closed end tubes), the pressure of the fluid increases, and the flow out of the nozzles is more uniform, as shown in Fig. 7 of *Yeh2*.

119. Instead of relying on the Bernoulli Principle to *increase pressure* and, as a result, *increase flow* from the lower-pressure downstream fluid, Claim 2 instead uses a larger nozzle opening which lowers the restriction through the nozzle (lowers hydraulic impedance), resulting in more flow with a smaller differential pressure. This is a very different approach than that taken by *Yeh* and *Yeh2*. There is simply nothing in *Yeh* or *Yeh2* that suggests modifying the nozzle size as the assembly length increases. In fact, *Yeh* teaches against increasing friction in the eccentric sand screen (as that would limit packing length), which would motivate a POSITA to limit nozzle size to avoid increasing friction from dehydrating the slurry.¹³² And as *Yeh2* teaches, there was a very narrow band of nozzle size that was considered appropriate. *Yeh2* teaches that “[p]ortholes [i.e. nozzles], either too large or too small would both cause potential plugging.”¹³³ *Yeh2* suggests that porthole flow area only between 7 and 10 times the gravel size would be acceptable.¹³⁴ A typical 30/50 mesh gravel, as

¹³² Ex. 1005, (*Yeh*) 24:54-60.

¹³³ Ex. 1006 (*Yeh2*) pg 3.

¹³⁴ Ex. 1006 (*Yeh2*) pg. 2.

described by *Yeh2*,¹³⁵ has gravel sizes between ~0.3mm (50 mesh) and ~0.6mm (30 mesh). *Yeh2* already teaches using the largest acceptable hole size (6 mm, or 10 X 0.6mm) in its shunt tubes. *Yeh2* Figure 14 also illustrates increased leak-off with decreasing spacing between nozzles.¹³⁶ A POSITA reading *Yeh2* (or *Yeh*) would not come away with the idea of increasing nozzle size beyond this as the assembly lengthens. They would, instead, come away with the idea that the solution to decreasing pressure and flow in the shunt tubes was to use a closed end shunt tube.

120. Although the '007 Patent solves the same problem (decreasing slurry flow out of the tubes) as *Yeh2*, it does so in a manner not disclosed or suggested by *Yeh* or *Yeh2*. Accordingly, *Yeh* and *Yeh2* fail to disclose or suggest all of the limitations of Claim 2.

C. CLAIM 3

Claim 3: “The completion assembly of claim 1, wherein the first sand screen assembly further comprises a junction block from which the transport tube and the packing tube extend, the plurality of nozzles being spaced apart from the junction block; and wherein the second sand screen assembly further comprises a junction block from which the transport tube and the packing tube extend, the plurality of nozzles being between the first sand screen assembly junction block and the packing tube nozzles is greater in the first sand screen assembly than the distance between the second sand screen assembly junction block and the packing tube nozzles in the second sand screen assembly.”

¹³⁵ Ex. 1006 (*Yeh2*) pg. 4.

¹³⁶ Ex. 1006 (*Yeh2*) pg. 5, Fig. 14.

121. Claim 3 depends from Claim 1. As Claim 1 would not have been obvious to a POSITA based on the disclosures of *Yeh* and *Yeh2*, Claim 3 would not have been obvious to a POSITA based on the teachings of *Yeh* and *Yeh2*.

D. CLAIM 4

Claim 4: “The completion assembly of claim 1, number of packing tube nozzles in the first sand screen assembly is less than the number of packing tube nozzles in the second sand screen assembly.”

122. Claim 4 depends from Claim 1. As Claim 1 would not have been obvious to a POSITA based on the disclosures of *Yeh* and *Yeh2*, Claim 4 would not have been obvious to a POSITA based on the teachings of *Yeh* and *Yeh2*.

123. Not only do Mr. Chambers and Petitioner rely on hindsight in a failed attempt to show obviousness of Claim 4, as they do for limitations 1[E] and Claim 2, they ignore the clear teachings of *Yeh* and *Yeh2* in doing so. The *Yeh/Yeh2* combination teaches against the specific configuration of Claim 4. The *Yeh/Yeh2* combination does not render Claim 4 obvious for similar reasons as those discussed for Claim 2 above. For example, increasing the number of nozzles would increase friction loss, reduce packing length, and increase leak-off in a similar manner to increasing nozzle diameter.¹³⁷ The *Yeh/Yeh2* combination also does not render Claim 4 obvious for additional reasons discussed below.

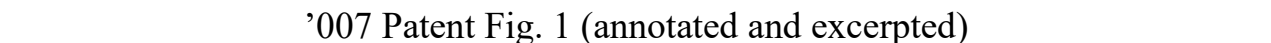
¹³⁷ See Section X.B above.

124. As Claim 4 depends from Claim 1, antecedent basis dictates that the “first sand screen assembly” and the “second sand screen assembly” have the same meaning in Claim 4 as they do in Claim 1. As discussed above, the configuration of sand screen assemblies that Petitioner points to in an attempt to show obviousness of Claim is the “concentric → crossover tool → eccentric” arrangement disclosed in Column 30 of *Yeh*.¹³⁸ It is only this embodiment that Petitioner and Petitioner’s expert suggests teaches the limitations of Claim 1.

125. Claim 1 discloses that “a source of pressurized working fluid fluidly coupled to an *upstream* end of the transport tube of the first sand screen assembly; wherein the first and second sand screen assemblies are arranged end to end relative to one another so that the base pipes are in fluid communication with one another and the transport tubes are in fluid communication with one another *such that the transport tube of the second sand screen assembly is fluidly coupled to the source of pressurized working fluid downstream of the transport tube of the first sand screen assembly*.”¹³⁹ In other words, the first sand screen assembly is described as being toward the top of the well (heel of the well in a horizontal), and the second sand screen assembly is described as being toward the bottom of the well (toe of the well in a horizontal). This is shown in Fig. 1 of the ’007 Patent, where sand screen

¹³⁸ Ex. 1005 (*Yeh*) 30: 13 – 26.

¹³⁹ ’007 Patent claim 1.



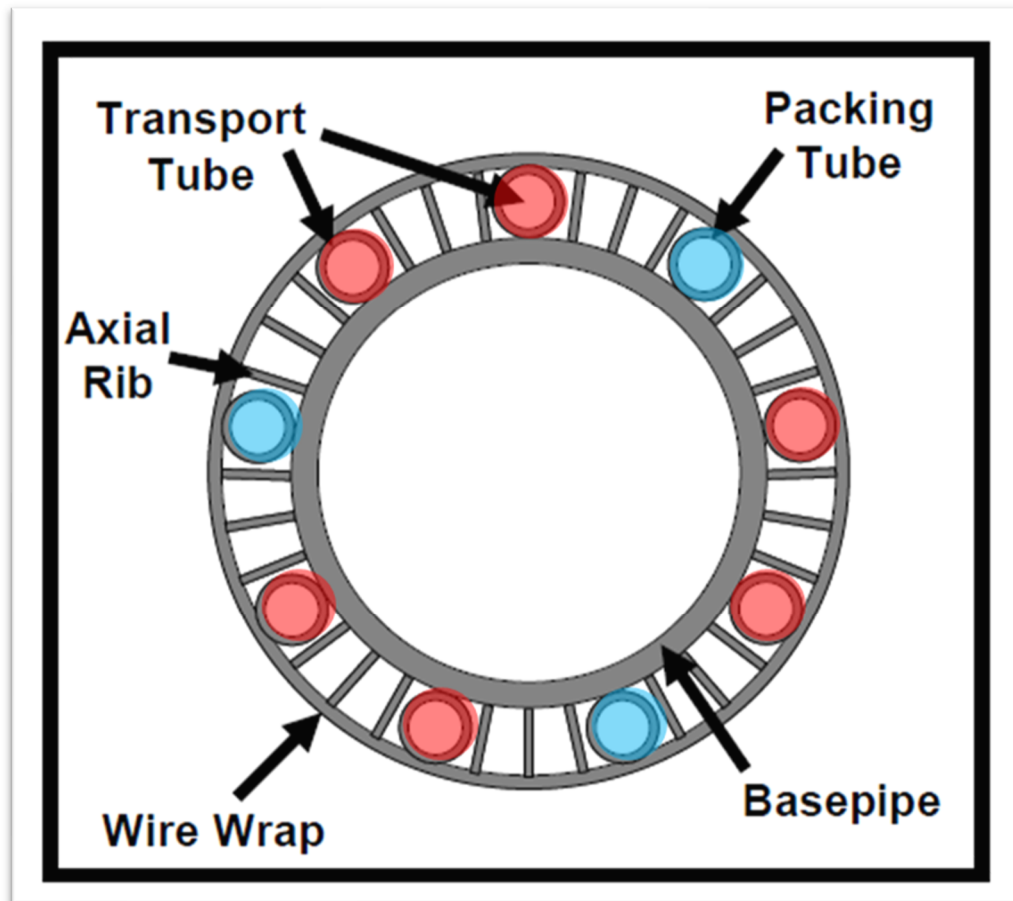
127. *Yeh* teaches a concentric sand screen assembly upstream of the crossover tool and an eccentric sand screen assembly downstream of the crossover tool. *Yeh* discloses “known concentric screens are capable of gravel packing 5,000

feet, compared to 3,000 feet with the commercial eccentric screens. The new crossover tool allows the operator to use the less-expensive eccentric screens on the toe or lower-pressure side of the interval during gravel packing operations, and to use the concentric screens on the heel or higher-pressure side of the interval during the gravel-packing operations.”¹⁴⁰ *Yeh2* teaches that “each manifold unit is designed to direct slurry into nine shunt tubes. Six of the shunts are non-ported transport tubes (annotated in red) that are continuous to the next manifold unit. The remaining three shunts are ported packing tubes (annotated in blue) for gravel discharge”,¹⁴¹ as shown in Figure 10 of *Yeh2*.¹⁴²

¹⁴⁰ Ex. 1005 (*Yeh*) 30:16 – 25.

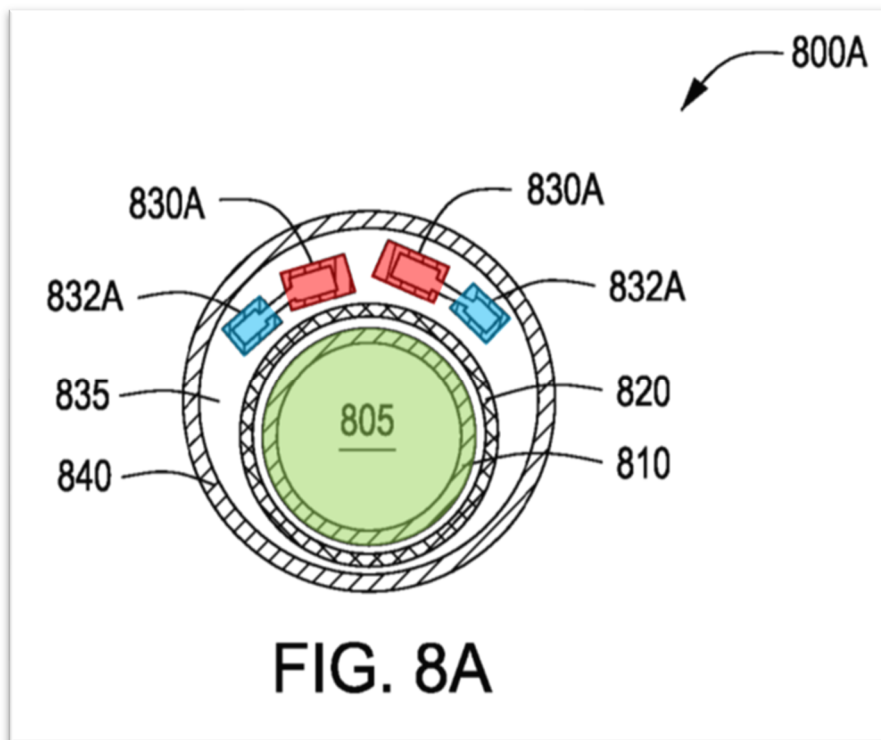
¹⁴¹ Ex. 1006 (*Yeh2*) pg. 4.

¹⁴² *See also* Ex.1005 (*Yeh*) Fig. 5B



Ex. 1006 (*Yeh2*) Fig. 10 (annotated)

128. In contrast, the eccentric sand screens of Yeh are a typical 2X2 arrangement where there are two transport tubes, 830A (highlighted in red) and two packing tubes, 832A (annotated in blue), surrounding the base pipe (highlighted in green).



Ex. 1005 (*Yeh*) Fig 8A (annotated)

129. *Yeh* does not talk about nozzle spacing.¹⁴³ However, *Yeh2* does discuss nozzle spacing. *Yeh* teaches that “laboratory tests confirmed that shunt tubes with 6 ft porthole spacing fully packed an annulus in a 10" ID fixture. The 6 ft porthole spacing in Figure 9 utilizes six portholes to pack one screen joint (40 ft) interval.”¹⁴⁴ *Yeh* further teaches that the leak-off rate (dehydration of the gravel) for closer spacing increases the risk of plugging the packing tube, and makes closer spacing undesirable.¹⁴⁵ In fact, each and every example or description of an acceptable

¹⁴³ See Ex. 1005 (*Yeh*) generally.

¹⁴⁴ Ex. 1006 (*Yeh2*) pg 4.

¹⁴⁵ Ex. 1006 (*Yeh2*) pg 5, Figure 14.

packing tube in *Yeh2* shows 6 foot spacing.¹⁴⁶ Because of the risk of plugging the packing tubes, *Yeh* suggests that spacing could be increased beyond 6 ft. (at the risk of not packing the entire annulus), but could not be decreased. There is no suggestion of changing the spacing of portholes (i.e. nozzles) along the length of the sand assembly, as either there would be an increased risk of plugging a packing tube or an increased risk of not packing the entire annulus.

130. Further, the combination of *Yeh* and *Yeh2* teaches that there are 50% more packing tubes in the upstream section (concentric with 3 packing tubes) than there are in the downstream section (eccentric with 2 packing tubes). Accordingly, a POSITA reading *Yeh* and *Yeh2* would understand the references to be teaching that there are **more** nozzles in the upstream (concentric) assembly than in the downstream (eccentric) assembly. This is the opposite of what Claim 4 claims.

131. A POSITA reading *Yeh/Yeh2* in combination, therefore, would have reasonably expected that there were more nozzles in the upstream sand screen assembly than in the downstream sand screen assembly, the opposite of the limitations of Claim 4.

132. Accordingly, the combination of *Yeh* and *Yeh2* fails to disclose or suggest the limitations of Claim 4, and the combination of references do not render Claim 4 obvious.

¹⁴⁶ See, e.g., 1006 (*Yeh2*) pg 5, fig. 9 – 15.

E. CLAIM 5

Claim 5: “The completion assembly of claim 1, wherein the cross-sectional flow areas of the passageway in the first and second transport tubes is the same.”

133. Claim 5 depends from Claim 1. As Claim 1 would not have been obvious to a POSITA based on the disclosures of *Yeh* and *Yeh2*, Claim 5 would not have been obvious to a POSITA based on the teachings of *Yeh* and *Yeh2*.

134. Not only do Mr. Chambers and Petitioner rely on hindsight in an attempt to show obviousness of Claim 5, as they do for many other claims, they ignore the clear teachings of *Yeh* and *Yeh2* in doing so. The *Yeh/Yeh2 combination* teaches against the specific limitations of Claim 5. Mr. Chambers in his deposition showed clearly that he was using the claims of the '007 Patent as a roadmap for his analysis.¹⁴⁷

135. As Claim 5 depends from Claim 1, antecedent basis dictates that the “first sand screen assembly” and the “second sand screen assembly” have the same meaning in Claim 5 as they do in Claim 1. As discussed above, the configuration of sand screen assemblies that Petitioner points to in an attempt to show obviousness of Claim is the “concentric → crossover tool → eccentric” arrangement disclosed in

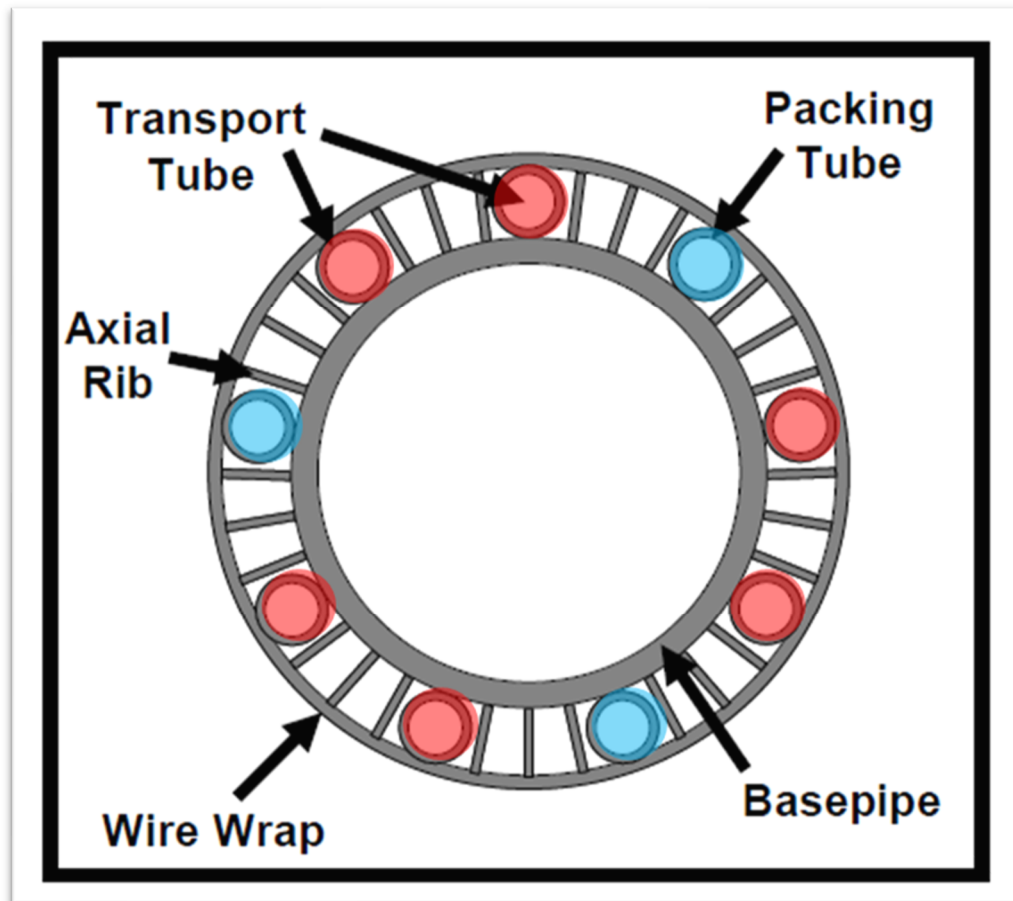
¹⁴⁷ Ex. 2001 (Chambes Deposition) 57:19-58:7.

Ex. 2002 p. 89

Column 30 of *Yeh*.¹⁴⁸ It is only this embodiment that Petitioner and Petitioner's expert suggests teaches the limitations of Claim 1.

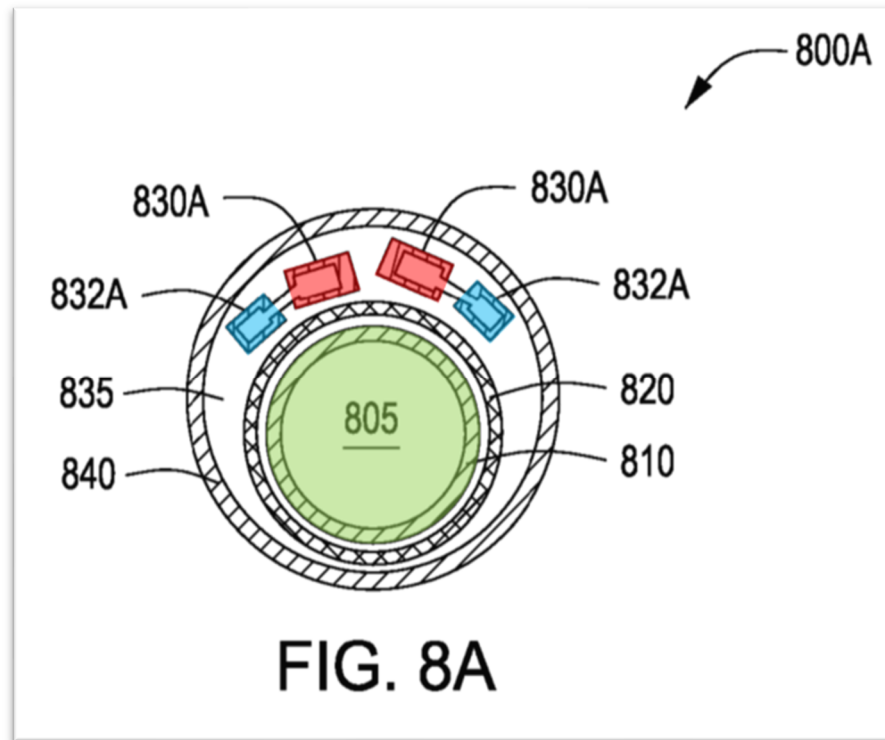
136. Even Petitioner's and Mr. Chambers' analysis shows that *Yeh* and *Yeh2* do not teach the limitations of Claim 5. As discussed above, antecedent basis requires that the claim terms of a dependent claim (in this case Claim 5) and the independent claim have the same meaning. Claim 1 claims “the shunt tube assembly having a transport tube and a packing tube, *where each of the tubes has a passageway defined therein*”. Accordingly, the “passageway” in Claim 5 refers to the individual transport tubes of the first and second (upper and lower) sand screen assemblies. Unlike Claim 4, which is looking at the number of nozzles in the entire sand screen assemblies, Claim 5 is only looking at individual transport tubes in the upper and lower sand screen assemblies. In the embodiment that Petitioner (and Mr. Chambers) point to, that allegedly teaches the limitations of Claim 1, *i.e.* the “concentric → crossover tool → eccentric” embodiment, *Yeh2* teaches, consistent with *Yeh*, that in the first sand screen assembly, there are 6 concentric round transport tubes (annotated in red) as shown in the figures below.

¹⁴⁸ Ex. 1005 (*Yeh*) 30: 13 – 26.



Ex. 1006 (*Yeh2*) Fig. 10 (annotated)

137. Further, there are two rectangular transport tubes (highlighted in red) in the eccentric (second) sand screen assembly.

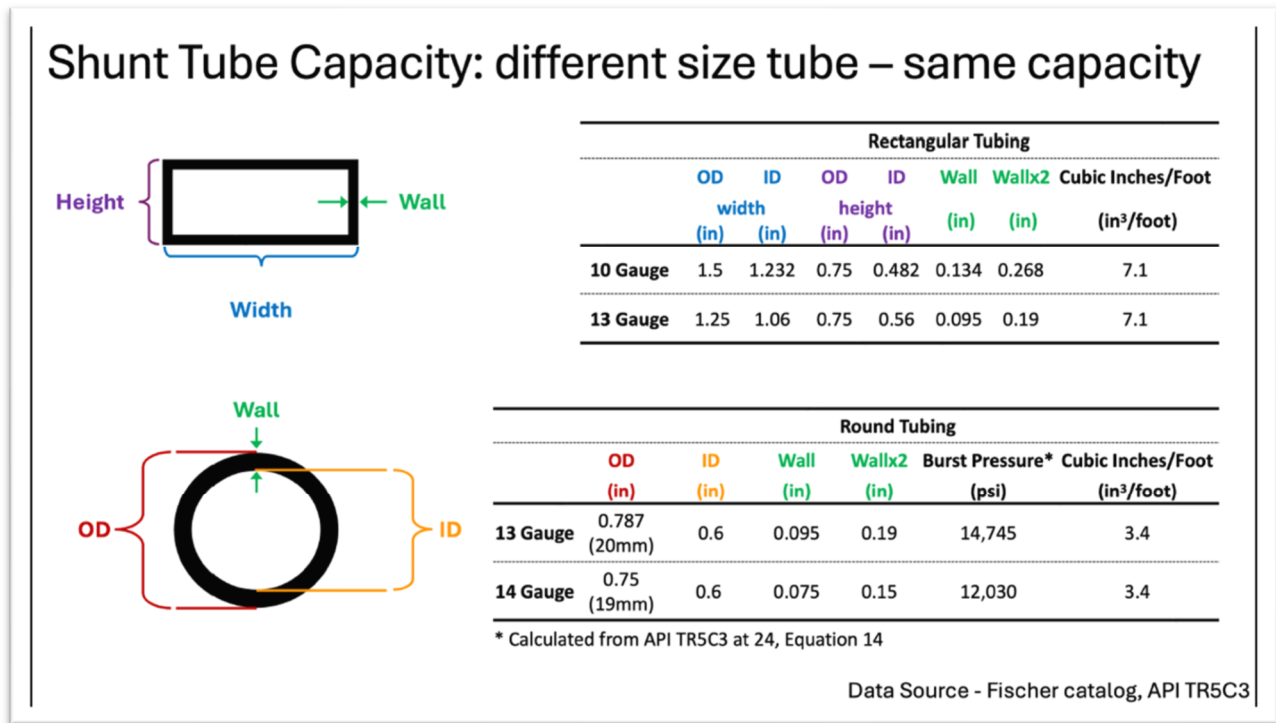


Ex. 1005 (*Yeh*) Fig. 8A (annotated)

138. Mr. Chambers' own analysis shows that the prior art does not teach that the cross-sectional areas of the first and second transport tubes are the same. Mr. Chambers provides calculations showing that the first transport tube (concentric circular) has a capacity of 3.4 in³/ft (a cross-sectional area, CSA, of 0.283 in²), and the second transport tube (eccentric rectangular) has a capacity of 7.1 in³/ft (a CSA of 0.592 in²).¹⁴⁹

¹⁴⁹ Ex. 1003 (*Chambers Declaration*) ¶331

Ex. 2002 p. 92



Ex. 1003 (Chambers Declaration) ¶331.

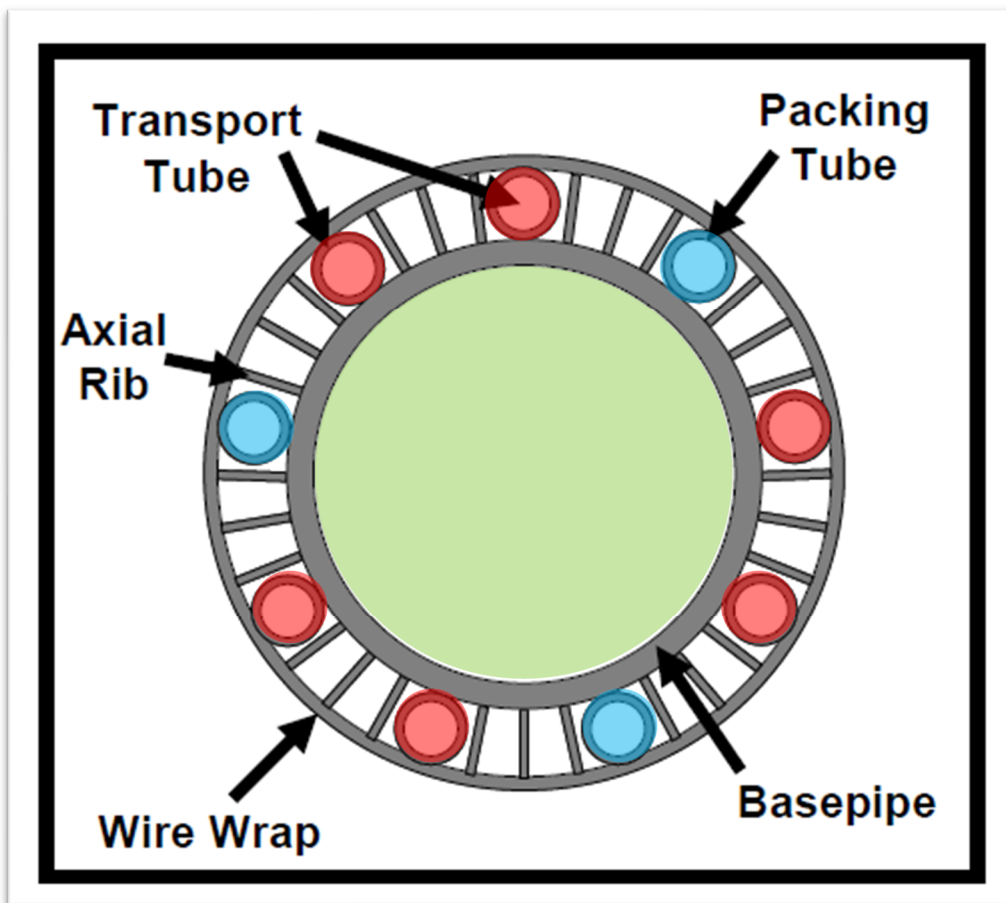
139. What Mr. Chambers actually shows is that it is *possible* to create two round tubes with the same cross-sectional area and different wall thicknesses, and two rectangular tubes with the same cross-sectional area and different wall thicknesses. Mr. Chambers does not show that the art teaches the first transport tube (round) has the same cross-sectional area as the second transport tube (rectangular). A quick calculation shows why such a configuration would not have been obvious to a POSITA. In order for the first transport tube (round) to have the same CSA as the second transport tube (rectangular, .592 in²), it would need to have an I.D. of over .868 inches. This is nearly a 50% increase in ID of the transport tubes. In order to have the same burst strength as the existing tubes, the thickness of the walls would

Ex. 2002 p. 93

have to increase, based on the “simplified” Barlow equation that Mr. Chambers cites.¹⁵⁰ For example, to get to the 12,250 burst pressure of the 14 gauge tube in Mr. Chambers’ example,¹⁵¹ the thickness of the wall would need to be increased to 0.095”, and the O.D. of each tube would be 1.0582 inches. When considering that there are 6 transport tubes in the concentric assembly taught by *Yeh* and *Yeh2* (annotated in red below), it would be clear that the OD of the entire tool would have to be increased substantially, or for the ID of the primary flow path (base pipe, annotated in green below) to be reduced substantially. As taught in *Yeh*, neither would have been a desirable, or obvious, result to a POSITA.

¹⁵⁰ Ex. 1003 (*Chambers Declaration*) ¶230

¹⁵¹ Ex. 1003 (*Chambers Declaration*) ¶332



Ex. 1005 (Yeh2) Fig. 10 (annotated)

140. Mr. Chambers, and Petitioner, also fail to show why a POSITA *would* include the general-purpose tubes of the Fischer catalog and API TR5C3 to the specific constrained environment of a gravel pack system. Mr. Chambers repeatedly states what a POSITA *could* do, rather than what a POSITA would have done.¹⁵²

¹⁵² See, e.g. Ex. 1003 (*Chambers Dec*, ¶¶ 328 – 330). I further disagree with Mr. Chambers statement in ¶330 that there are only three factors which influence burst pressure of a tube. Mr. Chambers ignores the fact that the shape of the tube (e.g. round vs. rectangular) influences burst pressure, as suggested by *Yeh* and the rest

141. *Yeh* further teaches away from having equal cross-sectional areas in the first and second transport tubes. As discussed above, the first sand screen assembly of *Yeh* has six round transport tubes, while the second sand screen assembly of *Yeh* has two rectangular transport tubes. *Yeh* further teaches that “an eccentric screen arrangement offers lower friction in the secondary flow paths when compared to shunt tubes in a concentric screen. It is believed that the use of eccentric screens at the toe of a horizontal completion will reduce the overall friction or extend the maximum gravel packing length of the completion.”¹⁵³ A POSITA would have understood this statement to be referring to the entire upper and lower sand screen assemblies and that the lower sand screen assembly (with two transport tubes) would have a lower friction than the upper sand screen assembly (with six transport tubes). A POSITA would have understood that in a system where two transport tubes have a lower friction than six transport tubes, then the cross-sectional area of each transport tube in the second assembly (two rectangular) must be larger than the cross-sectional area of each transport tube in the first assembly (six circular).

142. If the system of *Yeh* taught equal cross-sectional areas of the first and second transport tubes (it does not), as claimed in Claim 5, then the first sand screen assembly would have a total CSA of transport tubes 6 times greater than the second

of Mr. Chambers’ references. It is this factor that *Yeh* and *Yeh2* rely on for increased burst pressure (~5,000 PIS vs ~3,200 PSI).

¹⁵³ Ex. 1005 (*Yeh*) 24:55 – 60.

Ex. 2002 p. 96

sand screen assembly (or, in other words, the CSA of the second assembly is $1/6$ that of the first assembly). For example, using Mr. Chambers' example of 0.283 in^2 for the first sand screen assembly (round tubes), the first sand screen assembly would have a total transport tube CSA of 1.698 in^2 . If the second transport tube had the same CSA (as claimed in Claim 5), the total transport tube CSA of the second assembly would only be 0.566 in^2 . A POSITA would not have understood that an eccentric assembly with transport tube CSA $1/6$ that of the concentric assembly would have a lower friction, as *Yeh* teaches.

143. The only way for an assembly with two transport tubes to have a lower friction than one with six transport tubes is for the CSA of each of the two transport tubes to be larger than the CSA of each of the six transport tubes. *Yeh2* teaches this basic principle,¹⁵⁴ and Mr. Chambers admits it.¹⁵⁵ Further, Mr. Chambers admits that, "even though rectangular tubes can provide a larger cross-sectional area for flow within a confined eccentric annular space, it does not necessarily translate to lower friction pressure or pressure loss."¹⁵⁶ This means that, in order for the eccentric tubes to have lower friction (lower pressure loss) then they must have an even larger

¹⁵⁴ Ex. 1006 (*Yeh2*) pg 4 teaching that "[t]he friction in three packing tubes is higher than in six transport tubes plus the manifold." As seen in Figure 10 of

¹⁵⁵ Ex. 1003 (Chambers Declaration) ¶332 stating that a larger cross-sectional area available for flow leads to reduced frictional pressure drop.

¹⁵⁶ Ex. 1003 (Chambers Declaration) ¶103.

CSA than the round tubes of the concentric design. Accordingly, the CSA of each eccentric transport tube in *Yeh* must have been larger than the CSA of each concentric transport tube. Accordingly, *Yeh/Yeh2* teaches against the limitations of Claim 5.

144. This is even more true in that the fluid in the second (lower) sand assembly is dehydrated (higher gravel concentration) than the fluid in the first (upper) sand screen assembly.¹⁵⁷ A POSITA would have understood that a fluid with higher concentration of proppant would have higher friction, requiring the lower (second) sand screen assembly to have even higher CSA to meet *Yeh's* teaching of “lower friction” in the second eccentric sand screen assembly.

145. Finally, assuming *arguendo* that Claim 5 requires the CSA of combined transport tubes to be the same in the first and second sand screen assemblies, (it does not), Petitioner and Mr. Chambers still have not shown that the art teaches the limitation. Using Mr. Chambers' examples again, the six “first” transport tubes would have a combined CSA of 0.894 in² while the two “second” transport tubes would have a combined CSA of 1.184 in². Clearly, these are not the “same”.

146. To the extent that Petitioner argues that it would be simply a design choice or that a POSITA “could” just increase the size of the concentric transport

¹⁵⁷ See, e.g., Ex. 1006 (*Yeh2*) pg 5 teaching a gravel contraction of 4 ppa at the heel and 9ppa at the toe; see also Figure 15.

tubes or decrease the size of the lower transport tubes so that they matched, this would, initially, go against *Yeh*'s teachings of an eccentric assembly with a lower friction than a concentric, as discussed above. Further, such a decision cannot be made in a vacuum. *Yeh2* teaches that such decisions are "may be limited by wellbore dimensions, friction loss, manufacturing complexity, and overall cost."¹⁵⁸ To this I would add that changing the CSA of the upper concentric transport tubes to match the CSA of the lower eccentric transport tubes would mean that the base pipe in the concentric arrangement would have to shrink, or the overall tool size would have to increase. Neither of which would have been a desirable outcome to a POSITA. Further, I would contend that such a decision would be influenced by a variety of factors including:

- Presence of manifolds;
- Adding manifolds;
- Wall thickness;
- Material;
- weldability, corrosion/erosion resistance;
- Open-ended and closed-ended tubes;
- Nozzle size;

¹⁵⁸ Ex. 1006 *Yeh2* pg 5.

- Nozzle spacing;
- Nozzle distance from manifold;
- Jumpers (crossover tool) and pressure rating;
- Reducing leakoff;
- Rheology;

147. Mr. Chambers, in his deposition testimony, contradicted his declaration and agreed that such a change in the CSA was not a simple change.¹⁵⁹

148. As such, it would not be just a simple matter of arbitrarily changing CSA to meet the limitations of Claim 5. Further, such an argument is inappropriately applying hindsight and using the '007 Patent as a roadmap to read into *Yeh* and *Yeh2* what is simply not there.

149. Accordingly, the combination of *Yeh* and *Yeh2* fails to render the limitations of Claim 5 obvious.

F. CLAIM 6

Claim 6: “The completion assembly of claim 1, wherein the second end of the first sand screen assembly base pipe is connected to the first end of the second sand screen assembly base pipe forming a joint therebetween, the completion assembly further comprising a coupling interconnecting one end of a jumper tube to the transport tube of the first sand screen assembly, the other end of the jumper tube in fluid communication with the junction block of the second sand screen

¹⁵⁹ Ex. 2001 (Chambers Deposition) 58:19-59:10; 59:19-60:12.

assembly whereby the jumper tube straddles the joint between the first and second sand screen assemblies.”

150. Claim 6 depends from Claim 1. As Claim 1 would not have been obvious to a POSITA based on the disclosures of *Yeh* and *Yeh2*, Claim 6 would not have been obvious to a POSITA based on the teachings of *Yeh* and *Yeh2*.

G. CLAIM 7

Claim 7: “The completion assembly of claim 1, wherein the shunt tube assembly of the first sand screen assembly has a pressure rating between 5000 psi and 10000 psi, and the shunt tube assembly of the second sand screen assembly has a pressure rating of no more than 5000 psi.”

151. Claim 7 depends from Claim 1. As Claim 1 would not have been obvious to a POSITA based on the disclosures of *Yeh* and *Yeh2*, Claim 7 would not have been obvious to a POSITA based on the teachings of *Yeh* and *Yeh2*.

H. CLAIM 8

Claim 8: “The completion assembly of claim 1, wherein the shunt tube assembly of the first sand screen assembly has a pressure rating of between 5000 and 10000 psi.”

152. Claim 8 depends from Claim 1. As Claim 1 would not have been obvious to a POSITA based on the disclosures of *Yeh* and *Yeh2*, Claim 8 would not have been obvious to a POSITA based on the teachings of *Yeh* and *Yeh2*.

I. CLAIM 9

Claim 9: “The completion assembly of claim 1, wherein the shunt tube assembly of the first sand screen assembly has a pressure rating of over

a select threshold and the shunt tube assembly of the second sand screen assembly has a pressure rating of no more than the select threshold.”

153. Claim 9 depends from Claim 1. As Claim 1 would not have been obvious to a POSITA based on the disclosures of *Yeh* and *Yeh2*, Claim 9 would not have been obvious to a POSITA based on the teachings of *Yeh* and *Yeh2*.

J. CLAIM 10

Claim 10: “The completion assembly of claim 1, wherein the shunt tube assembly of the first sand screen assembly has a first burst pressure and the shunt tube assembly of the second sand screen assembly has a burst pressure less than the first burst pressure.”

154. Claim 10 depends from Claim 1. As Claim 1 would not have been obvious to a POSITA based on the disclosures of *Yeh* and *Yeh2*, Claim 10 would not have been obvious to a POSITA based on the teachings of *Yeh* and *Yeh2*.

XII. GROUND 2, YEH/YEH2 AND JONES DO NOT DISCLOSE OR SUGGEST ALL LIMITATIONS OF CLAIMS 14 – 20.

A. INDEPENDENT CLAIM 14

Claim 14[preamble]: “A method of installing a completion assembly in a wellbore, the method comprising:”

Claim 14[a]: “identifying an elongated production zone having an upstream proximal end and a downstream distal end with respect to a source of pressurized working fluid;”

Claim 14[b]: “determining a shunt tube system operating pressure associated with the proximal end of the production zone and selecting a high pressure shunt tube system based on the proximal end determined pressure;”

Claim 14[c]: “determining a shunt tube system operating pressure associated with the distal end of the production zone and selecting a low pressure shunt tube system based on the distal end determined pressure;”

Ex. 2002 p. 102

Claim 14[d]: “installing a first sand screen assembly in a wellbore adjacent the distal downstream end of the elongated production zone;”

Claim 14[e]: “attaching a second sand screen assembly to the first sand screen assembly at the proximal upstream end of the elongated production zone, wherein the first sand screen assembly has the low pressure shunt tube system and the second sand screen assembly has the high pressure shunt tube system, such that a downstream end of the high pressure shunt tube system is coupled to an upstream end of the low pressure shunt tube system; and,”

Claim 14[f]: “coupling the source of pressurized working fluid to an upstream end of the high pressure shunt tube system.”

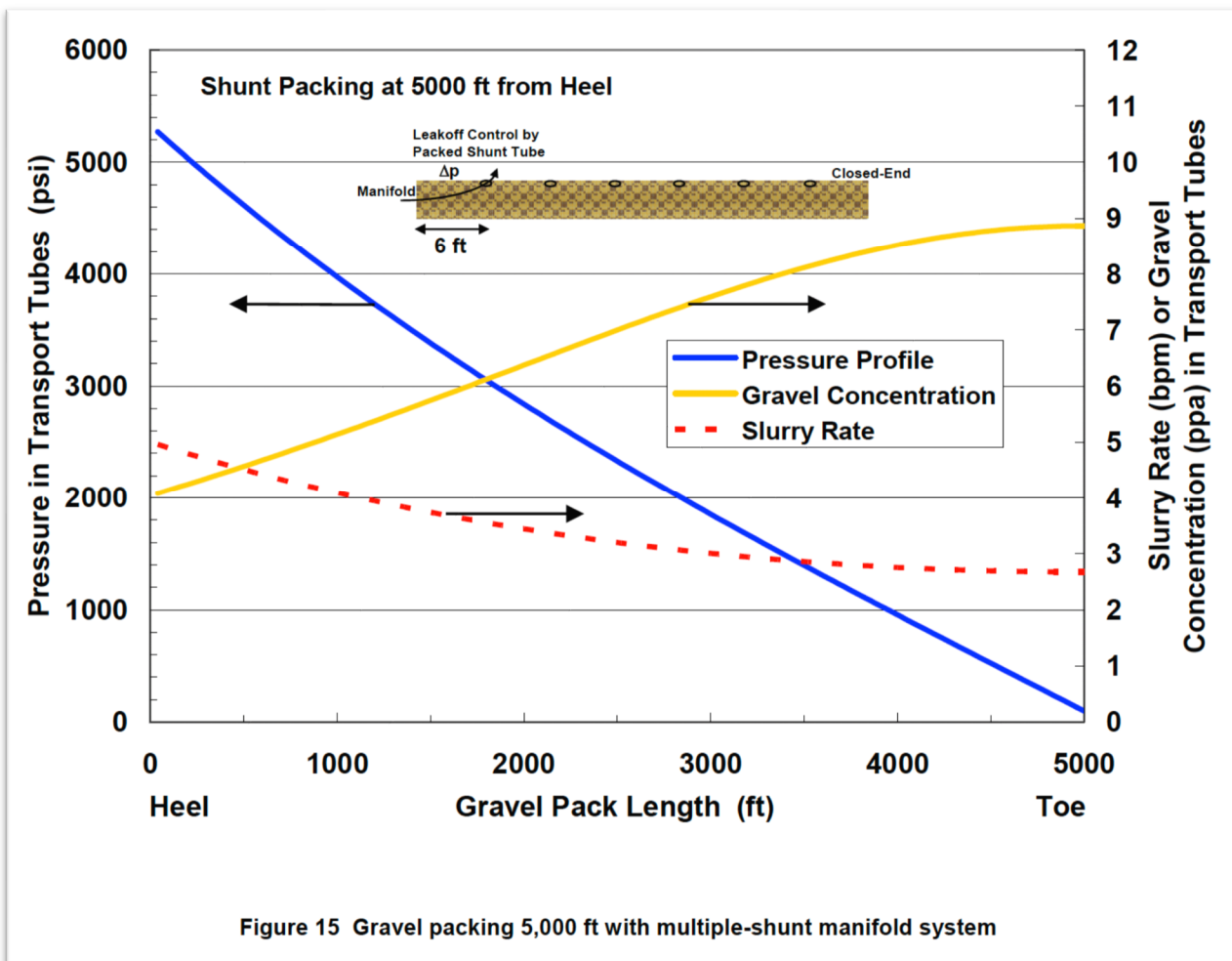
155. Neither the Petition nor Mr. Chambers have shown that the prior art discloses or suggests the Claim 14 limitation “determining a shunt tube system operating pressure associated with the distal end of the production zone and selecting a low pressure shunt tube system based on the distal end determined pressure.”

156. First, according to Mr. Chambers, the “distal end” of the production zone is located “near the toe” of *Yeh*’s Figure 2.¹⁶⁰ The Petition, relying on Mr. Chambers’ statements, also ties the “distal end” to the bottom of the well (the toe in a horizontal well).¹⁶¹

157. Second, for claim element 14[c], Mr. Chambers initially points to *Yeh*’s Figure 15 (duplicated below).

¹⁶⁰ Ex. 1003 (*Chambers Declaration*) ¶¶378 - 379.

¹⁶¹ Petition pg 63 – 64.



Ex 1006 (Yeh2) Figure 15.

158. Despite Mr. Chambers, and Petitioner, tying “distal end” to the bottom (or toe) of the well, Mr. Chambers then states that a POSITA, reading *Yeh/Yeh2* would not have chosen the second screen based on the pressure at the distal end, but rather some medial point. Mr. Chambers states that “[w]hen determining at what point along a horizontal to install eccentric screens, a POSITA would understand to place the eccentric screens starting at a point along the horizontal where the pressure dropped below the pressure tolerance limits of Yeh’s recommended commercial

eccentric screens. According to *Yeh*, this would be about 3,000 feet down from the horizontal from the heel. Data from *Yeh2*'s Figure 15 confirmed this understanding. According to Figure 15, the pressure in the shunt tube assembly is about 2,800 psi at 2,000 feet from the heel (or 3,000 feet from the toe)."¹⁶² According to Mr. Chambers' own interpretation, then, the "low pressure" sand screen assembly is chosen not based on operating pressure "near the toe" but based on some point about 2,000 feet from the heel or 3,000 feet from the toe.¹⁶³ Mr. Chambers confirmed this during his deposition.¹⁶⁴

159. The blue line in Figure 15 of *Yeh2* shows the pressure inside the shunt tubes from friction loss, as indicated by the relatively linear profile ending at around zero pressure.¹⁶⁵ There is not zero pressure in a formation where a sand screen assembly is being used. Mr. Chambers agreed.¹⁶⁶ Accordingly, there would be some shunt tube operating pressure at the toe that is non-zero and depends on the formation pressure. In step 508 (annotated in blue) the shunt tube assembly would need to be

¹⁶² Ex. 1003 (*Chambers Declaration*) ¶388.

¹⁶³ Merriam Webster definition of distal "situated away from the point of attachment or origin or a central point especially of the body."
Merriam Webster definition of medial point "being or occurring in the middle, extending toward the middle".

¹⁶⁴ Ex. 2001 (Chambers Deposition) 61:21-62:3.

¹⁶⁵ See, e.g., Ex. 1006 (*Yeh2*) pg 4 and pg 5 discussing at various locations the friction pressure loss is the governing factor in shunt tube design.

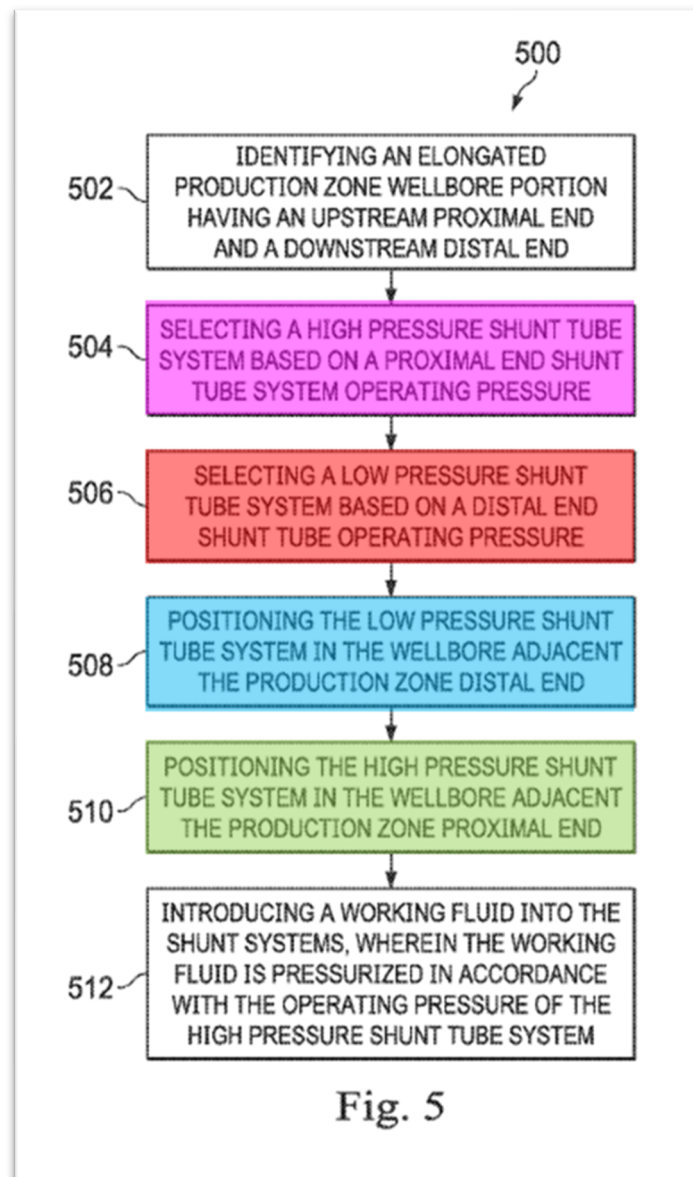
¹⁶⁶ Ex. 2001 (Chambers Deposition) 27:23-28:18.

able to handle this formation pressure differential at the toe where flow conditions are at the minimum, at the very least to keep the formation pressure from collapsing the transport tubes, for example prior to starting delivering slurry downhole or before slurry has reached the toe. During this step, the internal pressure is zero, and the maximum pressure differential is the formation pressure at the toe¹⁶⁷

160. At the toe, under the improved method disclosed in the '007 Patent, once slurry begins to be delivered at the toe, the differential pressure at the toe is near zero, only having enough pressure to overcome the differential pressure across the orifices (nozzles). The highest differential pressure in the “low pressure” shunt tube occurs somewhere upstream of the toe, as the internal pressure due to friction loss increases above and beyond the formation pressure to the point that the differential pressure across the walls of the shunt tubes approaches the burst rating of the shunt tube system. At that point, the changeover to a higher pressure system is made (step 510 annotated in green) and a high pressure system that can contain the total pressure at the proximal end (pre-selected in step 504, annotated in magenta).

¹⁶⁷ See, e.g. Ex.1027 (Barry) pg 4 discussing mechanical integrity.

Ex. 2002 p. 106

Ex. 1007 (*Jones*) Fig. 5 (annotated)

161. This methodology is not disclosed or even suggested by *Yeh* or *Yeh2*. *Yeh* simply teaches using a lower-pressure eccentric design below the crossover tool and a higher-pressure concentric design above the crossover tool. *Yeh2*, even assuming *arguendo* that Mr. Chambers' analysis is correct, at most shows the pressure loss due to friction in the shunt tubes but does not contemplate selecting the

Ex. 2002 p. 107

low-pressure shunt tube system based on the operating pressure of the shunt tube assembly at the distal end. Mr. Chambers' contradicts his own analysis when he suggests selecting a low-pressure shunt tube assembly based on the operating pressure of the shunt tube assembly not at the toe, but at some medial point.

162. Neither the Petition nor Mr. Chambers rely on any teaching of *Jones* to suggest this limitation and they could not.

163. Accordingly, *Yeh/Yeh2/Jones* fails to disclose or suggest all of the limitations of Claim 14 and Claim 14 would not have been obvious to a POSITA based on the teachings of the combination.

B. CLAIM 15

Claim 15: “The method of claim 14, further comprising: installing a plurality of interconnected first sand screen assemblies in a wellbore adjacent the production zone; and attaching a plurality of second sand screen assemblies to an uppermost first sand screen assembly upstream of the first sand screen assemblies.”

164. Claim 15 depends from Claim 14. As Claim 14 would not have been obvious to a POSITA based on the disclosures of *Yeh*, *Yeh2* and *Jones*, Claim 15 would not have been obvious to a POSITA based on the teachings of *Yeh*, *Yeh2*, and *Jones*.

C. CLAIM 16

Claim 16: “The method of claim 14, further comprising introducing a working fluid into the shunt systems, wherein the working fluid is

pressurized in accordance with the operating pressure of the high pressure shunt tube system.”

165. Claim 16 depends from Claim 14. As Claim 14 would not have been obvious to a POSITA based on the disclosures of *Yeh*, *Yeh2* and *Jones*, Claim 16 would not have been obvious to a POSITA based on the teachings of *Yeh*, *Yeh2*, and *Jones*.

D. CLAIM 17

Claim 17: “The method of claim 16, further comprising injecting the working fluid into the annulus adjacent the shunt tube system so as to form a gravel pack in the annulus.”

166. Claim 17 depends from Claim 14. As Claim 14 would not have been obvious to a POSITA based on the disclosures of *Yeh*, *Yeh2* and *Jones*, Claim 17 would not have been obvious to a POSITA based on the teachings of *Yeh*, *Yeh2*, and *Jones*.

E. CLAIM 18

Claim 18: “The method of claim 14, wherein the high pressure shunt tube system is disposed to operate at pressures of 5000 psi and the low pressure shunt tube system is disposed to operate at pressures of no more than 5000.”

167. Claim 18 depends from Claim 14. As Claim 14 would not have been obvious to a POSITA based on the disclosures of *Yeh*, *Yeh2* and *Jones*, Claim 18 would not have been obvious to a POSITA based on the teachings of *Yeh*, *Yeh2*, and *Jones*.

F. CLAIM 19

Claim 19: “The method of claim 14, wherein the high pressure shunt tube system is disposed to operate at pressures above a select threshold and the low pressure shunt tube system is disposed to operate at pressures of no more than the select threshold.”

168. Claim 19 depends from Claim 14. As Claim 14 would not have been obvious to a POSITA based on the disclosures of *Yeh*, *Yeh2* and *Jones*, Claim 19 would not have been obvious to a POSITA based on the teachings of *Yeh*, *Yeh2*, and *Jones*.

G. CLAIM 20

Claim 20: “The method of claim 14, wherein installing the first sand screen assembly and attaching the second sand screen assembly include disposing the first sand screen assembly and the second sand screen assembly in a horizontal portion of the wellbore.”

169. Claim 20 depends from Claim 14. As Claim 14 would not have been obvious to a POSITA based on the disclosures of *Yeh*, *Yeh2* and *Jones*, Claim 20 would not have been obvious to a POSITA based on the teachings of *Yeh*, *Yeh2*, and *Jones*.

XIII. GROUND 3 – THE COMBINATION OF YEH AND JONES FAILS TO RENDER CLAIMS 21-22 OBVIOUS.**A. INDEPENDENT CLAIM 21**

Claim 21[preamble]: “A completion assembly for deployment in a wellbore, the completion assembly comprising:”

Claim 21[a]: “a source of pressurized working fluid;”

Claim 21[b]: “a first sand screen assembly comprising a base pipe having perforations therein and extending between a first end and a second ends, a sand screen disposed around a portion of the base pipe, and a shunt tube assembly disposed outwardly of the sand screen, the shunt tube assembly having a transport tube and a packing tube, where each of the tubes has a passageway defined therein, the packing tube further including a plurality of nozzles spaced apart from each other, wherein each of the tubes and each nozzle has a cross-sectional flow area; and”

Claim 21[c]: “a second sand screen assembly comprising a base pipe having perforations therein and extending between a first end and a second ends, a sand screen disposed around a portion of the base pipe, and a shunt tube assembly disposed outwardly of the sand screen, the shunt tube assembly having a transport tube and a packing tube, the packing tube including a plurality of nozzles spaced apart from each other, wherein each of the tubes and each nozzle has a cross-sectional flow area;”

Claim 21[d]: wherein the first and second sand screen assemblies are arranged end to end relative to one another so that the base pipes are in fluid communication with one another and the transport tubes are in fluid communication with one another and the source of pressurized working fluid, the transport tube of the second sand screen assembly fluidly coupled to the source of pressurized working fluid downstream of the transport tube of the first sand screen assembly; and”

Claim 21[e]: “wherein the transport tube of the first sand screen assembly is formed of a first material and the transport tube of the second sand screen assembly is formed of a second material, the first material having a greater tensile strength than the second material.”

170. The Petition, and Mr. Chambers’ analysis, regarding claim limitation 21[e] are contrary to the teachings of *Yeh*, *Yeh2* and *Jones*. Though *Jones* does teach that the shunt tubes “may be made of any pressure-resistant material”, *Yeh* teaches

against the specific limitations of 21[e]. *Yeh* teaches using an eccentric screen in the lower pressure sections of the wellbore (near the toe) because the eccentric screens are less expensive, easier to acquire, and lower friction.¹⁶⁸ Using eccentric screens “reduces the overall cost of completion while still achieving the gravel packing goal.”¹⁶⁹ Thus, based on the teachings of *Yeh*, a POSITA would have been motivated to maximize the use of eccentric screens, relative to concentric screens, in order to reduce overall job cost and friction losses.

171. *Petitioner* suggests that “a skilled artisan needing to decrease burst pressure” would have looked to using a lower tensile strength material. However, neither the Petition nor Mr. Chambers explain why a POSITA, based on the teachings of *Yeh* and *Jones*, would have been motivated to decrease burst pressure in the downstream sand screen assembly.

172. A POSITA would not have looked to decrease the burst pressure of the second (eccentric) sand screen assembly as this would reduce the length that the lower cost, lower friction, more readily available eccentric assembly could be used. The Petition (and Mr. Chambers) state that a POSITA would have been motivated to use a lower strength material (presumably in the lower pressure second assembly) to “save cost” but fail to point to any analysis that reducing material strength of either

¹⁶⁸ See Ex. 1005 (*Yeh*) 30: 15 – 33; 24:51 – 60.

¹⁶⁹ Ex. 1005 (*Yeh*) 30:25 – 26.

the lower or upper sand screen assembly would in fact reduce overall cost of the completion (as required by *Yeh*, Ex. 1005, 30:25-26), while still meeting *Yeh*'s goals of using eccentric screens to reduce cost and have lower friction.¹⁷⁰ Neither Petitioner nor Mr. Chambers provide an analysis of how thinning the walls of the downstream eccentric screen would reduce the overall cost of completion.

173. A POSITA based on the teachings of *Yeh* and *Jones* would not be motivated to “reduce burst pressure” of the *Yeh* assembly by using a lower tensile strength material in the lower sand screen assembly as the Petition and Mr. Chambers suggest. Accordingly, neither the Petition nor Mr. Chambers have shown that 21[e] would have been obvious based on the combined teachings of *Yeh* and *Jones*.

B. CLAIM 22:

Claim 22: “The completion assembly of claim 21, wherein the transport tube of the first sand screen assembly has a first wall thickness and the transport tube of the second sand screen assembly has a second wall thickness, the first wall thickness being greater than the second wall thickness.”

174. Claim 22 incorporates the limitations of Claim 1[E] as discussed above in Section X.A. The *Yeh/Yeh2* fails to render this claim obvious for the same reasons as those disclosed above regarding limitation 1[E]. Further, Petitioner does not rely on any provisions of *Jones* to remedy this deficiency, as they could not. Petitioner

¹⁷⁰ Ex. 1005 (*Yeh*) 24:54-60, 30:20-33

(and Mr. Chambers) merely point to the flawed arguments regarding limitation 1[E] which fail for the same reasons as those discussed above regarding 1[E] in Section X.A.

XIV. GROUND 4 – THE COMBINATION OF *YEH/YEH2 AND JONES* FAILS TO RENDER CLAIM 23 OBVIOUS

A. CLAIM 23

Claim 23: “The completion assembly of claim 21, wherein the first sand screen assembly has a shunt tube assembly with a first pressure rating and the second sand screen assembly has a shunt tube assembly with a second pressure rating less than the first pressure rating.”

175. Claim 23 depends from Claim 21. *Yeh2* provides no additional teachings regarding why a POSITA would have been motivated to modify the material the screens are constructed of. As a result, Claim 23 would not have been obvious to a POSITA for the same reasons as those discussed above regarding Claim 21.

XV. CONCLUSION

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 7, 2025



Robert Durham, Ph.D.