

Filed on behalf of Weatherford U.S., L.P.

By: Douglas R. Wilson
Michelle E. Armond
Monica Arnold
ARMOND WILSON LLP
4685 MacArthur Court, Suite 390
Newport Beach, CA 92660
Telephone: (949) 932-0778
Email: ipr@armondwilson.com

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 No. IPR2024-00990
U.S. Patent No. 11,333,007

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 11,333,007**

TABLE OF CONTENTS

I.	INTRODUCTION.....	1
II.	BACKGROUND.....	3
A.	Well Drilling and Completion.....	3
B.	Halliburton’s ’007 Patent	7
C.	Prosecution History of the ’007 Patent	10
D.	ExxonMobil’s Prior Art “Alternate Path Technology”	11
1.	SPE22796 (EX1009)	12
2.	U.S. Patent No. 5,588,487 (“’487 Patent”) (EX1012).....	13
3.	U.S. Patent No. 4,945,991 (“Jones” or “’991 Patent”) (EX1007)	14
4.	U.S. Patent No. 5,113,935 (“Jones2” or “’935 Patent”) (EX1008)	15
5.	U.S. Patent No. 7,661,476 (“’476 Patent”) (EX1010).....	16
6.	Yeh (EX1005).....	18
a)	Yeh’s Sand Screen Assembly	19
b)	Yeh’s Fluid Dynamics Considerations	21
7.	Yeh2 (EX1006).....	22
8.	Hurst (EX1013)	25
9.	Lagrone (EX1014).....	26
10.	Hecker (EX1015).....	26
11.	Bonner (EX1016)	27
E.	Knowledge of a Skilled Artisan	28

F.	Claim Construction	29
III.	GROUND AND PRIOR ART PRESENTED	29
IV.	LEVEL OF SKILL AND KNOWLEDGE OF POSITA	31
V.	GROUND 1	32
A.	Claim 1	32
1.	Claim 1[preamble]: “A completion assembly for deployment in a wellbore, the completion assembly comprising:”	32
2.	Claim 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;”	33
3.	Claim 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;”	34
4.	Claim 1[c]: “a source of pressurized working fluid fluidly coupled to an upstream end of the transport tube of the first sand screen assembly;”	38
5.	Claim 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”.....	39
6.	Claim 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.”.....	41
B.	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.”.....	43
C.	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 spaced apart from the junction block, wherein the distance 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.”.....	47
D.	Claim 4: “The completion assembly of claim 1, wherein the 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.”.....	51
E.	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.”	52

F.	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 assembly whereby the jumper tube straddles the joint between the first and second sand screen assemblies.”	53
G.	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.”	55
H.	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.”	58
I.	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.”	58
J.	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.”	58
K.	Claim 11	59
1.	Claim 11[preamble]: “A completion assembly for deployment in a wellbore, the completion assembly comprising:”	59
2.	Claim 11[a]: “a source of pressurized working fluid;”	59

3.	Claim 11[b]: “a first sand screen assembly attached to a second sand screen assembly,”	59
4.	Claim 11[c]: “wherein the first sand screen assembly comprises a shunt tube assembly with a first burst pressure and the second sand screen assembly comprises a shunt tube assembly with a burst pressure less than the first burst pressure, and”	60
5.	Claim 11[d]: “wherein the shunt tube assembly with the first burst pressure is fluidly coupled between the source of pressurized working fluid and the shunt tube assembly with the burst pressure less than the first burst pressure.”.....	60
L.	Claim 12: “The completion assembly of claim 11, wherein the shunt tube assembly of the first sand screen assembly is disposed to operate at pressures between 5000 psi and 10000 psi and the shunt tube assembly of the second sand screen assembly is disposed to operate at pressures of no more than 5000 psi.....	61
VI.	GROUND 2.....	61
A.	Claim 14.....	61
1.	Claim 14[preamble]: “A method of installing a completion assembly in a wellbore, the method comprising:”.....	61
2.	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;”	62
3.	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;”.....	64
4.	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;”	65

5. Claim 14[d]: “installing a first sand screen assembly in a wellbore adjacent the distal downstream end of the elongated production zone;” 67
6. 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,” 67
7. Claim 14[f]: “coupling the source of pressurized working fluid to an upstream end of the high pressure shunt tube system.” 69
- B. 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 sandscreen assembly upstream of the first sand screen assemblies.” 72
- C. 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.” 73
- D. 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.” 73
- E. 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.” 74

F.	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.”	75
G.	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 wellbor.”	75
VII.	GROUND 3.....	76
A.	Claim 21	76
1.	Claim 21[preamble]: “A completion assembly for deployment in a wellbore, the completion assembly comprising:”	76
2.	Claim 21[a]: “a source of pressurized working fluid;”	76
3.	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”	76
4.	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;”	77
5.	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	77
6.	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.”	77
B.	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 reater than the second wall thickness.”	79
VIII.	GROUND 4.....	79
A.	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.”	79
IX.	SECONDARY CONSIDERATIONS.....	80
X.	DISCRETION UNDER 35 U.S.C. §§ 314(a) AND 325(d)	80
A.	<i>Fintiv</i> Supports Institution	80
B.	Discretionary Denial Under 35 U.S.C. § 325(d) Is Unwarranted.....	82
XI.	CONCLUSION	83

XII. GROUNDS FOR STANDING.....	83
XIII. MANDATORY NOTICES.....	83
A. Real Party-In-Interest (37 C.F.R. § 42.8(b)(1)).....	83
B. Related Matters (37 C.F.R. 42.8(b)(2)).....	83
C. Lead and Backup Counsel (37 C.F.R. 42.8(b)(3))	83
D. Service Information (37 C.F.R. 42.8(b)(4))	84

TABLE OF AUTHORITIES

	Page No(s).
<i>Advanced Bionics v. Med-El Elektromedizinische</i> , IPR2019-01469, 2020 WL 740292 (P.T.A.B. Feb. 13, 2020)	82
<i>Apple v. Fintiv</i> , IPR2020-00019, 2020 WL 2126495 (P.T.A.B. Mar. 20, 2020).....	80
<i>Apple v. Fintiv</i> , IPR2020-00019, 2020 WL 2486683 (P.T.A.B. May 13, 2020).....	80
<i>F5 v. Sunstone Info.</i> , IPR2022-00483, Paper 13 (P.T.A.B. Aug. 12, 2022)	80, 81
<i>Google v. Jawbone Innovations</i> , IPR2022-00649, Paper 13 (P.T.A.B. Oct. 31, 2022).....	82
<i>KSR Int’l Co. v. Teleflex Inc.</i> , 550 U.S. 398 (2007)	79

OTHER AUTHORITIES

37 C.F.R. § 42.8.....	83
37 C.F.R. § 42.101.....	83
35 U.S.C. § 102	30, 31
35 U.S.C. § 103	29
35 U.S.C. § 314	80
35 U.S.C. § 325	80, 82

TABLE 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”)

Weatherford U.S. v. Halliburton
Patent No. 11,333,007 – IPR Petition

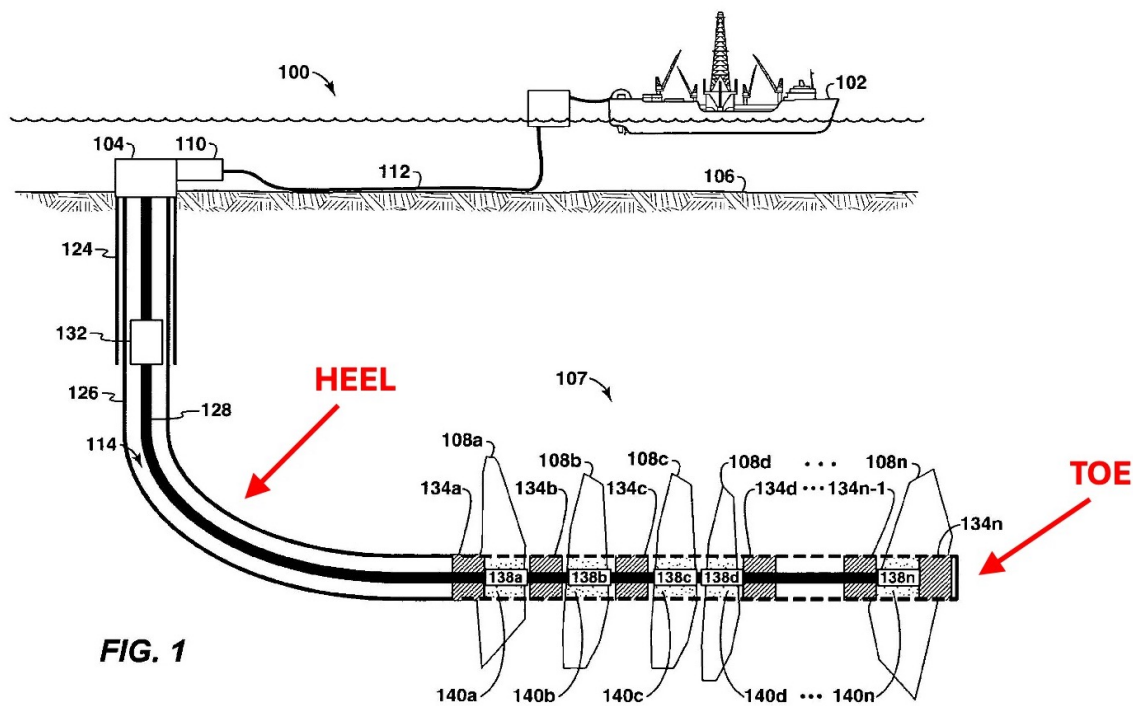
Exhibit No.	Description
1017	API Technical Report 5C3, published in December 2008 with an Addendum in October 2015 (excerpts)
1018	ASTM A554-16: Standard Specification for Welded Stainless Steel Mechanical Tubing (2016) (excerpts)
1019	Declaration of Christine Diedrich of the Society of Petroleum Engineers
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

Weatherford U.S. v. Halliburton
Patent No. 11,333,007 – IPR Petition

Exhibit No.	Description
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

I. INTRODUCTION

The parties in this IPR are leading equipment manufacturers in the oil and gas industry. In January, Patent Owner Halliburton sued Weatherford on U.S. Patent No. 11,333,007. The patent describes a sand screen for an oil well that uses gravel packing to ensure that sand particles cannot enter the production string and damage the equipment during oil and gas extraction.



As shown above, in a horizontal well, the point of deviation from vertical is called the “heel,” and the end of the horizontal run is the “toe.” Halliburton told the Patent Office that the novelty of its sand screen was using high-pressure assemblies in the heel and low-pressure assemblies in the toe, unlike existing designs that purportedly used the same sand screens throughout the horizontal.

Halliburton's statements couldn't be further from the truth. Beginning in the 1990s, Mobil (and later ExxonMobil after the 1999 merger) invested in pioneering research and development focused on optimizing sand screen shunt tubes for gravel packing, especially in long, horizontal wellbores. A research group led by Lloyd Jones and Charles Yeh at Mobil devised the tooling and parameters needed for gravel packing in these conditions.

Long before Halliburton's 2018 claimed filing date, the Jones/Yeh research group had already developed everything described in Halliburton's '007 Patent and more. In 1991, the group published "[a] new and superior gravel packing method called ALLPAK™ for alternate path gravel packing." EX1009, 1. They developed a completion assembly with the same basic arrangement shown in the '007 Patent, EX1010, and used higher-pressure shunt tubes at the heel compared to the toe, EX1005, 30:20-25.

Jones' and Yeh's research is famous in the oil and gas industry. They presented their findings at numerous international conferences. The lead Jones and Yeh references in this IPR have been cited dozens of times. Weatherford itself licensed this technology from ExxonMobil in 2013.

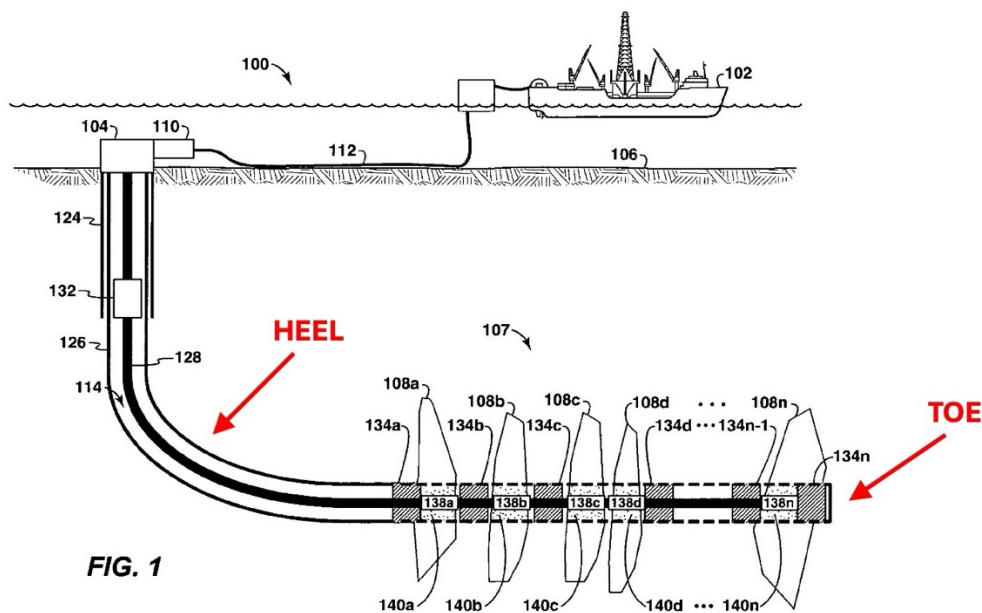
Yet none of this prior art was disclosed by Halliburton or considered by the Patent Office during prosecution of the '007 Patent. Instead, Halliburton disclosed only six references. EX1002, 169. This Petition presents publications and patents

by Yeh and Jones establishing that every aspect of Halliburton's patent was taught or suggested by these researchers first. The Board should cancel as unpatentable claims 1-12 and 14-23 of the '007 Patent.

II. BACKGROUND

A. Well Drilling and Completion

An oil well is constructed by drilling a hole into a formation containing oil or gas reserves. EX1003 ¶43; EX1005, 1:36-38, 8:58-9:4. Wells may be drilled vertically or horizontally. EX1003 ¶43; EX1005, 9:33-35. As shown below, the transition from vertical to horizontal is called the “heel,” and the end of the horizontal wellbore is called the toe.



EX1010, Fig. 1;¹ EX1003 ¶43.

After drilling, the well is lined with steel casing to prevent collapse of the borehole. EX1003 ¶44. Where the casing extends through the producing zone(s), it is perforated. *Id.* ¶45. Alternatively, the producing zone(s) are left uncased or “open hole,” which permits easier ingress of oil and gas into the borehole. *Id.*

In some formations, sand is produced with oil and gas, which results in erosion of metal production equipment. EX1005, 2:28-32; EX1003 ¶48. By the 1950s, the industry had implemented gravel packing to prevent sand intrusion. EX1003 ¶48. Gravel packing formed a porous boundary using “gravel” (or fine solid particles) to filter out sand but permit oil and gas to enter the perforated base pipe. *Id.* Gravel packing required transporting gravel in a carrier fluid (or gravel slurry) down the well between the formation wall (or perforated casing) and the base pipe. *Id.* The gravel could prematurely settle in the annulus between the base pipe

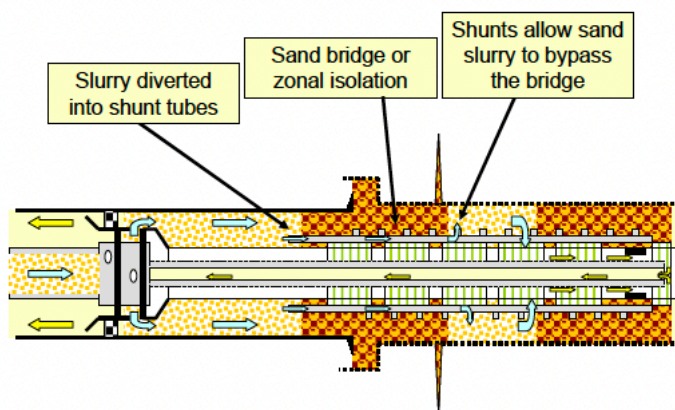


Figure 1 Alternate Path gravel packing with shunt tubes

and the formation wall leaving behind a sand bridge that blocked annular slurry flow

¹ All annotations are added unless otherwise noted.

and prevented downstream gravel packing. EX1006, Fig.1 (above). Later the industry also wrapped the perforated base pipe to create screens to help exclude sand. EX1003 ¶¶49, 53-56.

Because sand bridge formation was common, *id.* ¶60, by the 1990s service companies began using shunt tubes to provide an alternate flow path for gravel slurry to bypass sand bridges and pack downstream segments. *Id.* ¶61. Because the gravel slurry had to travel down the shunt tubes, *see, e.g., id.* ¶¶72-75, skilled artisans understood that shunt tube pressure rating determined the length of producing zone that could be gravel-packed. EX1006, 4 (“The friction loss in transport tubes and manifold limits the overall distance of shunt diversion.”); EX1003 ¶¶139-40, 190. Thus, the shunt tube pressure rating at the heel where the pressure was highest limited gravel packing length as reflected by the **blue line** in Figure 15 below.

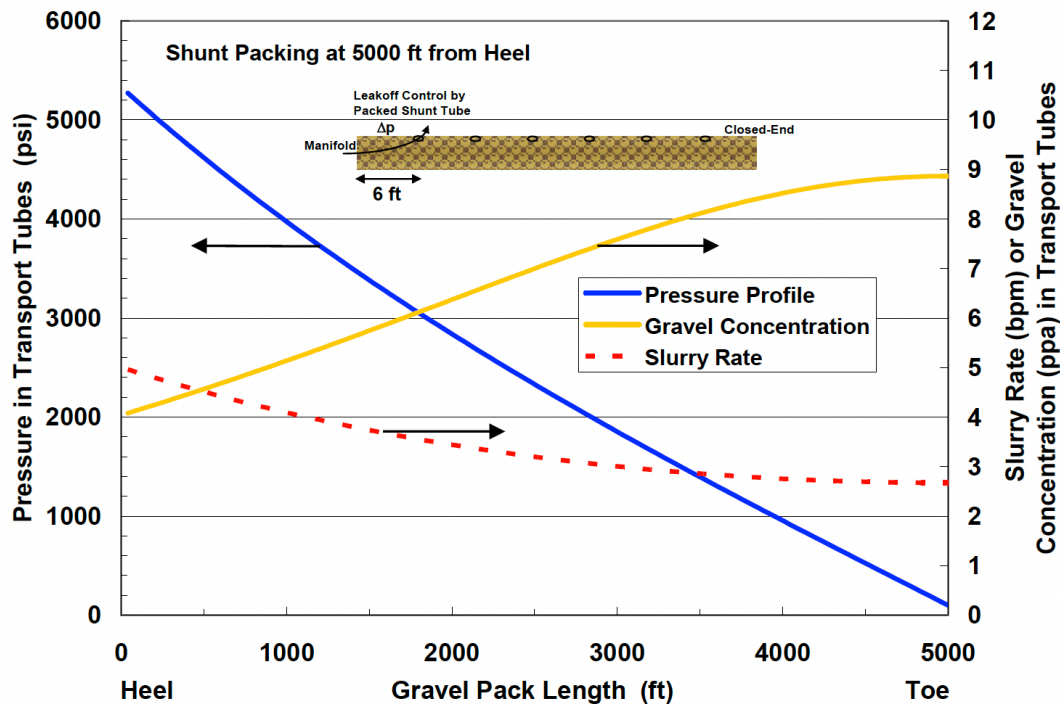


Figure 15 Gravel packing 5,000 ft with multiple-shunt manifold system

EX1006, Fig. 15; EX1003 ¶190.

Skilled artisans naturally developed sand screens with shunt tubes capable of handling pressures greater than 5,000 psi. EX1006, 5 (“Burst strength of shunt tubes must therefore be capable of accommodating this high [5,300 psi] hydraulic pressure.”); EX1003 ¶178. Because of the expense of these higher-pressure shunt tubes, operators, such as Yeh, suggested using them only at the heel where pressure would be highest and using lower-pressure tubes closer to the toe where pressure would be lowest. For example, Yeh taught:

The new crossover tool allows the operator to use the less-expensive [low pressure] eccentric screens on the toe or lower-pressure side of the

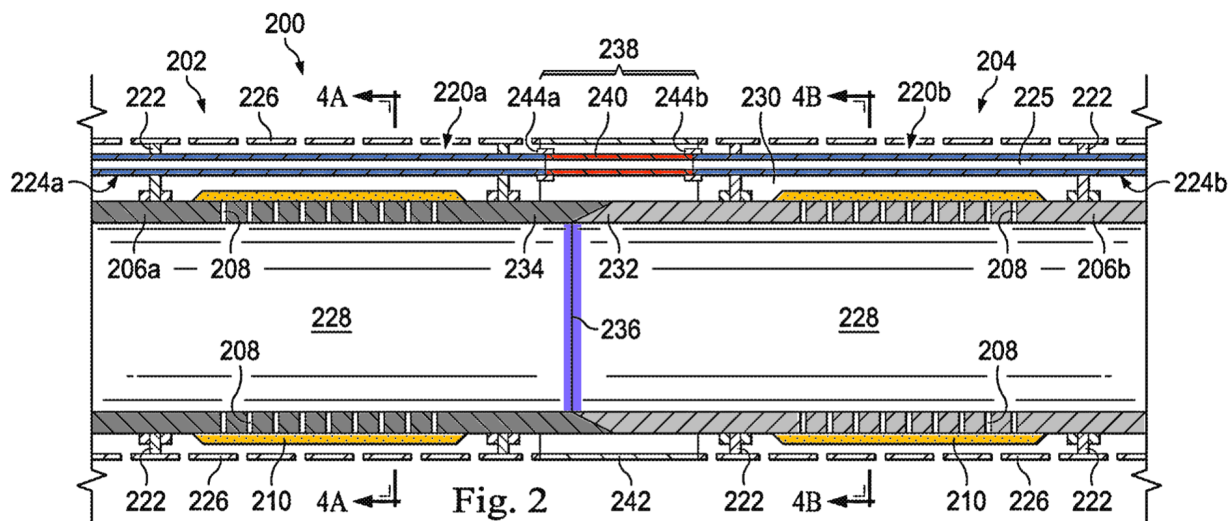
interval during gravel-packing operations, and to use the [high pressure] concentric screens on the heel or higher-pressure side of the interval

EX1005, 30:20-26; EX1003 ¶¶185-88.

B. Halliburton’s ’007 Patent

The ’007 Patent challenged here is titled “Multiple Shunt Pressure Assembly for Gravel Packing.” EX1001, 1. It purports to describe and claim an improvement on shunt tube assemblies for gravel packing. *Id.*, 2:4-13. The premise is that conventional technology used “multiple sand screen assemblies with shunt tube assemblies all of the same pressure rating” selected based on “the highest operating pressure expected to be required across the entire length of the gravel packing interval.” EX1001, 9:3-7, 9:15-25; EX1003 ¶240.

The ’007 Patent claimed to have invented using shunt tubes with higher pressure ratings upstream and lower pressure ratings downstream. EX1001, 9:36-65. Figure 2 showed a cross-section of two sand screen assemblies 202 and 204 forming a joint 236 (**purple**). *Id.*, 2:23-24, 5:6-9, 5:65-66; EX1003 ¶241. Both have their own base pipes 206a (**dark gray**) and 206b (**light gray**). EX1001, 5:63-65; EX1003 ¶241. The base pipes 206 have perforations 208 allowing fluid to enter from the annulus. EX1001, 5:19-20, 5:38-40; EX1003 ¶241.



EX1001, Fig. 2.

The sand screen (filter media 210 shown in **orange**) surrounds a section of the base pipes 206. EX1001, 5:17-19; EX1003 ¶242. It allows production fluid to enter through bore 228, while excluding sand. EX1001, 5:50-56; EX1003 ¶242. Each sand screen also has a shunt tube assembly 224 (**dark blue**). EX1001, 5:20-26; EX1003 ¶242. The shunt tubes 224a/224b can be fluidly coupled via jumper tube 240 (**red**). EX1001, 6:19-22; EX1003 ¶242.

Figure 3, shown below, provides a side view with the filter media 210 and outer shroud 224 removed. EX1001, 2:25-27, 6:37-40; EX1003 ¶243.

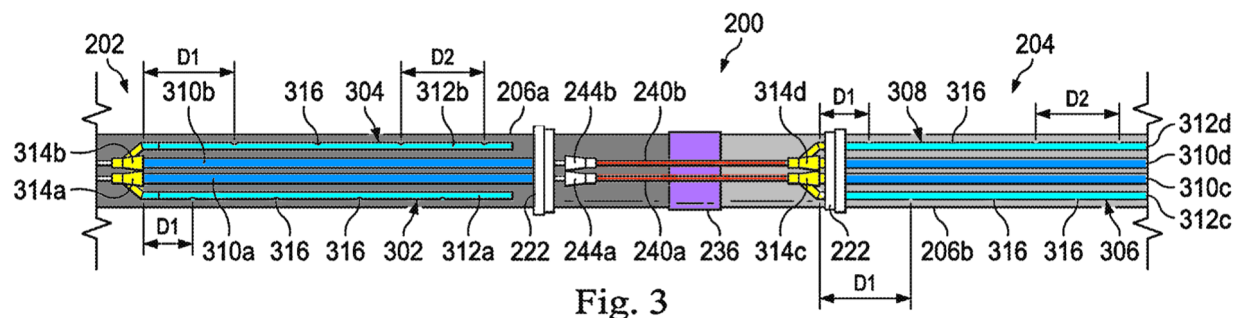
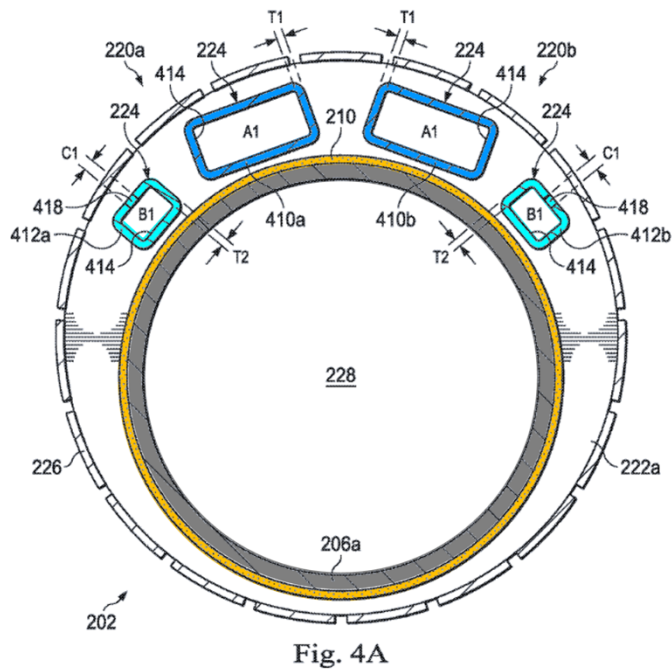


Fig. 3

EX1001, Fig. 3.

The shunt tube assembly can include transport and packing tubes. EX1001, 5:24-26; EX1003 ¶244. Sand screen assembly 202 includes two shunt tube assemblies 302 and 304. EX1001, 6:44-45; EX1003 ¶244. Shunt tube assembly 302, for example, includes transport tube 310a (blue) and packing tube 312a (light blue), which are coupled via junction block 314a (yellow). See EX1001, 6:52-56; EX1003 ¶244. Shunt tube assemblies 304, 306, and 308 have the same arrangement. EX1001, 6:45-56; EX1003 ¶244. Each packing tube 312 includes at least one nozzle 316. EX1001, 7:3; EX1003 ¶244.

Figure 4A (right) shows transport tubes 410 (blue) and packing tubes 412 (light blue) arranged eccentrically outside the base pipe 206a (dark gray) and sand screen 210 (orange). EX1001, Fig. 4A, 5:61-64, 7:42-47, 7:50-51; EX1003 ¶245. But the '007 Patent discloses that “other alignments ... may also be possible.” EX1001, 7:42-48; EX1003 ¶245.



All claims are directed to a completion assembly wherein the upstream shunt tube system is higher-pressure compared to the downstream shunt tube system. EX1001, 18:17-55 (claim 1), 19:42-54 (claim 11), 20:5-31 (claim 14), 20:59-22:9 (claim 21).

C. Prosecution History of the '007 Patent

The '007 Patent claims priority to U.S. Provisional Application No. 62/688,813, filed on June 22, 2018. EX1001, 1; *see* EX1003 ¶246. Halliburton disclosed only four prior art references during prosecution. EX1001, 1-2.

The Examiner rejected the claims as both not enabled and indefinite, EX1002, 263-69, and as obvious, *id.*, 270-84; EX1003 ¶247. She rejected pending claims 1,

5-15, and 18-23 over U.S. Patent Applications 2019/01452321 to Sessa in view of 2021/0123327 to Langlais (also referred to as Lang). EX1002, 270-284; EX1003 ¶247. Halliburton amended its claims to indicate that higher pressure rated components were located upstream and lower pressure rated components were located downstream. EX1002, 564-69; EX1003 ¶248. Halliburton argued that “traditionally, ... the lower production assembly ... [includes] multiple sand screen assemblies with shunt tube assemblies all of the same pressure rating.” EX1002, 573-74 (emphasis in original) (quoting EX1001, 9:3-7); EX1003 ¶249.

The Examiner found that this amendment plus specifying a horizontal well resolved the rejections and allowed the claims. EX1002, 578, 585-91, 564-69, 623; EX1003 ¶¶250-53.

D. ExxonMobil’s Prior Art “Alternate Path Technology”

Starting in the 1990s, a group at Mobil (later ExxonMobil) pioneered shunt tube assemblies for gravel packing. Their research was famous in the oil and gas industry, widely cited and presented at international conferences. EX1003 ¶¶8-12; *see id.*, Appendix Tables 1-2 (list of Exxon patents/publications). In 2013, Weatherford licensed ExxonMobil’s patented Alternate Path Technology. EX1011.

Their research publications and patents form the foundation of this Petition.

1. SPE22796 (EX1009)

In 1991, the Mobil research group of Jones, Yeh, Yates, Bryant, Doolittle, and Healy disclosed in SPE22796, entitled *Alternate Path Gravel Packing*, developing a “new and superior gravel packing method called ALLPAK™ for alternate path gravel packing” to address sand bridging. EX1009, 1; EX1003 ¶¶91, 125; EX1005, 3:8-22.

Alternate Path® Technology (“APT”) originated use of shunt tubes for gravel packing. EX1009, 1; EX1003 ¶¶92-99. Shunt tubes (**dark blue**) shown in Figures 1 and 2 below had perforations every few feet allowing the gravel slurry to flow into and pack the annulus. EX1009, 1; EX1003 ¶92.

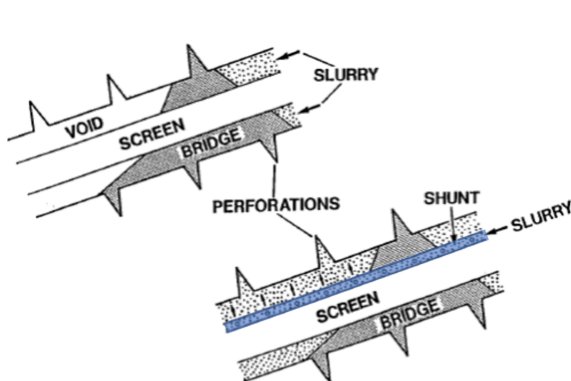


Figure 1 ALLPAK™ (Alternate Path Gravel Pack) Mechanism

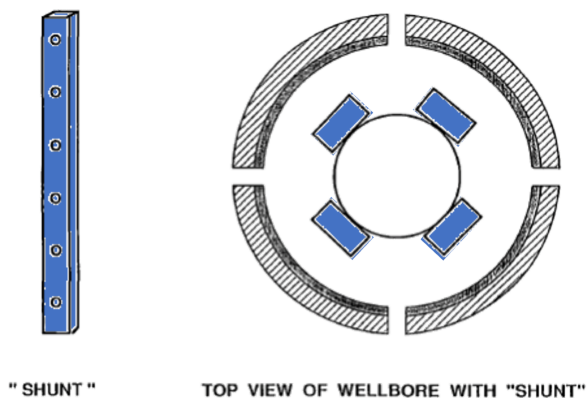


Figure 2 Schematic of ALLPAK™ Assembly

EX1009, Figs. 1, 2; EX1003 ¶89.

2. U.S. Patent No. 5,588,487 (“’487 Patent”) (EX1012)

The ’487 Patent, filed in 1995 and entitled *Tool for Blocking Axial Flow in Gravel-Packed Well Annulus*, was invented by Bryant and assigned to Mobil. EX1012, 1.

The ’487 Patent disclosed a “well screen for gravel-packing a wellbore interval comprising at least two joints connected by a well tool. Each joint is comprised of a length of screen section which has at least one, axially-extending shunt conduit thereon for carrying gravel slurry to different levels within the interval.” EX1012, Abstract; *see id.*, Fig. 1 (right); EX1003 ¶¶83-84. The ’487 Patent disclosed pumping a gravel slurry down a wellbore into shunt tubes 18 (dark blue), which were positioned outward of sand screen 17 (orange) and through tube perforations to fill the wellbore annulus. EX1012, Fig. 1; EX1003 ¶85.

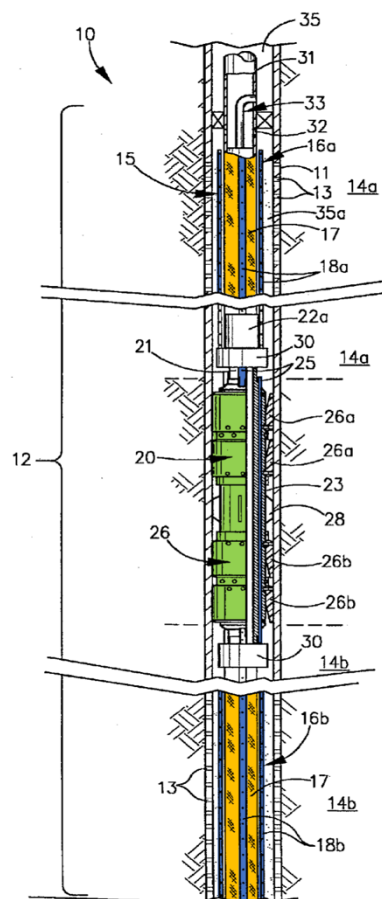


FIG. 1

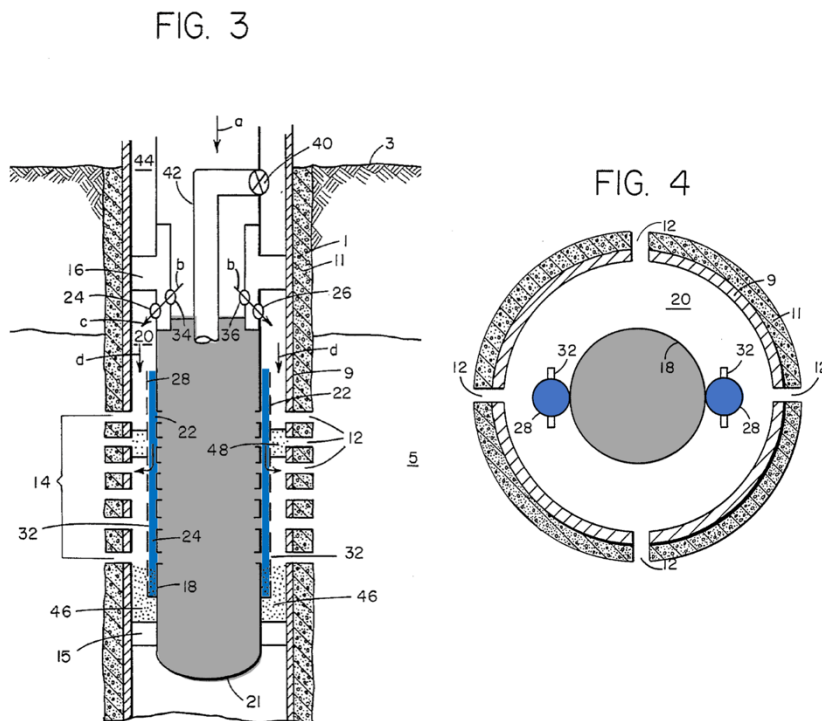
Sand screens in productive zones 14a-b were separated by a packing means 26 (green), and shunt tubes were connected via bypass tube 25 (dark blue). EX1012, Fig.1; EX1003 ¶86.

**3. U.S. Patent No. 4,945,991 (“Jones” or “’991 Patent”)
(EX1007)**

Jones, filed in 1989 and entitled *Method for Gravel Packing Wells*, was invented by Jones and assigned to Mobil.

EX1007, 1. It described a sand screen used to create a complete gravel pack despite sand bridges. *Id.*, 2:57-63; EX1003 ¶¶64-65, 89.

Figures 3 and 4 (right)



illustrated a sand screen 18 with a wire wrap (not shown) on a perforated blank pipe 21 (dark gray). EX1007, Figs. 3, 4, 2:47-49, 3:16-26, 4:58-60, 5:2-3; EX1003 ¶62.

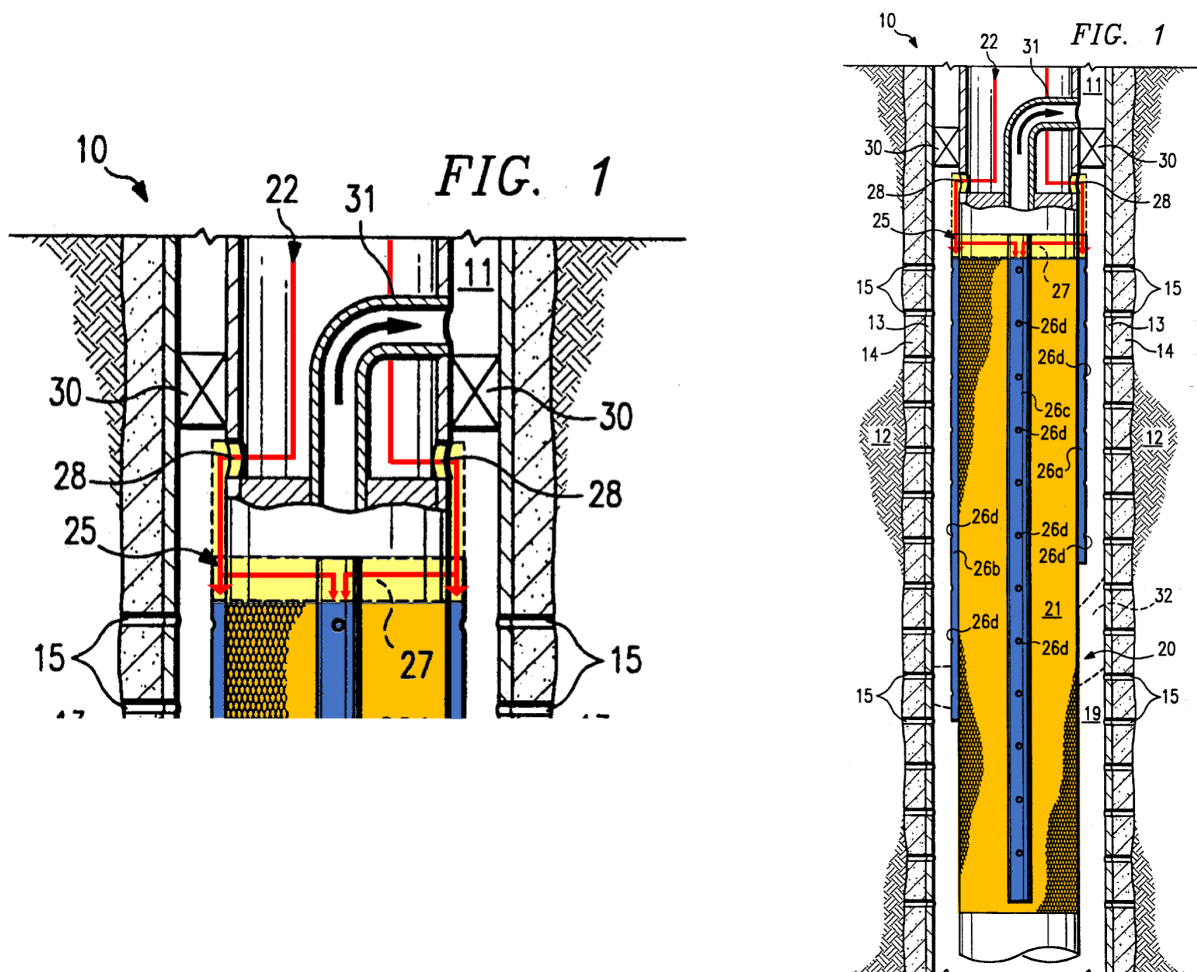
Conduits 28 (dark blue) were outside the sand screen 18. EX1007, 3:55-58; EX1003 ¶64. The conduits permitted gravel slurry flow through and out their perforations 30 into the annulus 20. EX1007, 3:60-67; EX1003 ¶64. “Although the conduit 28 may be made of any pressure-resistant material, it is preferably to be made of stainless steel.” EX1007, 4:11-13; EX1003 ¶172. Jones also disclosed

pumping gravel slurry “only through the conduit 28” rather than using conduits as a backup to the primary annulus path. EX1007, 5:38-44, Fig. 3; EX1003 ¶¶89-90.

4. U.S. Patent No. 5,113,935 (“Jones2” or “’935 Patent”) (EX1008)

Jones2, filed in 1991 and entitled *Gravel Packing of Wells*, was co-invented by Jones and Yeh and assigned to Mobil. EX1008, 1.

Figure 1 (below) illustrated conduits 26a-c (**dark blue**) outside sand screen 21 (**orange**). EX1008, 3:58-61. In the closed configuration, the conduits were connected using manifold 27 (**yellow**) and directly connected to outlet ports 28 (**yellow**) in the crossover sub 22. EX1008, Fig. 1, 4:1-9; EX1003 ¶106. In this configuration, the gravel slurry (**red arrows**) is pumped through outlet ports 28, into manifold 27, through conduits 26a-c, and into annulus 19 via perforations 26d. EX1008, 3:58-61; EX1003 ¶106.



EX1008, Fig.1.

5. U.S. Patent No. 7,661,476 (“’476 Patent”) (EX1010)

The ’476 Patent, effectively filed in 2006 and entitled *Gravel Packing Methods*, was co-invented by Yeh, Haeberle, Barry, Hecker, and Long and assigned to ExxonMobil. EX1010, 1; EX1003 ¶72. The ’476 Patent’s co-inventors, Yeh, Barry, and Hecker, were also co-inventors of primary reference Yeh. *Id.*; EX1005, 1.

The '476 Patent improved on previous APT disclosures (illustrated in Figure 2 (below)). EX1003 ¶125; *see also id.* ¶¶ 126-29, 134-37, 143.

Figure 2 depicted sand control devices 200a, 200b joined via base pipe 202 (dark gray) with each surrounded by a sand screen 204 (orange). EX1010, 7:23-27; EX1003 ¶126. Packing tubes 208a (light blue) and transport tubes 208b (blue) were disposed about each sand screen 204. EX1010, 7:31-35; EX1003 ¶126. The packing tubes 208a had nozzles 212 for injecting gravel slurry into the annulus. EX1010, 7:35-38; EX1003 ¶126.

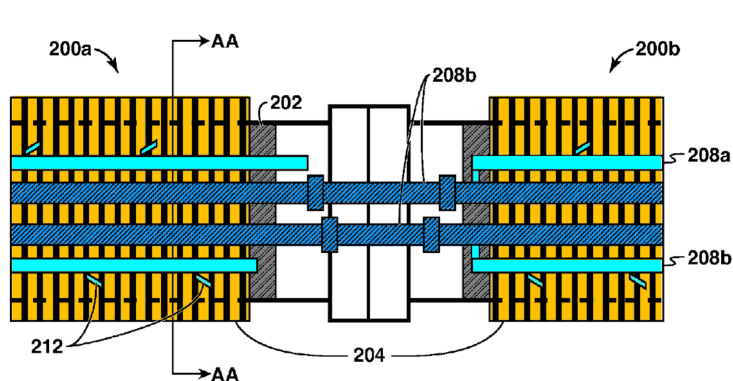


FIG. 2A
Prior Art

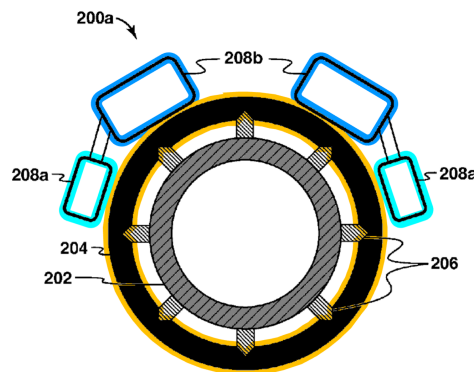


FIG. 2B
Prior Art

EX1010, Figs. 2A, 2B; EX1003 ¶126.

6. Yeh (EX1005)

Yeh (U.S. Patent No. 9,797,226), filed November 17, 2011 and entitled *Crossover Joint for Connecting Eccentric Flow Paths to Concentric Flow Paths*, co-invented by Yeh, Barry, Hecker, Moffett, Entchev, and Hyde and assigned to ExxonMobil, described a sand control system for gravel packing. EX1005, 1:17-20, 4:25-30, 9:5-9:21, 30:13-16; EX1003 ¶¶178, 211. Figure 2 (right) illustrated sand control devices 200 installed in production intervals 112, 114, and 116 of wellbore 100. EX1005, Fig. 2, 11:9-11, 11:53-56; EX1003 ¶¶212-14. The sand screen included a base pipe 205 (**dark gray**) with a filter medium 207 (**orange**). EX1005, 4:44-46, 9:11, 11:17; EX1003 ¶214. Packers 212, 214, and 216 (**green**) isolated intervals 112, 114, and 116. EX1005, 11:66-12:2, 12:62-65, 13:13-15; EX1003 ¶214. The sand screens also included at least one shunt tube. EX1005, 4:46-47; EX1003 ¶214.

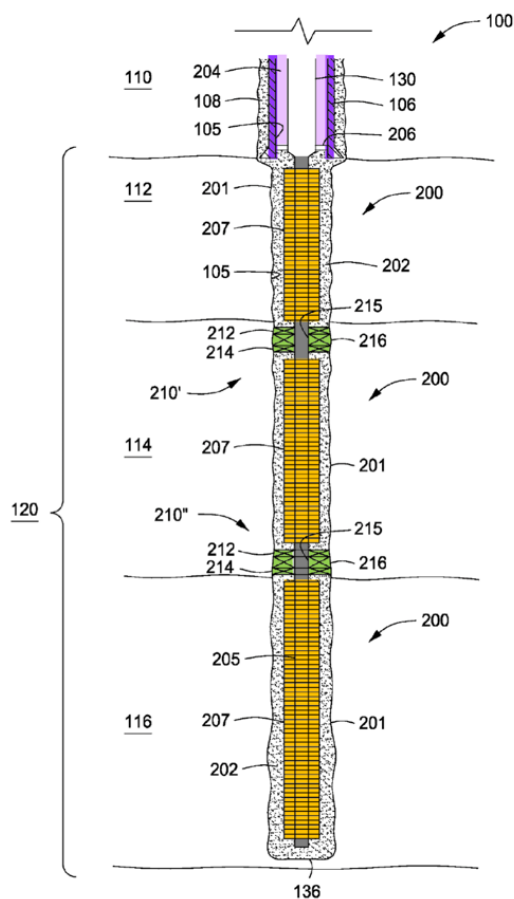
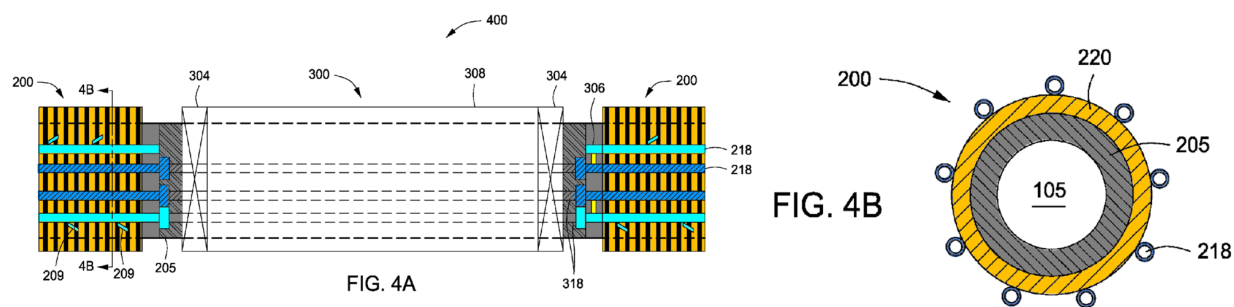


FIG. 2

a) Yeh's Sand Screen Assembly

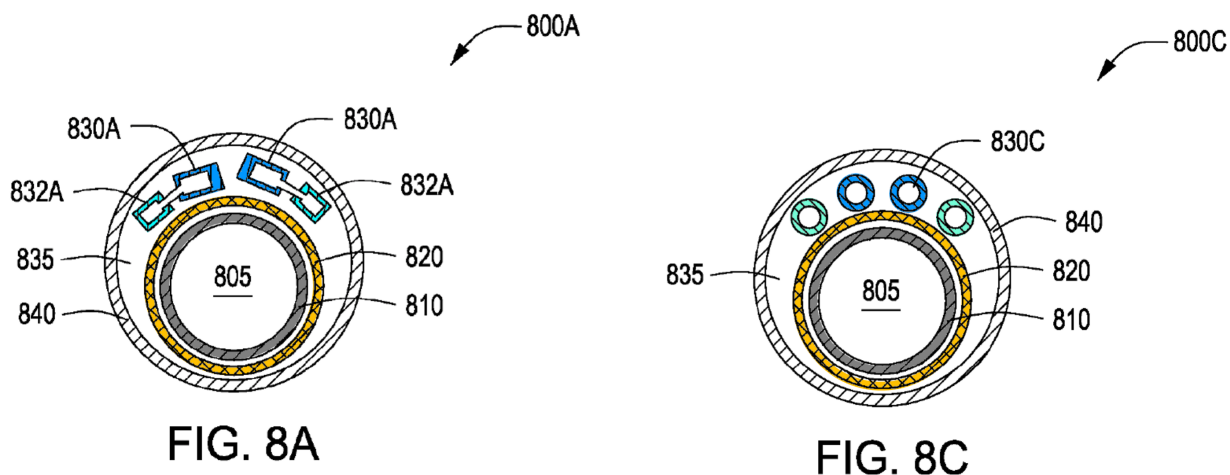
Figures 4A and 4B illustrated a packer between two sand screens. EX1005, 15:53-58, 16:1-4; EX1003 ¶218. One end of each base pipe 205 (dark gray) was connected to the packer base pipe 302. EX1005, 15:23-32, 15:55-58; EX1003 ¶218. The outer mesh 220 (orange) was disposed about the perforated base pipe 205. EX1005, 16:4-12; EX1003 ¶218. The packer shunt tubes 318 were connected to the sand screen shunt tubes 218 (blue, Figure 4A). EX1005, 15:58-60; EX1003 ¶218. Packing tubes 218 (light blue, Figure 4A) had nozzles 209 to allow gravel slurry flow to the annulus. EX1005, 15:60-64; EX1003 ¶218. Transport tubes 218 (blue, Figure 4A) did not have nozzles but were connected to packing tubes 218 (yellow). See EX1005, 15:60-64, 24:26-28; EX1003 ¶218. Figure 4's sand screen was concentric, meaning the base pipe 205 and shunt tubes 218 had a common center line. EX1003 ¶218.



EX1005, Figs. 4A, 4B.

Yeh also disclosed eccentric shunt tubes like “FIG. 2B in U.S. Pat. No. 7,661,476” or sand control device 800A illustrated in Figure 8A. EX1005, 16:18-25, 24:15-29; EX1003 ¶218.

Figure 8A showed eccentric sand control device 800A with a base pipe 810 (dark gray) providing a primary flow path 805, a filter medium 820 (orange), transport tubes 830A (blue), and packing tubes 832A (light blue). EX1005, 24:1-8, 24:22-29, 24:53-54; EX1003 ¶219. Figure 8C showed an alternative eccentric sand screen with round shunt tubes 830C. EX1005, 24:48-50; EX1003 ¶220.



EX1005, Figs. 8A, 8C.

Yeh also disclosed a crossover joint 1000, illustrated in Figure 10, to connect first and second wellbore tools. EX1005, 26:41-44, Fig. 10; EX1003 ¶¶186-87. Figure 10 below showed the crossover joint 1000 with a primary flow path 1005 (dark gray) and secondary flow path 1020 (red). EX1005, 25:44-55; EX1003

¶¶186-87, 221. The first end 1012 is connected to an eccentric tool, and the second end 1014 is connected to a concentric tool. EX1005, 26:7-12, 26:16-21; EX1003 ¶¶187-88. The tools could be sand screens. EX1005, 30:13-14; EX1003 ¶188.

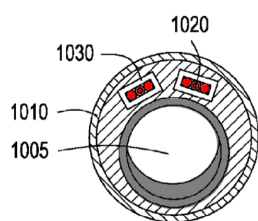


FIG. 10B

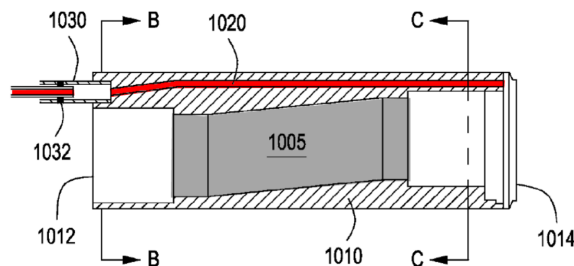


FIG. 10A

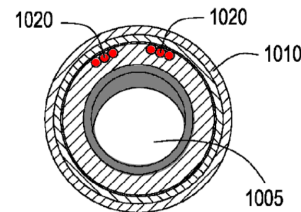


FIG. 10C

EX1005, Figs. 10A, 10B, 10C; EX1003 ¶¶185, 221.

b) Yeh's Fluid Dynamics Considerations

Yeh's crossover tool was specifically designed to permit transitioning from concentric screens (high pressure) to eccentric screens (low pressure): "concentric screen→crossover tool→eccentric screen." EX1005, 30:13-14; EX1003 ¶¶185, 222. Yeh understood that the shunt tube differential pressure was highest at the heel (upstream) and decreased toward the toe due to friction pressure drop. EX1005, 28:11-24 ("For example, a 6,500 psi differential pressure is expected near the heel of [sic] when gravel packing a 5,000-foot horizontal completion interval."); EX1003 ¶¶178, 222. As Yeh explained, "[t]he 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” EX1005, 30:20-25; EX1003 ¶¶185, 222.

7. Yeh2 (EX1006)

IPTC 12549 (“Yeh2”), published in 2008 and entitled *Unlocking the Limits of Extreme Length in Alternate Path Gravel Packing*, was co-authored by Yeh, Clingman, Dale, Moffett, Harrison, Barry, Hecker, and Haeberle who were affiliated with ExxonMobil. EX1006, 1; EX1003 ¶109.

Yeh2 described the history of APT beginning in the 1990s. EX1006, 2; EX1003 ¶109. Figure 1 illustrated how “shunt tubes divert slurry through distributed portholes to fill annular voids until a complete pack is placed.” *Id.*

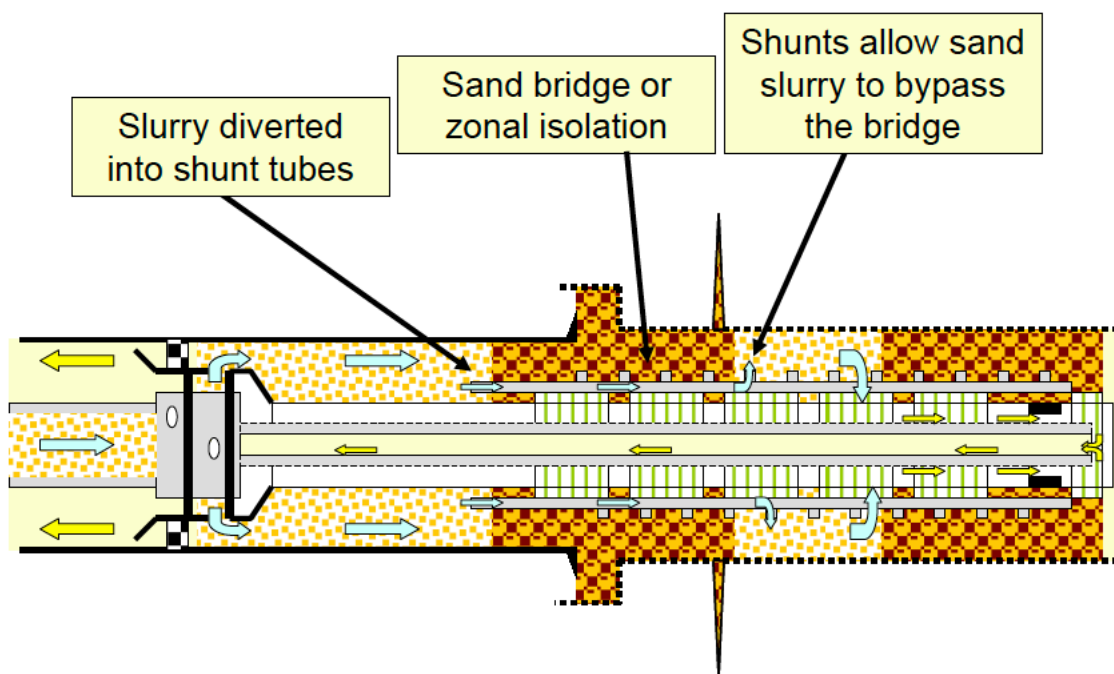


Figure 1 Alternate Path gravel packing with shunt tubes

EX1006, Fig. 1.

Yeh2 described a problem with shunt tubes plugging in extended intervals. EX1006, 2-3; EX1003 ¶110. To overcome this problem, Yeh2 suggested a manifold at the entrance of each shunt tube assembly and to “incorporate[] 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,” as shown in Figure 6a below. EX1006, 3.

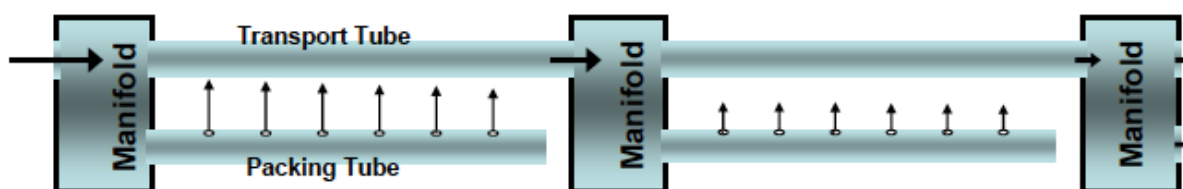


Figure 6a Shunt manifold system

EX1006, Fig. 6a. Yeh2 disclosed this shunt tube assembly was “field-proven” and successful in “hundreds of wells.” EX1006, 3; EX1003 ¶110. Yeh2 taught 6-foot nozzle spacing on packing tubes based on testing showing a nozzle could pack 8-10 feet of annulus. EX1006, 4; EX1003 ¶110.

Yeh2 also taught that distance to the first nozzle was important. As the annulus was packed, the adjacent packing tubes would also become internally gravel packed. EX1006, 3; EX1003 ¶¶197-98. The slurry would then bypass the packed packing tubes via the transport tubes and flow to downstream sections. EX1006, 3; EX1003 ¶109. But some carrier fluid would “leak-off” into those packing tubes and

the annulus and concentrate the slurry as it progressed. EX1006, 2; EX1003 ¶¶123-24, 196-97. In extreme length intervals, leak-off could permit gravel accumulation in the manifolds. EX1006, 5. Yeh2's Figure 14, below, illustrated how distance to the first nozzle was inversely proportional to leak-off rate.

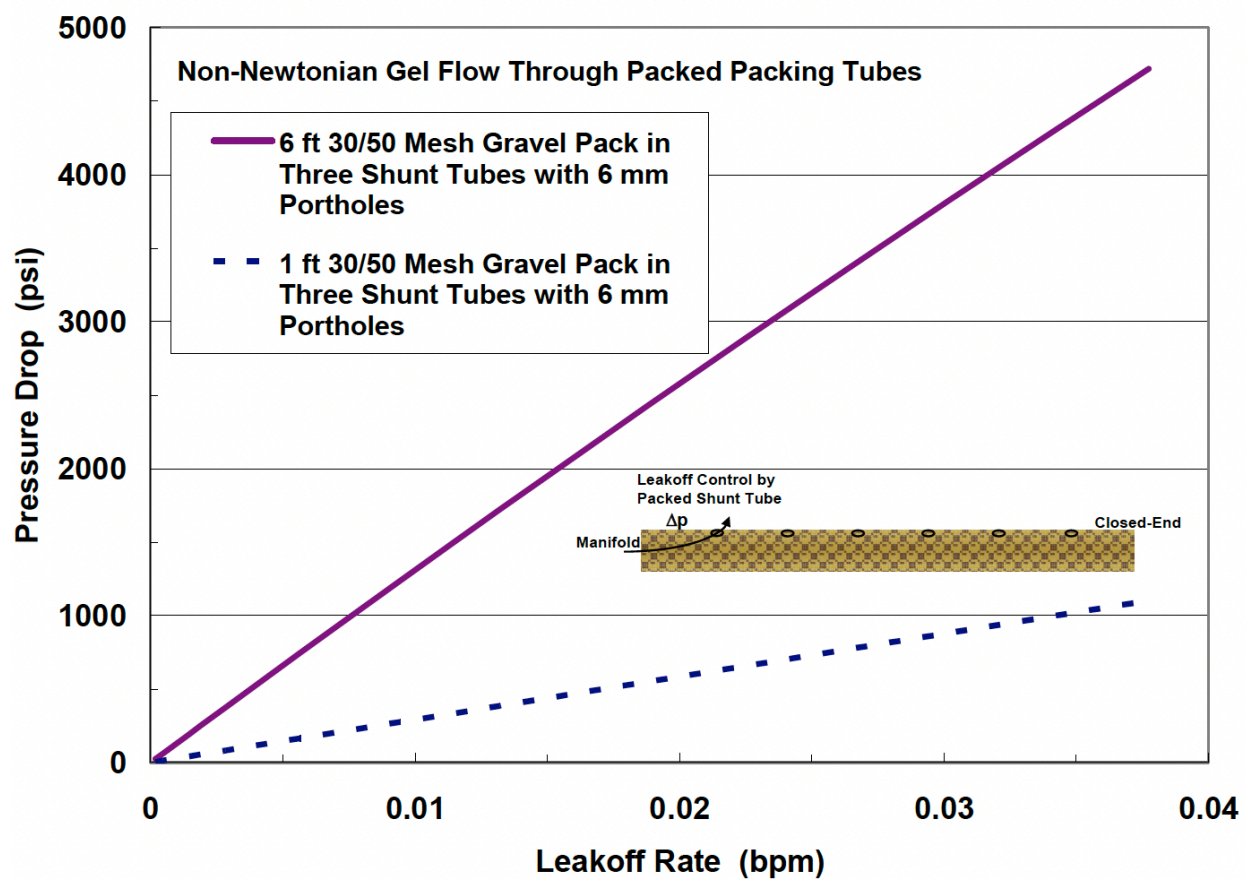


Figure 14 Leakoff through packed shunt tube

EX1006, Fig. 14; EX1003 ¶123.

Yeh2 also taught the parameters of a horizontal 5,000-foot sand screen installation, including shunt tube friction pressure drop (**blue line**), slurry

concentration (**orange line**), and slurry flow rate (**red line**) as slurry flowed from heel to toe. EX1006, 5, Fig. 15; EX1003 ¶¶124, 139-40, 190.

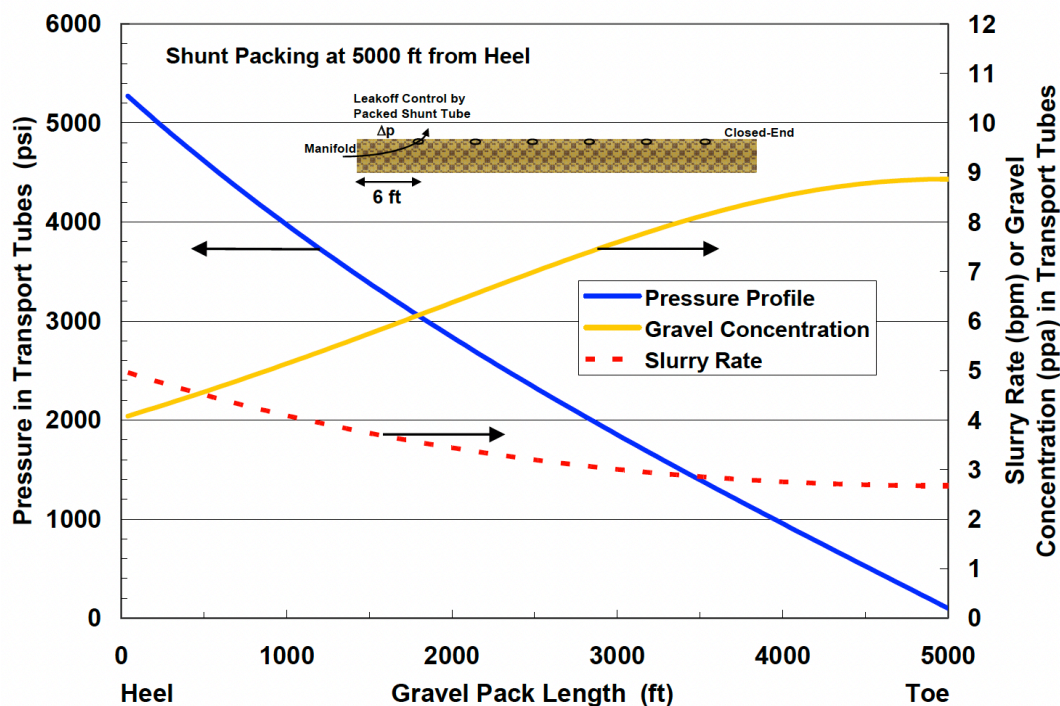


Figure 15 Gravel packing 5,000 ft with multiple-shunt manifold system

EX1006, Fig. 15.

8. Hurst (EX1013)

SPE 86532 ("Hurst"), entitled *Alternate Path Completions: A Critical Review and Lessons Learned from Case Histories with Recommended Practices for Deepwater Applications*, was published in 2004 and co-authored by Hurst, *et al.* EX1013, 1. Hurst provided a history of APT, including rationales for making improvements. *Id.*; EX1003 ¶¶101-02, 130-31, 150, 152, 204-05, 208-09.

9. Lagrone (EX1014)

SPE 530 (“Lagrone”), published in 1963 and entitled *A New Development in Completion Methods—The Limited Entry Technique*, disclosed the basic concept that flow rate through a hole in pipe (e.g., nozzle) is proportional to the pressure drop across the hole. EX1014, 695. Lagrone’s Figure 3, below, illustrated this relationship across 3/8" and 1/2" holes. *Id.*, 696.

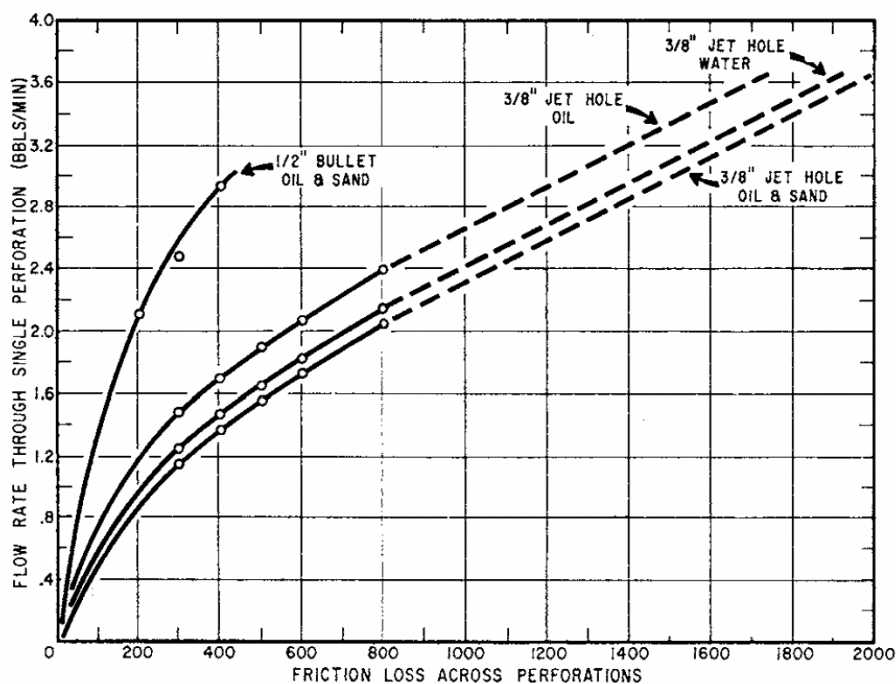


Fig. 3—Flow rate vs friction loss, laboratory measured (courtesy of The Halliburton Co.).

EX1014, Fig. 3; EX1003 ¶¶303-04.

10. Hecker (EX1015)

SPE 135102 (“Hecker”), published in 2010 and entitled *Extending Openhole Gravel Packing Capability: Initial Field Installation of Internal Shunt Alternate*

Path Technology, was co-authored by Hecker and Yeh, *et al.* EX1015, 1. Hecker described improvements to the “current eccentric 2×2 APT screens.” *Id.*, 1; EX1003 ¶¶118-20, 130. Hecker explained that the 2×2 eccentric system allowed for gravel packing wells up to 3,200 feet in length with the limitation being “limit[ing] the shunt friction pressure to 3,000 psi to maintain reliability in the shunt packing system.” EX1015, 2; EX1003 ¶132.

11. Bonner (EX1016)

SPE-169440 (“Bonner”), published in 2014 and entitled *Design and Validation of an Improved Shunt Tube System*, was co-authored by A. Bonner, *et al.*, who were affiliated with Patent Owner Halliburton. EX1016, 1. Bonner disclosed a shunt tube system designed to be “functionally the same as existing industry-proven designs, in order to enjoy the empirical evidence of years of successful application of shunt tube gravel-packing technology.” EX1016, 2; EX1003 ¶¶153-54.

Bonner used the “well known” 2×2 eccentric configuration. EX1016, 3, Fig. 5; EX1003 ¶155. Bonner’s Figure 5 (right) is the same as the ’007 Patent’s Figure 4A, shown above. EX1016, Fig. 5; EX1001, Fig. 4A.

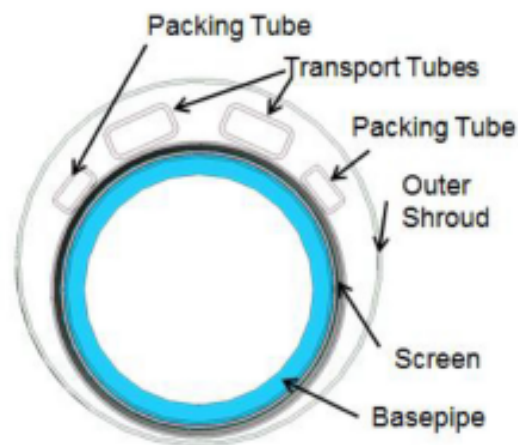
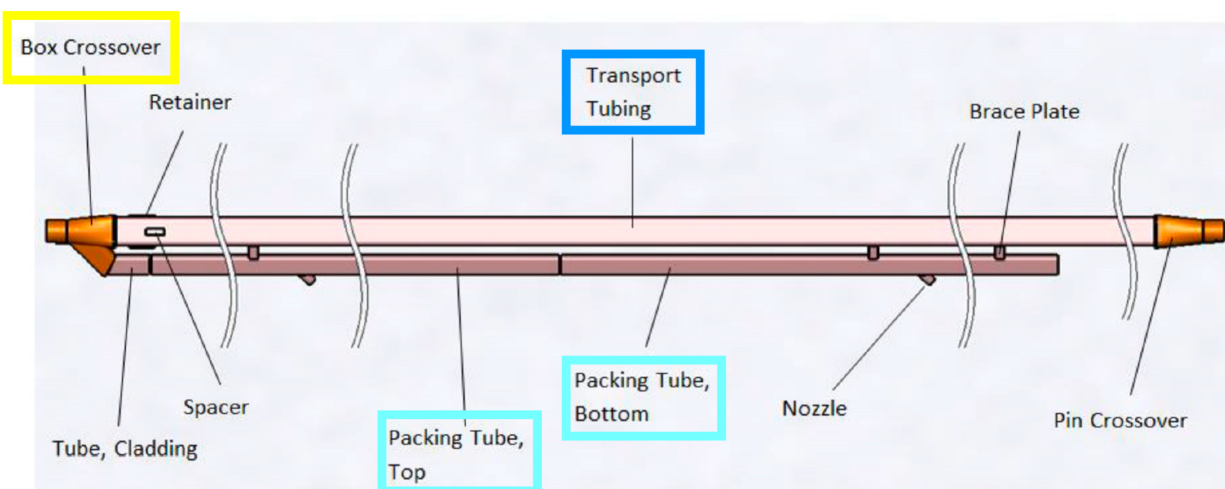


Figure 5—Cross section of shunt tube system

Figure 8 illustrated a side view, wherein a box crossover (yellow box) connected a transport tube (blue box) to a packing tube (light blue box) that had nozzles.

EX1016, 3, Fig. 8; EX1003 ¶156.



EX1016, Fig. 8.

E. Knowledge of a Skilled Artisan

Given ExxonMobil's research, a skilled artisan considering a problem in the gravel-packing area had a wealth of research to consider in June 2018. In addition to the published art, one of skill also had background engineering knowledge and resources. For example, practitioners in the industry relied upon standards providing guidance on engineering concepts and data, such as the American Petroleum Institute ("API") and ASTM International. EX1003 ¶228.

API published Technical Report 5C3 in December 2008 with an Addendum in October 2015. EX1017; EX1003 ¶229. The report described calculations for

tubing including burst pressure. The yield pressure is calculated using the “Barlow Equation,” which is $P = 2fkt/D$ where P is yield pressure; f is the minimum yield of the tubing material; k is generally 0.875; t is tubing wall thickness; and D is tubing outside diameter. EX1017, 19. A skilled artisan understood from this equation that for a given material (with given f), yield pressure is directly proportional to tubing wall thickness and inversely proportional to outside diameter. When considering design changes for tubing, there were only a few available options to consider. EX1003 ¶¶230, 232-35. Burst pressure had a similar equation (Equation 14) that was largely the same as Barlow’s Equation but used tensile strength and added correction factors. EX1003 ¶¶234-35 (citing EX1017, 24).

Additionally, a skilled artisan would have ready access to ASTM published standards, such as A554-16, which was published in March 2016, EX1018, 1, and provided tensile strengths for various stainless steels, *id.*, Table S2.1, 7; EX1003 ¶231.

F. Claim Construction

Petitioner believes no limitations require explicit construction for the claims to be found unpatentable. EX1003 ¶¶41-42.

III. GROUNDS AND PRIOR ART PRESENTED

Petitioner requests review and cancellation of claims 1-12 and 14-23 under 35 U.S.C. § 103.

Weatherford U.S. v. Halliburton
Patent No. 11,333,007 – IPR Petition

Ground	Challenged Claim(s)	Ground
1	1-12	Yeh optionally in view of Yeh2
2	14-20	Yeh in view of Yeh2 and optionally Jones2
3	21-22	Yeh in view of Jones
4	23	Yeh in view of Jones and Yeh2

- Yeh is prior art under 35 U.S.C. § 102(a)(1) and (2) (AIA) because it was effectively filed in December 2010, was actually filed November 17, 2011, and issued on October 24, 2017 before the earliest June 22, 2018 priority date claimed in Halliburton’s ’007 Patent. EX1005; EX1001.
- Yeh2 is prior art under 35 U.S.C. § 102(a)(1) (AIA) because it published in 2008 (EX1019 ¶10) before June 22, 2018. EX1006; EX1001.
- The ’476 Patent is prior art under 35 U.S.C. § 102(a)(1) and (2) (AIA) because it was effectively filed in November 2006, was actually filed on November 9, 2007, was published on June 5, 2008, and issued on February 16, 2010 before June 22, 2018. EX1010; EX1001.
- Hurst is prior art under 35 U.S.C. § 102(a)(1) (AIA) because it published in February 2004 (EX1019 ¶8) before June 22, 2018. EX1013; EX1001.
- Lagrone is prior art under 35 U.S.C. § 102(a)(1) (AIA) because it published in July 1963 (EX1019 ¶7) before June 22, 2018. EX1014; EX1001.

- Hecker is prior art under 35 U.S.C. § 102(a)(1) (AIA) because it published in September 2010 (EX1019 ¶9) before June 22, 2018. EX1015; EX1001.
- Jones2 is prior art under 35 U.S.C. § 102(a)(1) and (2) (AIA) because it was effectively filed in May 1991 and issued on May 19, 1992 before June 22, 2018. EX1008; EX1001.
- The '487 Patent is prior art under 35 U.S.C. § 102(a)(1) and (2) (AIA) because it was effectively filed in September 1995 and issued December 31, 1996 before June 22, 2018. EX1012; EX1001.
- Jones is prior art under 35 U.S.C. § 102(a)(1) and (2) (AIA) because it was effectively filed in August 1989 and issued August 7, 1990 before June 22, 2018. EX1007; EX1001.
- Bonner is prior art under 35 U.S.C. § 102(a)(1) (AIA) because it published in May 2014 (EX1019 ¶¶13-14) before June 22, 2018. EX1016; EX1001.

IV. LEVEL OF SKILL AND KNOWLEDGE OF POSITA

At the time of the alleged invention in 2018, 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.

EX1003 ¶¶36-40.

V. GROUND 1

A. Claim 1

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

Claim 1 would have been obvious over Yeh optionally in view of Yeh2. Yeh disclosed or suggested each of the limitations in claim 1. *See* § II.D.6. To the extent required, one of skill would have looked to Yeh2 because Yeh2 describes the same APT system as Yeh in the same 5,000-foot horizontal wellbore, except that Yeh taught combining concentric and eccentric screens for that example. *See* EX1005, 3:8-62 (describing Alternate Path® sand screen technology); EX1006, 1 (same). Yeh2 provided additional details regarding this example that one of skill could use in implementing the system and would have expected success because they describe the same system. EX1003 ¶256.

To the extent limiting, Yeh disclosed the preamble: “[T]he present invention relates to the *completion of wellbores using sand screens and gravel packs.*”

EX1005, 1:28-32;² EX1003 ¶¶256-59.

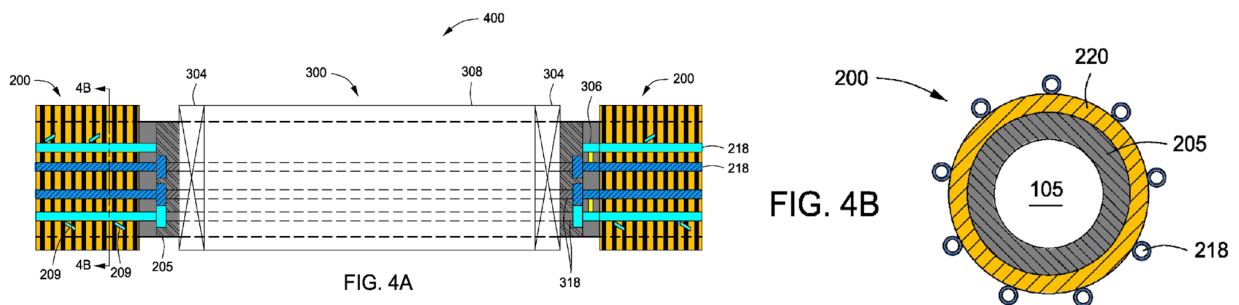
² All emphasis in this Petition is added unless otherwise noted.

2. **Claim 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;”**

Yeh disclosed this limitation. EX1003 ¶¶260-70.

Yeh taught that an example completion assembly can be “concentric screen → crossover tool → eccentric screen” wherein the crossover tool connects the primary and secondary flow paths of the sand screens. EX1005, 30:13-14, 25:41-65; EX1003 ¶¶262-63.

The “concentric screen” would be the first sand screen assembly. Yeh’s Figures 4A and 4B (below) depict a packer 300 with concentric screens 200 attached to both ends. EX1005, 15:53-54, 16:1-4; EX1003 ¶¶264-65; *supra* § II.D.6.a).



EX1005, Figs. 4A, 4B.

The screen 220 (**orange**) wraps around a portion of perforated base pipe 205 (**dark gray**). EX1005, 15:53-58, 16:1-12, Fig. 2 (showing partial coverage), Fig. 4A (same); EX1003 ¶266. The base pipe 205 has first and second ends as shown in Figures 1 and 2. EX1005, 11:11-12; EX1003 ¶268.

Shunt tubes 218 of Figures 4A and 4B—packing (**light blue**) and transport (**blue**)—are external to screen 220. EX1005, 16:38-39; EX1003 ¶¶269-70. Figure 4A showed Yeh’s “packing tubes” 218 have multiple “ports or nozzles” 209. EX1005, 15:60-64, Fig. 4A; EX1003 ¶269. Ports, nozzles, and tubes inherently have an internal cross-sectional area. EX1003 ¶269. Shunt tubes have a passageway with a cross-sectional area defined therein to permit flow as shown in Figure 4B. *Id.*; EX1005, 4:47-48 (“The shunt tube serves as an alternate flow channel.”), 4:53-56 (same).

3. **Claim 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;”**

Yeh disclosed or suggested this limitation. EX1003 ¶¶271-77.

In Yeh’s example, the “eccentric screen” is the second sand screen assembly. *See* EX1005, 30:13-14; EX1003 ¶272. Yeh’s Figure 8A below illustrates an

eccentric sand screen 800A, which is like the '007 Patent's Figure 4A. *Compare* EX1005, Fig. 8A *with* EX1001, Fig. 4A (below); EX1003 ¶273. Screen 800A includes base pipe 810, which has slotted openings. EX1005, 2:37-39, 2:57-61, 24:4-8; EX1003 ¶274. Yeh's sand screens are "joints," which are tubing lengths with first and second ends. EX1005, 3:60-62; EX1003 ¶274. Yeh's eccentric screen also "comprises a filter medium 820 [screen] around [a portion of] base pipe 810." EX1005, 24:6-8, Figs. 2, 4A; EX1003 ¶274.

The shunt tube assembly of screen 800A was outside screen 820 and included transport tubes 830A (blue) and packing tubes 832A (light blue) as were "known in the art." EX1005, 24:15-29; EX1003 ¶275; *see supra* § II.D.5. As noted in claim 1[a], "packing tubes" have "ports or nozzles," EX1005, 15:60-64, that are spaced apart and have a cross-sectional flow area, EX1005, Fig. 4A; EX1003 ¶275. Similarly, shunt tubes have a passageway with a cross-sectional area defined therein to permit flow as shown in Figure 8A. EX1003 ¶275; EX1005, 4:47-48, 4:53-56.

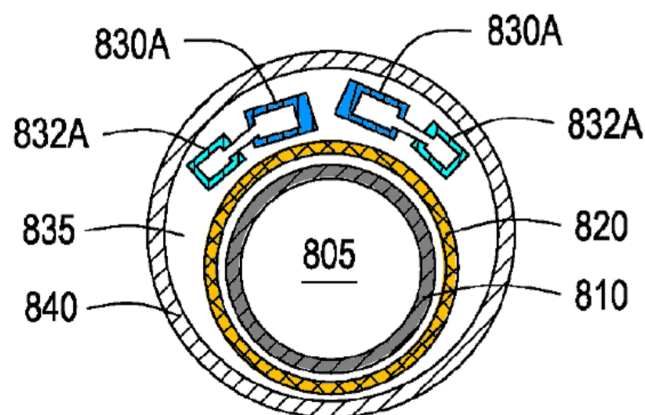


FIG. 8A

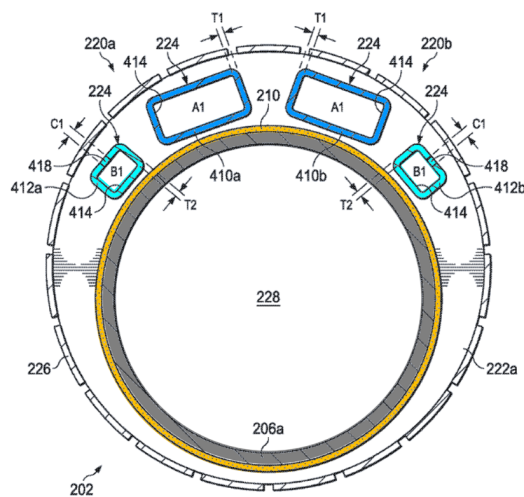


Fig. 4A

EX1005, Fig. 8A; EX1001, Fig. 4A.

Yeh disclosed that “[t]he alternate flow channels in the illustrative sand screens 800A, 800C are rectangular or round shunt tubes” EX1005 at 24:10-12; *see also id.*, 4:57-60; EX1003 ¶276. Yeh illustrated an eccentric screen with round shunt tubes in Figure 8C. EX1003 ¶276. Yeh also taught that eccentric screens use “packing tubes and transport tubes.” EX1005, 16:30-37; EX1003 ¶276, such that shunt tubes 830C would include packing (light blue) and transport tubes (blue). EX1003 ¶276.

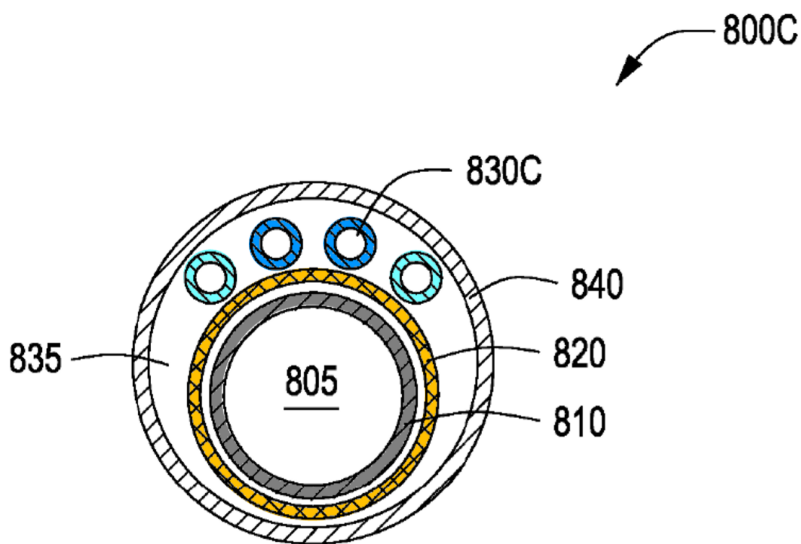


FIG. 8C

EX1005, Fig. 8C.

If Yeh hadn't disclosed packing and transport tubes in its round tube example, such use would have been obvious because Yeh explained that such use "in general is known in the art." EX1005, 24:26-28; EX1003 ¶277. Thus, a POSITA would have readily recognized the well-known efficiency of packing tubes distributing gravel slurry while transport tubes bypass the zone once gravel packing was complete as taught by Yeh and Bonner and would have expected success. EX1016, 2 (describing importance of using "industry-proven designs"); EX1003 ¶277.

4. **Claim 1[c]: “a source of pressurized working fluid fluidly coupled to an upstream end of the transport tube of the first sand screen assembly;”**

Yeh optionally in view of Yeh2 disclosed this limitation. EX1003 ¶¶278-84. The '487 Patent (EX1012), which is incorporated by reference in Yeh, disclosed a source of pressurized working fluid. EX1005, 3:12-18; EX1003 ¶279; *see supra* § II.D.2. Specifically, the '487 Patent taught pumping (*i.e.*, pressurizing) gravel slurry, which is a working fluid, EX1001, 4:11-14, into fluidly coupled sand screen shunt tubes and subsequently into the annulus. EX1012, 5:4-13; EX1003 ¶¶279-81; *see supra* § II.D.2. Thus, Yeh disclosed a pump as a source of pressurized working fluid.

Yeh2 confirms this understanding, explaining that “[g]ravel packing for sand control involves **pumping slurry** (gravel + carrier fluid) into a wellbore annulus” as shown in Figure 1 below. EX1006, 2; EX1003 ¶¶282-83.

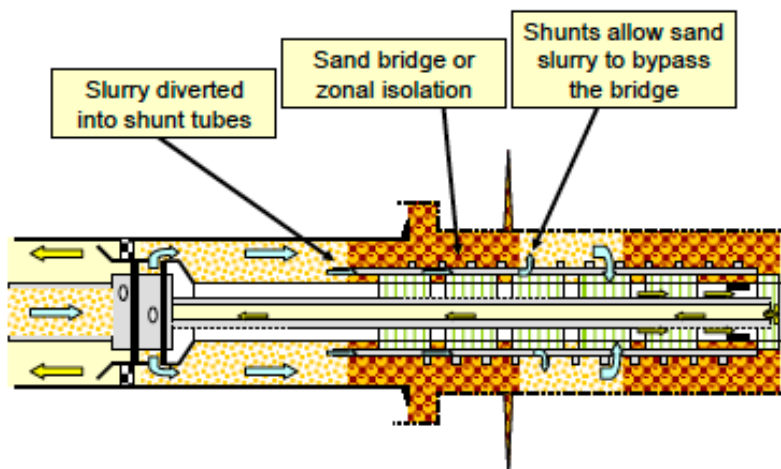


Figure 1 Alternate Path gravel packing with shunt tubes

EX1006, Fig. 1. Alternatively, it would have been obvious to combine Yeh2's pump with Yeh as explained in claim 1[preamble] because one of skill knew gravel slurry required a source of pressure. EX1003 ¶¶280-83.

Yeh additionally disclosed that APT “employs shunt tubes (or shunts) that allow the gravel slurry to bypass selected areas along a wellbore,” showing that the shunt tubes are fluidly coupled to the source of pressurized working fluid at the upstream end. EX1005, 3:9-12; *see also id.*, 4:47-53 (“The shunt tube serves as an alternate flow channel.”), 28:66-29:2; EX1012, 1:58-61 (Shunt tubes “receive gravel slurry as it enters the wellbore annulus.”); EX1003 ¶284.

5. **Claim 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”**

Yeh disclosed this limitation. EX1003 ¶¶285-89. First, as explained in claim 1[b], Yeh disclosed: “concentric screen → crossover tool → eccentric screen.” EX1005, 30:13-14; EX1003 ¶286. In this example, the concentric and eccentric screens are the first and second sand screen assemblies, respectively. EX1003 ¶286. As shown, the concentric and eccentric screens are arranged end-to-end separated by a crossover tool so that their respective base pipes and transport tubes are fluidly

connected. EX1003 ¶288. Thus, the gravel slurry flows from the concentric screen transport tubes (*see* claim 1[a]) as described above in claim 1[c] to the downstream eccentric screen transport and packing tubes (*see* claim 1[b])).

Crossover tool 1000's primary flow path 1005 (**dark gray**) and secondary flow path 1020 (**red**) are illustrated below:

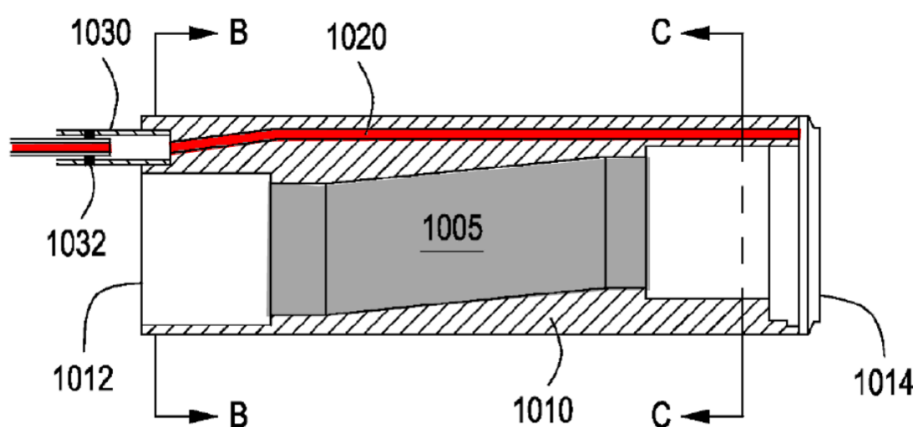


FIG. 10A

EX1005, Fig. 10A; *see also id.*, 25:46-55, 25:62-65, 26:42-47; EX1003 ¶287; *supra* § II.D.6.a). Yeh's crossover tool connects the primary and secondary flow paths of concentric and eccentric screens. EX1005, 30:13-14, 25:41-44, 26:35-56, 28:66-29:2, 30:51-67; EX1003 ¶¶287-89.

6. **Claim 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.”**

Yeh suggested this limitation. EX1003 ¶¶290-97. Yeh disclosed that concentric screen shunt tubes can contain higher pressure than eccentric screens. EX1005, 28:10-24. Specifically, “to maintain the mechanical integrity (that is, to stay within the burst, bending, and collapse ratings) of secondary flow paths, a certain surrounding wall thickness is required.” EX1005, 28:20-23; EX1003 ¶291. Yeh also disclosed that concentric screens should be placed at the heel, or higher-pressure side, of an interval; whereas, eccentric screens should be placed at the toe, or lower-pressure side. EX1005, 30:13-26; EX1003 ¶292.

On the high-pressure side, Yeh disclosed that the shunt tubes (including transport tubes) would have to contain a higher differential pressure, such as 6,500 psi near the heel in a 5,000-feet horizontal wellbore, than the shunt tubes in the lower-pressure side. *See* EX1005, 28:17-24, 30:16-20; EX1003 ¶292. One of skill understood that friction pressure drop through shunt tubes dictated this differential pressure. EX1005, 24:57-60; EX1006, 4 (“The number and size of shunt tubes must be within the acceptable range of the friction pressure loss and the overall dimensions of the screen assembly.”); EX1010, 23:41-51; EX1003 ¶296.

From Yeh’s express disclosure that a “certain surrounding wall thickness is required” “to stay within the burst, bending, and collapse ratings,” one of skill would have understood that a higher-pressure shunt tube assembly necessitated greater wall thickness. *See* EX1005, 28:20-23; EX1017, 24 (Equation (14) showing burst pressure roughly directly proportional to wall thickness); EX1003 ¶295. When looking to save cost toward the toe as taught by Yeh, one of skill knew from Equation (14) that to decrease burst pressure, there were only three options—weaker material (decrease f), thinner wall (decrease t), or greater diameter (increase D). *Id.* ¶294. One of skill would have found it obvious to decrease transport tube wall thickness toward the toe because doing so would save cost by using less metal in eccentric screens. *Id.* ¶293; *see also* EX1005, 30:20-26 (describing cost savings with eccentric screens).

Additionally, a skilled artisan understood that lesser wall thickness in transport tubes increased inside diameter and thus cross-sectional flow area resulting in lower friction pressure drop. *See* EX1005, 28:20-24 (increasing wall thickness increases pressure tolerance but decreases inside diameter); EX1003 ¶296. Lower friction pressure drop reduced the pressure requirement throughout the transport tubes from heel to toe, which further reduced cost by lowering burst pressure requirements in the concentric screens and extending potential gravel packing length. *See* EX1005, 24:54-60 (describing reduced friction pressure drop benefit of

eccentric screens); EX1006, 4 (“The friction loss in transport tubes and manifold limits the overall distance of shunt diversion.”); EX1003 ¶296. Indeed, Hurst (EX1013), specifically referenced by Yeh, EX1005, 3:26-33, confirms that “[f]or a given fluid composition and gravel concentration, *friction and thus the pressure applied to each zone can be controlled through the shunt tube dimensions (diameter and length)*” EX1013, 3-4; *see supra* § II.D.8.

Given the well-understood constraints on tubing wall thickness, one of skill would have expected success with reduced wall thickness in Yeh’s eccentric screens. EX1003 ¶¶294-97.

B. 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.”

Claim 2 would have been obvious over Yeh optionally in view of Yeh2 because claim 2 adds only routine optimization. EX1003 ¶¶298-307; *see* §§ II.D.6-II.D.7.

One of skill would have understood that (1) pressure decreased in shunt tubes along a horizontal interval from heel to toe as Yeh taught (claim 1[e]), EX1005, 30:15-26, and (2) that pressure drop affected selection of the nozzle cross-sectional flow area. EX1003 ¶299.

To ensure a complete gravel pack near the toe where slurry injection pressure was low, one of skill would have known to increase the cross-sectional flow area of the packing tube nozzles, the number of nozzles, or both. EX1003 ¶307. One of skill would have known that leak-off causes slurry dehydration as slurry is pumped down the horizontal zone, making slurry more viscous at the toe, which also reduces flow through ports or nozzles. EX1003 ¶300; *supra* § II.D.7. Yeh2's Figure 15 (below) illustrated this known pressure drop (**blue line**) and increase in gravel slurry concentration (**orange line**) from heel to toe. EX1006, Fig. 15; EX1003 ¶301; *supra* § II.D.7.

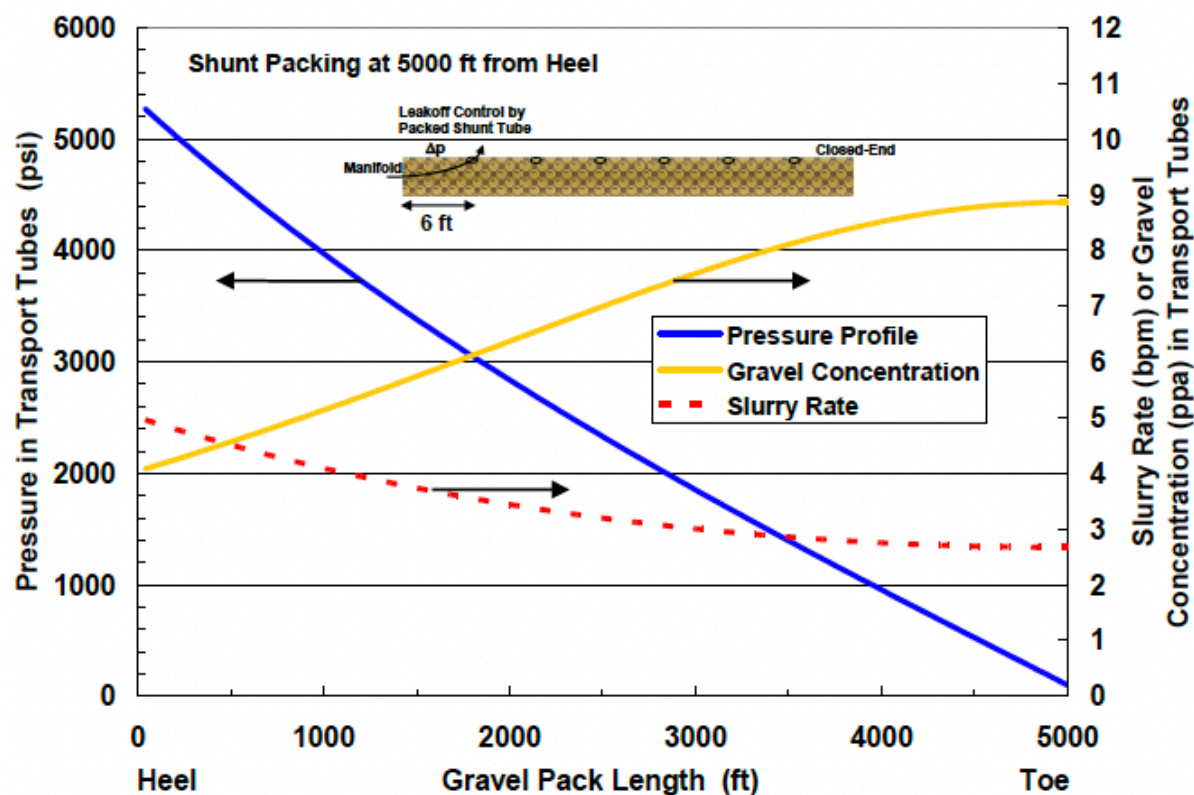


Figure 15 Gravel packing 5,000 ft with multiple-shunt manifold system

EX1006, Fig. 15.

Relatedly, Lagrone's Figure 3 shows that flow through a hole in the pipe is roughly directly proportional to the pressure drop (*i.e.*, driving force) across that hole. EX1014, Fig. 3 (showing flow proportional to pressure drop for a given hole size); EX1003 ¶¶303-04; *supra* § II.D.9.

Together, one of skill would have understood that with a constant nozzle size, flow through a nozzle located significantly downstream from the heel would be

significantly less due to the decreased pressure available. EX1003 ¶¶302-03. Yeh2 depicts this known effect in a figure with arrow size reflecting flow rate.

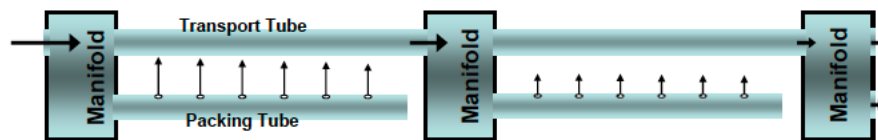
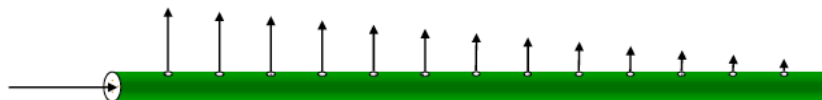


Figure 6a Shunt manifold system

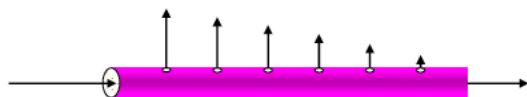
EX1006, Fig. 6a. Figure 7 demonstrates the same phenomenon:

1 bpm slurry flow through a 16 mm ID shunt tube with 6 ft porthole spacing

Case A Open-End Shunt with 6 mm Portholes over 80 ft Interval



Case B Open-End Shunt with 6 mm Portholes over 40 ft Interval



Case C Closed-End Shunt with 6 mm Portholes over 40 ft Interval

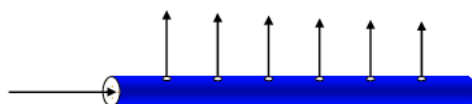


Figure 7 Flow diversion in a single shunt

Id., 4 (discussing Figure 7), Fig. 7.

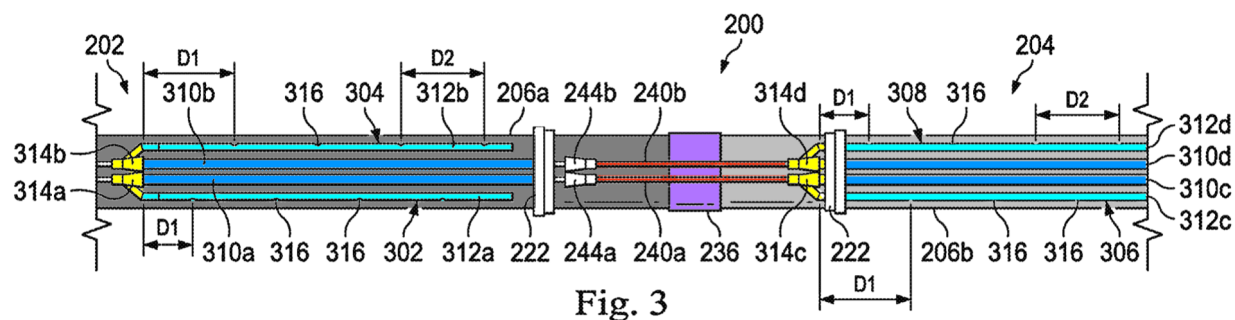
Thus, one of skill would have used a larger nozzle size closer to the toe to provide adequate slurry flow to offset decreased pressure and higher viscosity slurry. EX1003 ¶303. Indeed, Hurst (EX1013), which is referenced by Yeh, confirms this understanding: “For a given fluid composition and gravel concentration, *friction and*

thus the pressure applied to each zone can be controlled through ... the nozzle diameter and frequency.” EX1013, 3-4; EX1003 ¶306; *see also supra* § II.D.8.

C. 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 spaced apart from the junction block, wherein the distance 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.”

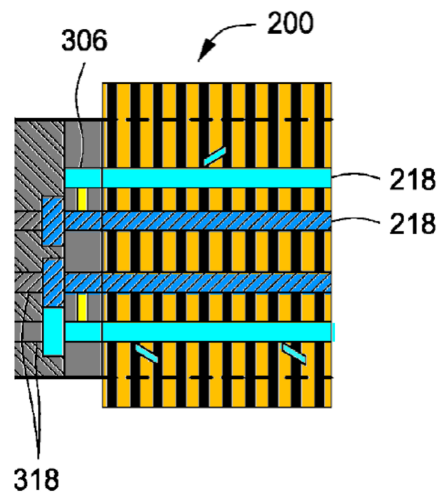
Claim 3 would have been obvious over Yeh in view of Yeh2 because it adds only routine optimization. EX1003 ¶¶308-22; *see* §§ II.D.6-II.D.7.

The “junction block” 314 in the ’007 Patent is shown in **yellow** in Figure 3 below, which is a manifold for distributing flow between the packing and transport tubes. EX1003 ¶309.



EX1001, Fig. 3, 6:47-51.

Yeh disclosed the junction block in Figure 4A in **yellow** below.



EX1005, Fig. 4A (cropped).

Yeh2 explained the need for a manifold at the entrance of each shunt tube assembly to distribute flow between transport and packing tubes as shown in Figure 6a. EX1006, 3; EX1003 ¶310; *see supra* § II.D.7.

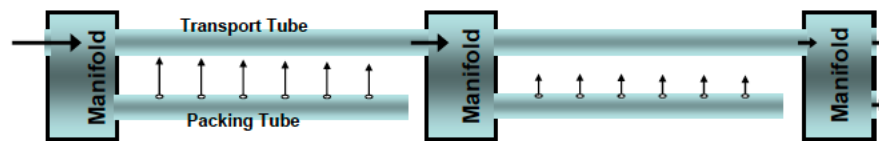


Figure 6a Shunt manifold system

EX1006, Fig. 6a.

One of skill would have been motivated to use a manifold as taught by Yeh and Yeh2 to gravel pack a long interval as taught by Yeh. EX1003 ¶311. One of skill would have understood that the manifold is a junction block from which the

transport tube and the packing tube extend and expected success as taught by Yeh2.
Id.

Yeh2 also explained how to optimize nozzle spacing for gravel packing long intervals. First, in long horizontal wells, “some fluid (gel) leaks off and is lost through the packing tubes into the annulus and screen” in previously packed zones as shown in Figure 6b below. EX1006, 5; EX1003 ¶313; *see supra* § II.D.7.

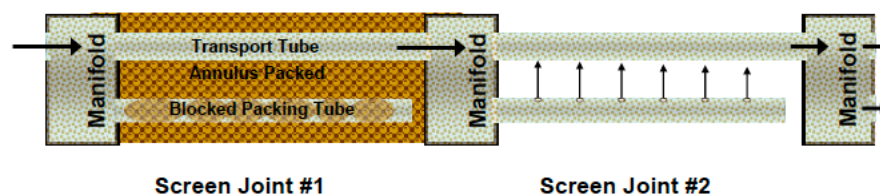
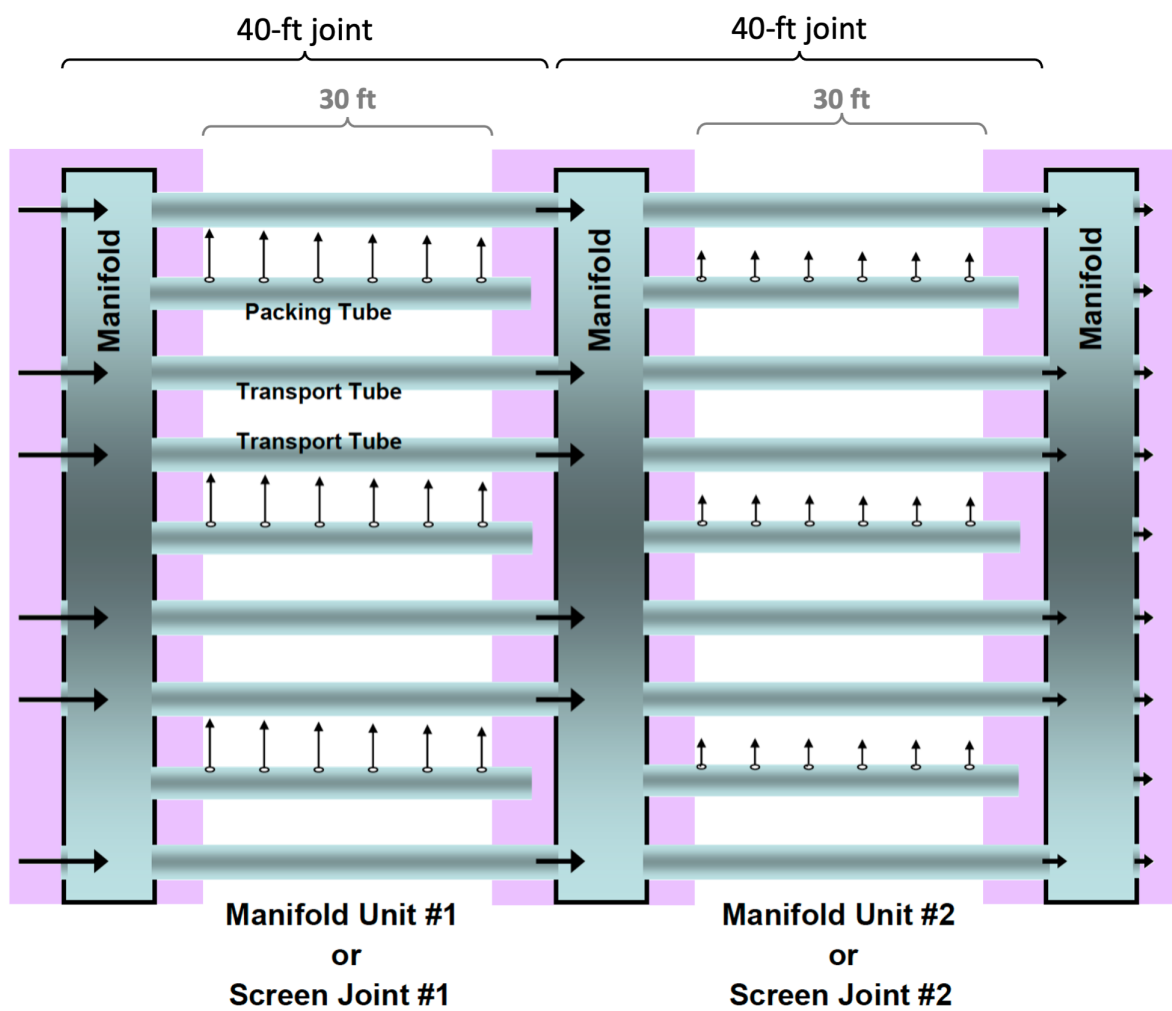


Figure 6b Shunt manifold system bypassing shunt plugging

EX1006, Fig. 6b.

Second, Yeh2 taught that leak-off can be reduced by increasing the distance of the first nozzle downstream of the manifold. EX1006, 5, Fig. 14; EX1003 ¶¶314-15; *see supra* § II.D.7. Also, nozzles cannot be spaced apart beyond the distance that a single nozzle can completely pack, which is 8-10 feet. EX1006, 4; EX1003 ¶110. Yeh2 further disclosed the Figure 9 design (below) for gravel packing extreme length intervals. EX1006, Fig. 9. However, one of skill understood that the six-foot nozzle spacing in Figure 9 would create a ten-foot-long gap (purple) around the manifold where gravel packing might not be complete. EX1003 ¶316.



EX1006, Fig. 9.

As the pressure drops toward the toe, both leak-off and gravel injection flow drop absent some geometric adjustment. EX1006, Fig. 15; EX1003 ¶317. Both factors would motivate a skilled artisan to shorten the distance between the manifold and the first nozzle in the packing tubes of the second sand screen assembly to shorten the 10-foot nozzle spacing and increase the likelihood of obtaining a

complete gravel pack around the manifold. EX1003 ¶¶317-21. Both factors would also suggest success to a skilled artisan. *Id.* ¶322.

D. Claim 4: “The completion assembly of claim 1, wherein the 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.”

Claim 4 would have been obvious over Yeh optionally in view of Yeh2 because it adds only routine optimization. EX1003 ¶¶323-26; *see* §§ II.D.6-II.D.7. Whether Yeh2 is viewed as knowledge of a POSITA or a combination because it taught the same system as Yeh with corresponding expectation of success, for all the reasons discussed in claim 2, it would have been obvious to use more nozzles in the packing tubes of the second sand screen assembly (*i.e.*, the eccentric screen) than the packing tubes of the first sand screen assembly (*i.e.*, the concentric screen). EX1003 ¶324.

The reduced pressure available for gravel packing toward the toe would have motivated one of skill to add more nozzles to the packing tubes to decrease the annular length that a nozzle must pack and to increase the cross-sectional area available for gravel packing slurry to enter the annulus. *See* EX1006, Fig. 15; *see also id.*, 5 (“Figure 15 shows the predicted pressure, rate, and gravel concentration profile in the shunt tubes over the 5,000 ft interval.”); EX1003 ¶325; *supra* § II.D.7. Hurst confirms a POSITA would know how to manipulate slurry flow using nozzle

frequency, explaining that “[f]or a given fluid composition and gravel concentration, *friction and thus the pressure applied to each zone can be controlled through* the shunt tube dimensions (diameter and length) as well as *the nozzle diameter and frequency.*” EX1013, 3-4; EX1003 ¶326; *see supra* § II.D.8.

E. 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.”

Claim 5 would have been obvious over Yeh optionally in view of Yeh2 because it adds only routine optimization. EX1003 ¶¶327-33. For all the reasons explained in claim 1[e], one of skill would have known that in the claim 1 example, the second transport tube would have a smaller wall thickness than the first transport tube. Although that can result in a larger inside diameter if the outside diameter is held constant, one of skill also understood that the outside diameter could be reduced while maintaining the same inside diameter. EX1003 ¶328. One of skill would have understood that this reduction in outside diameter would reduce material cost. Tubing is sold by weight of metal used to manufacture it. *Id.* Reducing the outside diameter to maintain the same inside diameter would reduce the metal needed to produce a same size cross-sectional flow path yet would have sufficient burst pressure rating to satisfy Yeh’s requirements. *Id.* ¶¶329-32.

Although this would sacrifice the potentially larger flow path, one of skill would have understood the benefits of such a tradeoff and would be motivated by

the cost savings to make the change, especially where the flow of slurry is decreasing toward the toe, resulting in less cross-sectional area needed for flow. EX1006, 5 (“Approximately 3 bpm (vs. 5 bpm at the heel) eventually gets down to the toe to fill the void.”); *see also id.*, Fig. 15; EX1013, 3-4 (“[F]riction ... can be controlled through the shunt tube dimensions (diameter and length) ...”); EX1003 ¶333.

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

Claim 6 would have been obvious over Yeh in view of Yeh2. EX1003 ¶¶334-40; *see* §§ II.D.6-II.D.7.

Yeh and Yeh2 disclose the “junction block” of claim 6 and its use in the apparatus of Yeh as discussed in claim 3. EX1003 ¶335.

Both the junction block 314 (yellow) and jumper tube 240 (red) are illustrated in Figure 3 from the ’007 Patent below. EX1003 ¶336.

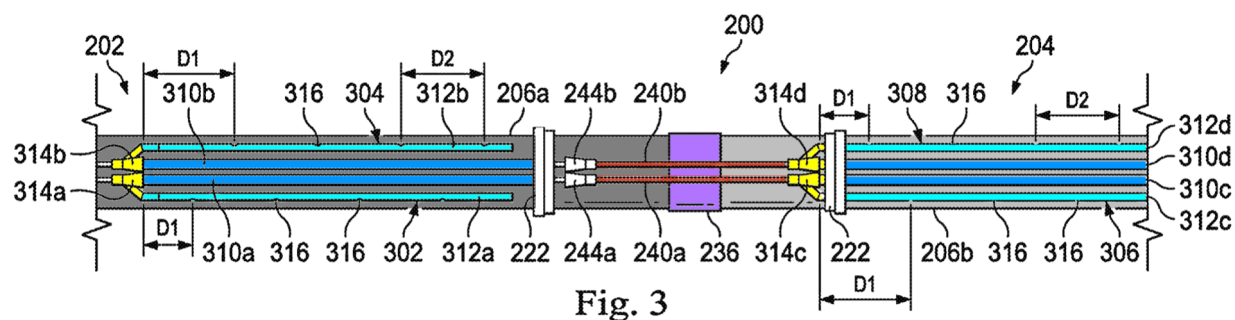


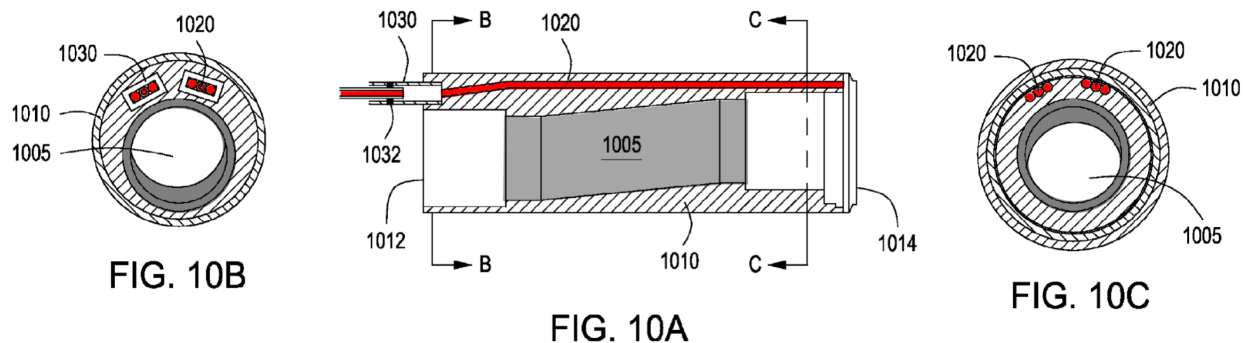
Fig. 3

EX1001, Fig. 3.

Claim 1 recites first and second ends of the base pipes of the first and second sand screen assemblies but does not specify which end (*i.e.*, upstream or downstream) constitutes the first or second end of the base pipes. *See* EX1001, 18:19-21, 18:30-32, 18:43-45.

Because Yeh disclosed connecting base pipes and shunt tubes of screens as follows: “concentric screen → crossover tool → eccentric screen,” EX1005, 30:13-14, it disclosed connecting the second end of the first sand screen assembly base pipe (*i.e.*, the downstream end) to the first end of the second sand screen assembly base pipe (*i.e.*, the upstream end) forming a joint therebetween, EX1003 ¶337.

Yeh’s secondary flow path 1020 (**red**) in Figures 10A-C below is a jumper tube that fluidly connects the secondary flow path of the sand screens and straddles the base pipe joint, and secondary flow path 1020 preferably “comprises a plurality of shunt tubes or a shunt annulus for carrying gravel slurry.” EX1005, 26:44-46; *see id.*, 25:56-26:21, 26:42-65; EX1003 ¶338; *supra* § II.D.6.a).



EX1005, Figs. 10A, 10B, 10C. Yeh disclosed that the “concentric wellbore tool [first sand screen assembly] may connect to the second end 1014 of the crossover joint 1000 ... through the use of a *coupling*.” *Id.*, 26:28-32. Thus, the secondary flow path 1020 would fluidly connect the transport tubes of the concentric screen and the manifold of the downstream eccentric screen leading to the packing and transport tubes of the eccentric screen. EX1003 ¶¶339-40; *see* EX1005, 28:66-29:2.

G. 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.”

Claim 7 would have been obvious over Yeh in view of Yeh2 because it adds only routine optimization. EX1003 ¶¶341-47.

First, Yeh disclosed an operating pressure of 6,500 psi in the shunt tubes of the first sand screen assembly near the heel, which is between “5000 psi and 10000 psi,” and the need for shunt tubes to withstand that pressure, which requires a corresponding pressure rating of 6,500 psi. EX1005, 28:10-24; EX1003 ¶342.

Second, Figure 15 of Yeh2 confirms Yeh’s disclosure in the same 5000-foot horizontal well described in Yeh. EX1006, Fig. 15; *see also id.*, 5; EX1003 ¶343; *supra* § II.D.7. Figure 15 shows that shunt tube operating pressure (**blue line**) at the heel is approximately 5,300 psi, requiring a pressure rating of at least that much. EX1006, 5 (“Transporting 5 bpm slurry at the heel through the shunt tubes to the toe void requires 5,300 psi. Burst strength of shunt tubes must therefore be capable of accommodating this high hydraulic pressure.”).

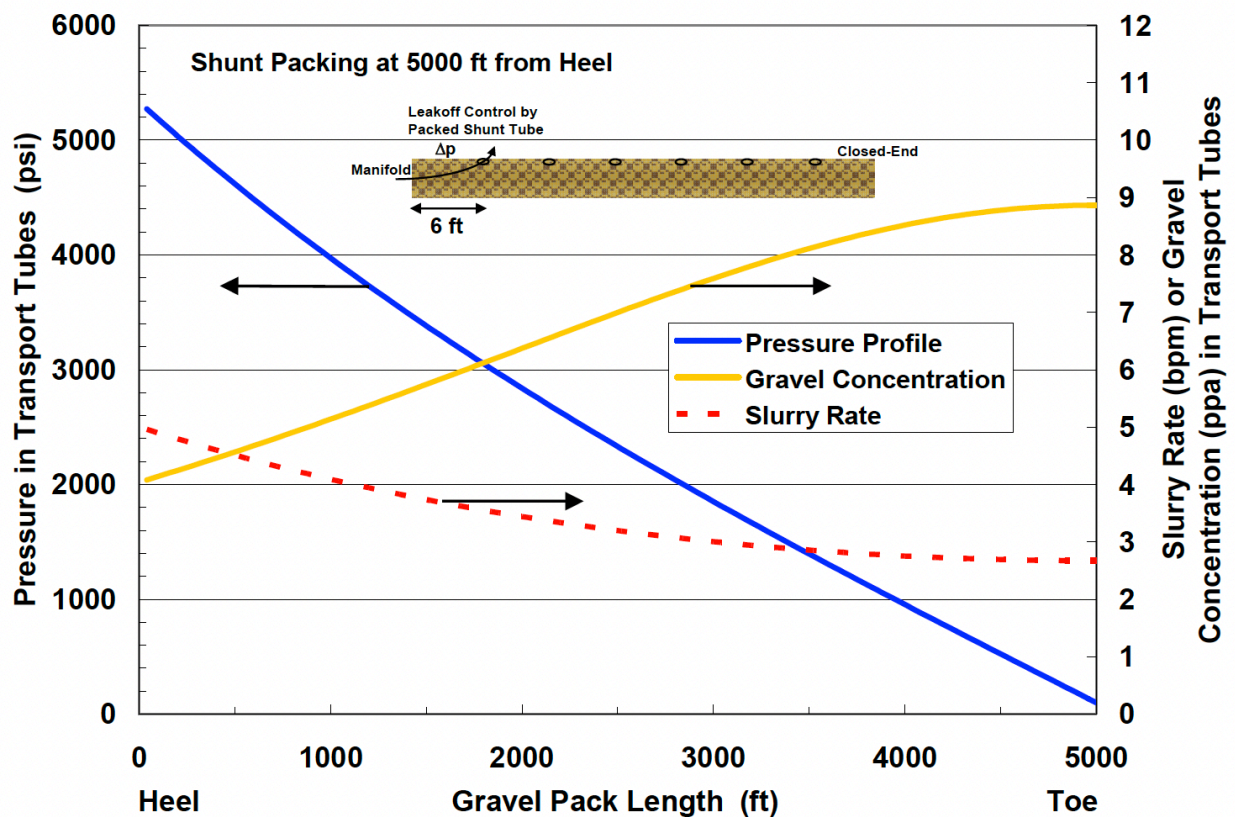


Figure 15 Gravel packing 5,000 ft with multiple-shunt manifold system

EX1006, Fig. 15. Thus, Yeh2 expressly teaches a burst pressure of 5,300 psi and confirms Yeh’s teaching of a pressure rating between “5000 psi and 10000 psi.” EX1003 ¶344.

Third, Yeh explained that concentric screens have a higher pressure rating than eccentric screens. EX1005, 30:15-26 (“[K]nown concentric screens are capable of gravel packing 5,000 feet, compared to 3,000 feet with the commercial eccentric screens.”), 30:44-45 (“The concentric round shunt tubes allow for higher fluid injection pressures.”); EX1003 ¶345.

Also, one of skill would understand from Yeh that eccentric screens operating at a lower pressure should have a lower pressure rating than the concentric screens and could estimate the pressure rating using Figure 15 from Yeh2. EX1003 ¶346. For example, shunt tubes in eccentric screens disposed toward the toe would operate at approximately 2,400 psi (2,500 feet from the heel or midway in Figure 15), which requires a corresponding pressure rating of 2,400 psi, which is “no more than 5000 psi.” *Id.* ¶347.

It would have been obvious to combine Yeh2’s pressure teachings with Yeh as explained in claim 1[preamble] because Yeh did not provide this detail regarding the 5,000-feet horizontal example. *Id.* ¶346. One of skill would have expected success because the pressure data relates to the same 5,000-feet horizontal well scenario taught by Yeh. *Id.* ¶347.

H. 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.”

Claim 8 would have been obvious over Yeh in view of Yeh2 because the combination discloses this aspect of the concentric sand screen as discussed in claim 7. EX1003 ¶¶348-350.

I. 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.”

Claim 9 would have been obvious over Yeh in view of Yeh2 for the same reasons as claim 7 because at a select threshold of 5,000 psi, for example, Yeh in view of Yeh2 disclosed and/or suggested this claim. EX1003 ¶¶351-52. Moreover, this limitation is satisfied for any select threshold between the pressure rating of the eccentric and concentric sand screen shunt tubes. *Id.* ¶352.

J. 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.”

Claim 10 would have been obvious over Yeh in view of Yeh2 for the same reasons discussed for claim 7. EX1003 ¶¶353-54. “Burst pressure” is a “pressure rating,” specifically the ability to hold internal pressure. EX1003 ¶354. Yeh’s reference to 6,500 psi differential pressure for concentric screens refers to the shunt

tube's ability to hold internal pressure, *i.e.*, its burst pressure rating. *See* EX1005, 28:17-24 (explaining that holding “a 6,500 psi differential pressure” requires a certain “wall thickness” to “stay within the burst” rating). Yeh2 confirms this understanding. EX1006, 5 (“***Burst strength*** of shunt tubes must therefore be capable of accommodating this [5,300 psi] hydraulic pressure.”).

K. Claim 11

1. Claim 11[preamble]: “A completion assembly for deployment in a wellbore, the completion assembly comprising:”

Claim 11 would have been obvious over Yeh in view of Yeh2. Yeh in view of Yeh2 disclosed or suggested each of the limitations in claim 11. EX1003 ¶¶355-56; *see* § II.D.6. One of skill would have looked to Yeh2 for data on Yeh's APT system as explained in claim 1[preamble].

To the extent limiting, Yeh disclosed the preamble. *See* claim 1[preamble].

2. Claim 11[a]: “a source of pressurized working fluid;”

Yeh disclosed this limitation for the same reasons discussed for claim 1[c]. EX1003 ¶357.

3. Claim 11[b]: “a first sand screen assembly attached to a second sand screen assembly,”

Yeh disclosed this limitation for the same reasons discussed for claim 1[d]. EX1003 ¶358.

4. **Claim 11[c]: “wherein the first sand screen assembly comprises a shunt tube assembly with a first burst pressure and the second sand screen assembly comprises a shunt tube assembly with a burst pressure less than the first burst pressure, and”**

Yeh in view of Yeh2 disclosed or suggested this limitation for the same reasons discussed in claims 1[e], 7, and 10. EX1003 ¶359.

5. **Claim 11[d]: “wherein the shunt tube assembly with the first burst pressure is fluidly coupled between the source of pressurized working fluid and the shunt tube assembly with the burst pressure less than the first burst pressure.”**

Yeh in view of Yeh2 disclosed or suggested this limitation. EX1003 ¶¶360-61.

As explained in claims 1[c] and 1[d], Yeh in view of Yeh2 disclosed a source of pressurized working fluid (pump) that is fluidly coupled to an upstream end of the shunt tubes of the first sand screen assembly (concentric screen). The shunt tube assembly with the burst pressure less than the first burst pressure (eccentric screen) is fluidly coupled downstream of the first sand screen assembly as explained in claim 1[d]. Thus, the concentric screen shunt tube assembly is between the slurry pump and the eccentric screen shunt tube assembly. *Id.* ¶361.

- L. Claim 12: “The completion assembly of claim 11, wherein the shunt tube assembly of the first sand screen assembly is disposed to operate at pressures between 5000 psi and 10000 psi and the shunt tube assembly of the second sand screen assembly is disposed to operate at pressures of no more than 5000 psi.”**

Claim 12 would have been obvious over Yeh in view of Yeh2 for the same reasons discussed in claim 7. EX1003 ¶¶362-64. Here, “disposed to operate” indicates an operating pressure rather than a pressure rating, which Yeh and Yeh2 disclosed as explained in claim 7. *Id.* ¶¶363-64.

VI. GROUND 2

A. Claim 14

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

Claim 14 would have been obvious over Yeh in view of Yeh2 and optionally Jones2. EX1003 ¶¶365-67. One of skill would have looked to Yeh2 as explained in claim 1[preamble]. *Id.* ¶366.

To the extent limiting, Yeh disclosed a method of installing a completion assembly in a wellbore. Yeh taught in Figure 12 steps “for completing a wellbore in a subsurface formation The method 1200 is applicable for the installation of wellbore tools having flow paths that do not align.” EX1005, 28:31-33, Fig. 12; EX1003 ¶367. The “wellbore tools” constitute a completion assembly. *E.g.*, EX1005, 30:13-14; EX1003 ¶214.

2. 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;”

Yeh disclosed or suggested this limitation. EX1003 ¶¶368-79.

First, as explained in claim 1[c], Yeh disclosed via the '487 Patent a pump as a source of pressurized working fluid (gravel slurry) delivered through a wellhead at the surface. EX1003 ¶369. Thus, all positional references are with respect to the surface, which is upstream from all production zones. *Id.* ¶¶215, 369.

Second, Yeh’s method applies to the completion assembly “concentric screen → crossover tool → eccentric screen.” EX1005, 30:13-14 (disclosing “[a]nother tool sequence for use with a crossover joint”); EX1003 ¶370. The crossover joint connects the primary and secondary flow paths of the completion assembly as discussed in claim 1[d]. EX1005, 25:41-65; EX1003 ¶370.

Third, Yeh’s method runs the completion assembly into “a *selected* subsurface location within the wellbore.” EX1005, 28:61-64; EX1003 ¶371. Then, fluid is injected through the secondary flow paths of the completion assembly. EX1005, 28:66-29:3; EX1003 ¶371.

Yeh disclosed that this completion assembly (concentric and eccentric screens) is used for gravel packing long intervals. EX1005, 30:13-17; EX1003, ¶372. One of skill understood that gravel packing is performed in production zones, such that this example involves a “long” (elongated) production zone. EX1005,

2:33-41, 2:55-61 (describing sand screens “as a part of the production string”); EX1003 ¶373. Because Yeh disclosed that this elongated production zone is “selected,” EX1005, 28:61-65, the production zone had to be identified. EX1003 ¶¶374-75.

Confirming this understanding, Yeh provided an example description of sand screens in open-hole portion 120 of wellbore 100, which has three subsurface intervals 112, 114, and 116, each of which may contain oil deposits. EX1005, 10:28-45; EX1003 ¶378. Each interval 112, 114, and 116 is a production zone, or they collectively constitute a production zone. EX1003 ¶378. Figure 2 (right) shows the “sand control devices 200 along each of the intervals 112, 114, 116” EX1005, Fig. 2, 11:59-60; EX1003 ¶378. The sand control devices are sand screen assemblies. EX1005, 11:9-25 (describing sand control devices having “a base pipe 205” and a “filter medium 207 [which] may

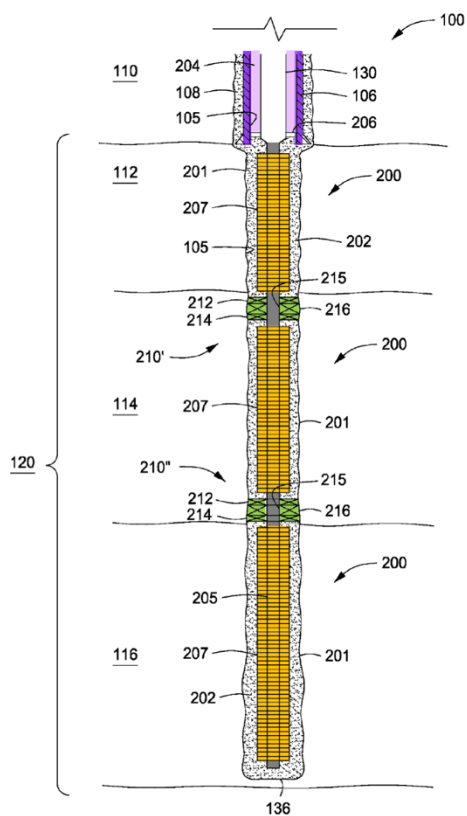


FIG. 2

be a wire mesh screen”); EX1003 ¶378. Thus, Yeh taught disposing sand screen assemblies throughout a producing zone from “upper interval 112” to “lower interval 116.” EX1003 ¶379. Figure 2 shows that each interval/zone has an upstream

proximal end (top in Figure 2) and a downstream distal end (bottom in Figure 2) with respect to the pump, as would be true of every producing zone in a wellbore. EX1003 ¶215.

Further, one of skill reading Yeh, including the '487 Patent, would understand that Yeh's horizontal 5,000-feet (elongated) production zone has an upstream proximal end at the heel and a downstream distal end at the toe. EX1005, 30:15-32 (calling this example "a horizontal completion"); EX1003 ¶¶374, 379.

3. 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;"

Yeh disclosed or suggested this limitation as explained in claim 1[e]. EX1003, ¶¶380-83.

Although "high pressure" is undefined, to the extent it has a meaning, it is relative to the shunt tube system selected for the distal end of the production zone. EX1003 ¶381. Yeh's concentric screen comprises the high-pressure shunt tube system. *Id.* ¶382.

One of skill would have known to determine the shunt tube system operating pressure throughout the production zone to select appropriate shunt tube systems based on Yeh's teaching that this was necessary and beneficial. EX1005, 28:10-24 (describing need to maintain "mechanical integrity"), 30:20-25; *see also* EX1006, 5

(“Burst strength of shunt tubes must therefore be capable of accommodating this high hydraulic pressure.”); EX1003 ¶383.

4. 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;”

Yeh disclosed or suggested this limitation for the reasons provided in claim 1[e] and 14[b]. EX1003 ¶¶384-88. Although undefined, “low pressure” in limitation 14[c] is only meaningful relative to the “high pressure shunt tube system” in limitation 14[b]. *Id.* ¶385. Yeh’s eccentric screen comprises the low-pressure shunt tube system. *Id.* ¶388.

Additionally, a skilled artisan understood that friction causes an almost linear pressure drop along a horizontal production zone as confirmed by the pressure profile (**blue line**) shown in Figure 15 of Yeh2. EX1006, Fig. 15; *see also id.*, 5; EX1003 ¶¶386-87; *supra* § II.D.7.

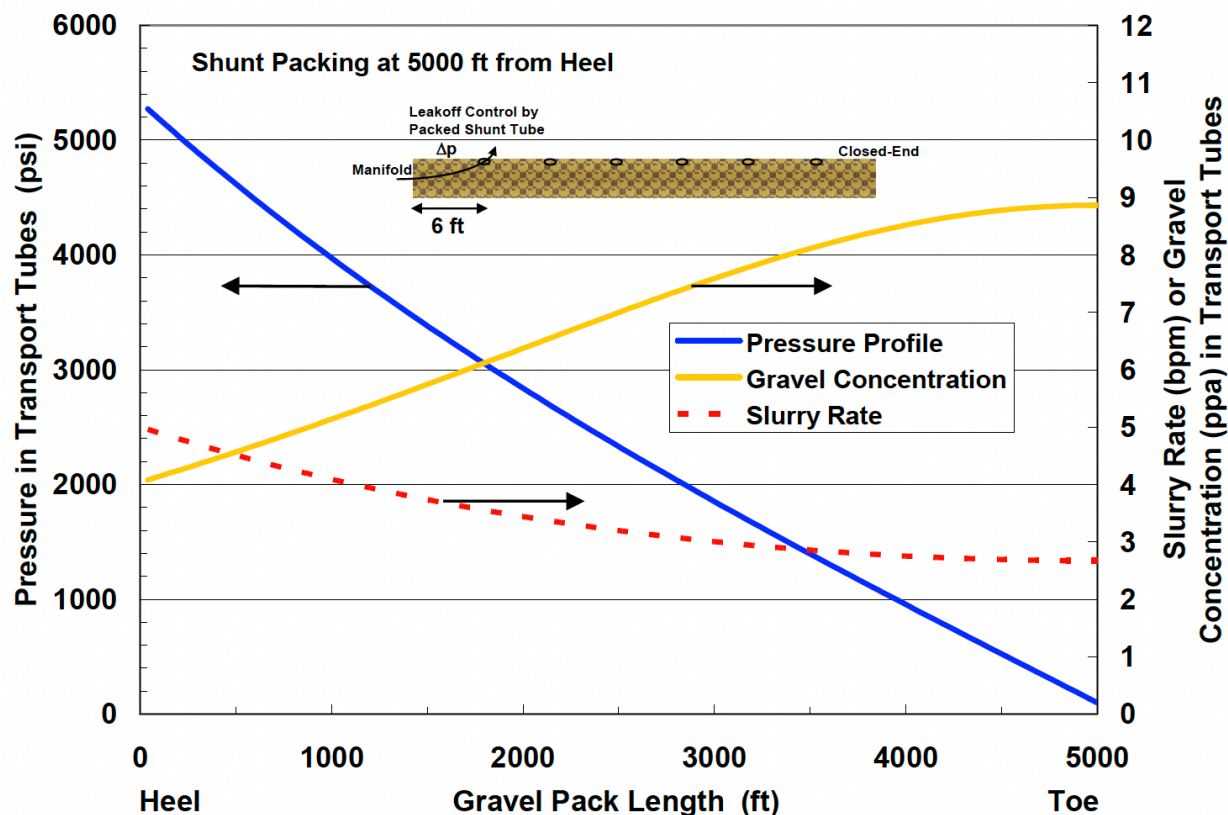


Figure 15 Gravel packing 5,000 ft with multiple-shunt manifold system

EX1006, Fig. 15.

Thus, one of skill would have implemented Yeh's teaching to use eccentric screens toward the toe at any point at which the slurry pressure dropped below the pressure capacity of the eccentric screen shunt tubes, which is about 3,000 feet from the toe. EX1005, 30:16-20; EX1003 ¶388. Figure 15 of Yeh2 shows this operating pressure to be about 2,800 psi at 3,000 feet from the toe (2,000 feet on the x-axis). EX1006, Fig. 15. And Hecker, specifically referenced in Yeh, EX1005, 3:34-44, confirms this understanding of a POSITA: "Maximum [current eccentric screen]

shunt system working pressure of 3,000 psi which limits the packable length to ~3,200 ft pumping at 5 barrels per minute (bpm),” EX1015, 1.

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

Yeh disclosed or suggested this limitation. EX1003 ¶¶389-92.

Yeh disclosed that in the example of claim 14[a] the method included running the completion assembly (concentric screen → crossover tool → eccentric screen) “to a selected subsurface location within the wellbore.” EX1005, 28:35-36, 28:61-63; EX1003 ¶¶390, 392. The selected location was a horizontal elongated production zone as explained in claim 14[a]. EX1003 ¶391.

Additionally, as discussed in claim 14[c], Yeh disclosed that the eccentric screens should be placed on the toe or distal end of the production zone. EX1005, 30:13-26; EX1003 ¶392.

6. 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,”

Yeh disclosed this limitation as explained in claims 14[a] and 14[b]. EX1003 ¶¶393-96. The second sand screen assembly is Yeh’s concentric screen, which is

disposed in the proximal upstream end of the elongated production zone (the heel) and has the high-pressure shunt tube system as explained in claims 1[e] and 14[b]. EX1003 ¶394. Yeh disclosed attaching the concentric screen to the eccentric screen as explained in claims 1[d] and 14[a]. EX1005, 28:40-41, 28:61-63, 30:13-14; EX1003 ¶395. Yeh's eccentric screen has the low-pressure shunt tube system as explained in claim 14[c]. *Id.*

Yeh's example, "concentric screen → crossover tool → eccentric screen," EX1005, 30:13-14, shows that the downstream end of the concentric screen shunt tube system is coupled to the upstream end of the eccentric screen shunt tube system. *See* EX1005, 28:48-60 ("the at least one secondary flow path of the first wellbore tool is in fluid communication with the at least one secondary flow path of the second wellbore tool"); EX1003 ¶395.

As explained in limitation 14[a], Yeh discloses the use of sand screens to avoid the production of sand, which causes erosion in production equipment. EX1005, 1:25-36. Thus, a POSITA understood that sand screens must be installed throughout the producing zone to avoid the production of sand and would have expected success. EX1003 ¶396.

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

Yeh in view of Yeh2 and optionally Jones2 disclosed this limitation, expressly or inherently. EX1003 ¶¶397-407.

First, Yeh explained that after running the tools to a selected location, “[f]luid is then injected into the wellbore. ... The method 1200 then includes further injecting the fluid from the wellbore and *through the secondary flow paths of the first wellbore tool*, the crossover joint, and the secondary flow paths for the second wellbore tool.” EX1005, 28:61-29:3; EX1003 ¶398. To inject fluid through the secondary flow paths of the first wellbore tool (concentric screens), the source of pressurized working fluid (pump) necessarily must be coupled upstream of the concentric screen shunt tube system because the shunt tubes are connected in series from that point throughout the downstream sand screen assemblies. EX1003 ¶399. Thus, the coupling is at least inherent in Yeh. Without such coupling, the shunt tubes would be inoperative and useless. And to the extent they are not “coupled” when initially installed, they would become coupled as soon as a sand bridge forms because it would force slurry through the shunt tubes. EX1005, 4:47-53; EX1003 ¶400.

A skilled artisan also would have known that the pump had to be coupled to the upstream end of the high-pressure shunt tube system to provide gravel slurry to that system. EX1003 ¶401.

For example, Yeh2 describes how gravel slurry is injected into shunt tubes at the entrance to a producing zone with reference to Figure 1

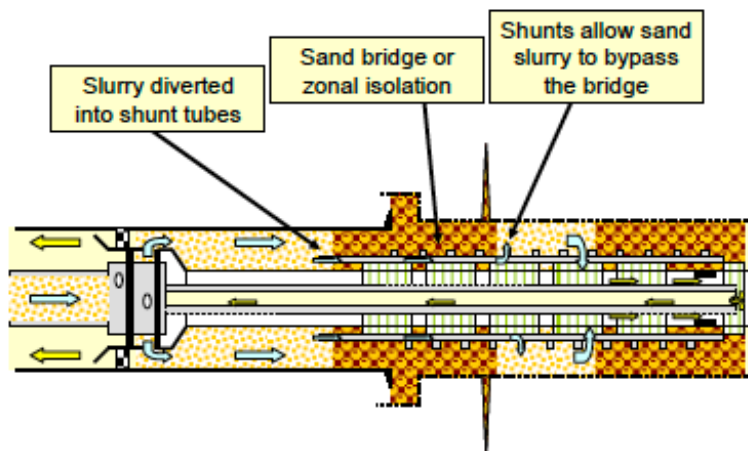


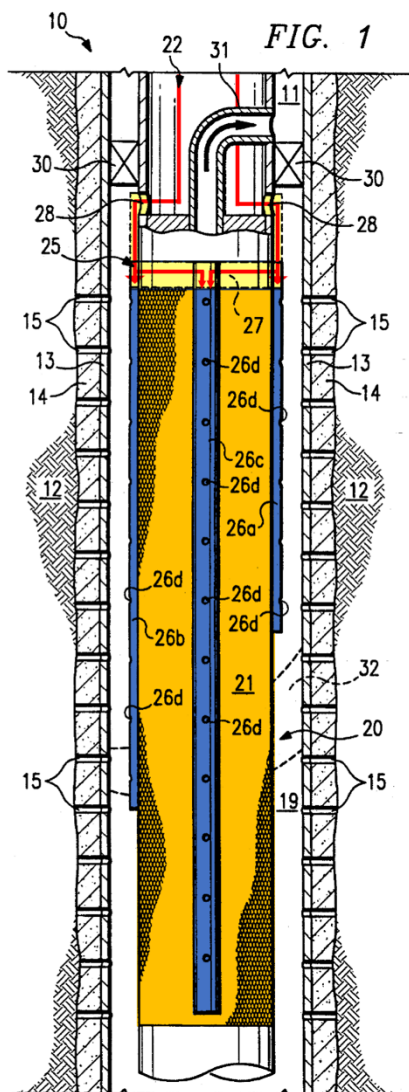
Figure 1 Alternate Path gravel packing with shunt tubes

(right): “Shunt tubes remain inactive until the annulus is blocked during the gravel pack operation. [APT] diverts flow through the shunt tubes and by-passes any blockage, such as a premature sand bridge, to continue gravel packing.” EX1006, 2.

To the extent Yeh did not already disclose this feature, it would have been obvious to couple the source of pressurized working fluid to the shunt tubes to be able to divert gravel slurry around a premature sand bridge, which is the very purpose of the shunt tubes in both Yeh and Yeh2. A POSITA would have expected success because such coupling is necessary for the shunt tubes to function as Yeh2 taught. EX1006, 2; EX1003 ¶¶402-03.

Alternatively, Yeh in view of Yeh2 and Jones2 suggested “coupling.” Jones2 identifies inventors Jones and Yeh and is entitled “Gravel Packing of Wells.” EX1008, 1. Because Jones2 is in the same field—gravel packing with shunt tubes—as Yeh and Yeh2 and involves Yeh as a co-inventor, a POSITA would have readily looked to Jones2 for additional information on gravel packing. EX1003 ¶404. Confirming this, Yeh points to Jones2 as an “[a]dditional reference[] which discuss[es] fluid bypass technology.” EX1005, 3:18-20; EX1003 ¶404.

Jones2 described an “[a]pparatus for gravel packing a wellbore interval having shunt means (i.e. conduits) [dark blue] on the external surface of a sand screen [orange] which can selectively deliver a gravel slurry [red arrows] to different levels of the interval during operation.” EX1008, Abstract; EX1003 ¶405. Jones2 taught that in some embodiments “the conduits are manifolded together and are connected to the outlet ports in the cross-over so that *the slurry flows directly into the conduits* for distribution in the interval.” EX1008, 2:48-54; EX1003 ¶405. Jones2 disclosed the manifold,



annotated in yellow in Figure 1 (above). EX1008, Fig. 1, 4:4-9 (describing manifold 27); EX1003 ¶405. Jones2 taught that this arrangement would provide “a better distribution of gravel ... and a better overall gravel pack efficiency ... in certain applications such as those where long intervals are being completed.” EX1008, 4:34-39; EX1003 ¶405. Thus, one of skill would be motivated to directly couple the slurry to the shunt tubes in Yeh’s long horizontal example as recommended by Jones2 and would have expected success based on Jones2. EX1003 ¶¶406-07.

B. 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.”

Claim 15 would have been obvious over Yeh in view of Yeh2 and optionally Jones2 for the same reasons discussed in claim 14. EX1003 ¶¶408-11.

Additionally, Yeh disclosed a plurality of interconnected concentric sand screens and eccentric sand screens to cover long intervals, such as the 5,000-feet example in claim 14:

It may be difficult to acquire more complex concentric sand screens in *quantities needed for extended horizontal completions*. Therefore, the crossover joint allows a horizontal completion to continue without delay by *combining concentric screens with the more readily available eccentric screens*.

EX1005, 30:27-33; EX1003 ¶409. One of skill understood that for wellbores longer than a sand screen joint length of, for example 30-40 feet, multiple sand screens were required. *See* EX1005, 30:27-33 (referencing “quantities needed for extended horizontal completions”); *see also* EX1006, 4 (“one screen joint (40 ft)”), Fig. 6b (showing series of sand screen joints). Yeh also described using a plurality of interconnected sand screens to cover a production zone in Figure 2, confirming a skilled artisan’s understanding that sand screens should cover the production interval. EX1005, Fig. 2; EX1003 ¶411.

C. 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.”

Claim 16 would have been obvious over Yeh in view of Yeh2 and optionally Jones2 for the reasons described in claim 14[f]. EX1003 ¶¶412-14. As explained in claim 1[e], Yeh disclosed that the gravel slurry must be at 6,500 psi near the heel, which is the concentric screen shunt tube operating pressure. EX1005, 28:11-23.

D. 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.”

Claim 17 would have been obvious over Yeh in view of Yeh2 and optionally Jones2. EX1003 ¶¶415-19. Although claim 17 does not specify which “shunt tube

system” it references, claim 17 would have been obvious for any of the “shunt tube systems” of claim 14. EX1003 ¶415.

Yeh disclosed injecting fluid into the wellbore and into the secondary flow paths of the concentric and eccentric screens as explained in claim 14[f]. EX1005, 28:61-29:3; EX1003 ¶416. The “wellbore” is the annulus adjacent to all the shunt tube systems identified in claim 14. EX1003 ¶416. Yeh2 also described the gravel slurry’s journey into the annulus as described above in claim 14[f]. EX1006, 2, Fig. 1; EX1003 ¶¶417-18. Similarly, in the alternative arrangement in which the slurry is directly routed into the shunt tubes as described in Jones2, the entirety of the slurry would be injected into the annulus adjacent all the shunt tube systems via the packing tube nozzles to form a gravel pack. EX1003 ¶419.

E. 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.”

Claim 18 would have been obvious over Yeh in view of Yeh2 and optionally Jones2 because it adds simple routine optimization. EX1003 ¶¶420-23.

Yeh in view of Yeh2 described the pressures at which the shunt tubes operated for the same reasons described for claims 1[e], 7, and 14[c]. As explained in claim 14[c], the eccentric screen shunt tubes ranged from approximately 2,800 psi to 0 psi

at the toe, all of which is “no more than 5000 [psi].” EX1006, 5, Fig. 15; EX1003 ¶¶421-22.

Also, because the concentric screen shunt tubes operated between either 5,300 psi (Yeh2) or 6,500 psi (Yeh) psi and approximately 2,800 psi (from Yeh2), they operated “at pressures of 5,000 psi.” EX1003 ¶423.

F. 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.”

Claim 19 would have been obvious over Yeh in view of Yeh2 and optionally Jones2 for the same reasons discussed in claims 9 and 18. EX1003 ¶¶424-25. For example, if 2,800 psi is the threshold, the high-pressure shunt tube system will operate above 2,800 psi, and the low-pressure shunt tube system will operate at no more than 2,800 psi as explained in claim 18. The threshold could be any value between 2,800 psi and 6,499 psi. EX1003 ¶425.

G. 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.”

Claim 20 would have been obvious over Yeh in view of Yeh2 and optionally Jones2 because Yeh’s example referenced in claim 14 is in a horizontal wellbore.

EX1005, 30:15-32; *see also id.*, 9:33-41 (explaining that its teachings apply to horizontal zones). EX1003 ¶¶426-27.

VII. GROUND 3

A. Claim 21

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

Claim 21 would have been obvious over Yeh in view of Jones (EX1007). EX1003 ¶¶428-29.

To the extent limiting, Yeh disclosed the preamble for the same reasons discussed for claim 1[preamble].

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

Yeh disclosed this limitation. EX1003 ¶430; *see* claims 1[c] and 11[a].

3. **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”**

Yeh disclosed this limitation. EX1003 ¶431; *see* claim 1[a].

4. **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;”**

Yeh disclosed this limitation. EX1003 ¶432; *see* claim 1[b].

5. **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**

Yeh disclosed this limitation. EX1003 ¶433; *see* claim 1[d].

6. **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.”**

Yeh in view of Jones disclosed or suggested this limitation for the same reasons discussed in claim 1[e] and Jones’ additional teaching on shunt tube materials. EX1003 ¶¶434-39. Jones described gravel packing using sand screens with shunt tubes. EX1007, 1. Thus, one of skill would have looked to Jones for additional teachings on sand screen shunt tubes. EX1003 ¶434.

Regarding claim 1[e], Yeh disclosed using different pressure-rated shunt tubes in the first and second sand screen assemblies and suggested adjusting the shunt tube wall thickness to achieve the desired pressure rating. EX1005, 28:17-23; EX1003 ¶435. Based on Equation (14), a skilled artisan needing to decrease burst pressure would have readily looked to the finite predictable options, such as material selection (decrease f), tubing wall thickness (decrease t), or outside diameter (increase D). EX1003 ¶435. Given the space constraints on sand screens limiting increasing outside diameter, *id.* ¶436, one of skill would have decreased wall thickness (t), decreased tensile strength (f), or both to save cost. It would have been obvious that using a lower tensile strength material (instead of or in addition to decreasing wall thickness) would achieve a lower pressure rating and save cost. *Id.*

Jones, which disclosed a sand screen with an alternate flow path, *see supra* § II.D.3, also taught that although shunt tubes “may be made of any pressure-resistant material, [they are] preferably to be made of stainless steel,” EX1007, 4:11-13; EX1003 ¶437. Thus, it would have been obvious to use different steels (including different stainless steels) to achieve a different pressure rating between the concentric and eccentric screens, and one of skill would have expected success based on Equation (14) and Jones’ teaching. EX1003 ¶¶438-39.

- B. 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.”**

Claim 22 would have been obvious over Yeh in view of Jones as discussed in claim 21[e]. EX1003 ¶¶440-42.

Using wall thickness and/or material selection as described by Yeh and Jones, as discussed above regarding claim 21[e], would have been selecting from two options with a predictable expectation of success. EX1003 ¶¶441-42; *KSR Int’l v. Teleflex, Inc.*, 550 U.S. 398, 421 (2007) (finite number of identified, predictable solutions are obvious to try).

VIII. GROUND 4

- A. 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.”**

Claim 23 would have been obvious over Yeh in view of Jones and Yeh2. EX1003 ¶443. One of skill would have readily understood Yeh2’s additional teachings provided specific data to back up Yeh’s teachings, *see* claim 1[preamble], and would have readily applied them to Yeh in view of Jones as applied for claim 21. The combination disclosed or suggested the added limitations of claim 23 as explained in claims 1[e], 7, and 21[d].

IX. SECONDARY CONSIDERATIONS

There are no relevant secondary considerations regarding the '007 Patent. EX1003, ¶444.

X. DISCRETION UNDER 35 U.S.C. §§ 314(a) AND 325(d)

The Board should not discretionarily deny trial.

A. *Fintiv* Supports Institution

None of the *Fintiv* factors support denying institution in favor of district court litigation. *See Apple v. Fintiv*, IPR2020-00019, 2020 WL 2126495, at *2 (P.T.A.B. Mar. 20, 2020) (precedential); *see also* Director's Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation (June 21, 2022) ("Guidance Memo").

The first *Fintiv* factor is neutral because neither party has moved to stay the district court litigation, although Weatherford will do so. *See, e.g., F5 v. Sunstone Info.*, IPR2022-00483, Paper 13 at 12 (P.T.A.B. Aug. 12, 2022) (factor one was neutral because no stay of district court litigation). The Board should not infer "how the District Court would rule should a stay be requested by the parties in the parallel case here." *Apple v. Fintiv*, IPR2020-00019, 2020 WL 2486683, at *5 (P.T.A.B. May 13, 2020) (informative).

Factor two weighs strongly in favor of institution because the district court has not set any trial date, and the anticipated Final Written Decision here would issue

several months to a year before any trial. *See, e.g., F5*, IPR2022-00483, Paper 13 at 12. The Complaint was filed in January 2024, EX1020, and Weatherford filed a motion to transfer to the Southern District of Texas in April. The latest median time to trial in the Western District of Louisiana is 33.6 months and is 30.7 months in the Southern District of Texas. EX1021, 31, 36; Guidance Memo at 8 (median time to trial statistics must be considered). A Final Written Decision should occur by November 2025 at least months before any district court trial.

Fintiv factor three also supports institution. The Louisiana litigation is still in the pleading stages, and neither the parties nor the district court have invested significant effort. Weatherford diligently filed this Petition about four months after the Louisiana complaint. EX1020; *see, e.g., F5*, IPR2022-00483, Paper 13 at 13 (weighing factor three against denial because of modest investment in the litigation and petitioner's diligence in filing the petition).

Factor four supports institution. Halliburton asserted only claims 11 and 12 in Louisiana, yet this Petition challenges 22 claims. EX1020 ¶37 [LA complaint]. Because the Board will determine patentability here well before any trial, there is little concern of duplicative effort. *See, e.g., F5*, IPR2022-00483, Paper 13 at 13-14.

Fintiv factor five is at best neutral. Unsurprisingly, the parties here are also in the parallel litigation, but this alone does not favor denial. *F5*, IPR2022-00483,

Paper 13 at 14 (weighing factor five against denying institution because there was no evidence of overlap with the trial court date); *Google v. Jawbone Innovations*, IPR2022-00649, Paper 13 at 11 (P.T.A.B. Oct. 31, 2022).

Factor six weighs against denial because this Petition presents a compelling challenge based on the Yeh prior art that was not previously presented or cumulative of previously presented art and disclosed features that Halliburton alleged were missing during prosecution. *Infra* § IX.B.II.C; Guidance Memo at 4-5.

Fintiv is no bar to instituting trial here.

B. Discretionary Denial Under 35 U.S.C. § 325(d) Is Unwarranted.

Section 325(d) also does not support discretionary denial. The grounds presented in this Petition were not considered or cumulative of art previously presented to the Patent Office. *Advanced Bionics v. Med-El Elektromedizinische*, IPR2019-01469, 2020 WL 740292, at *2-3 (P.T.A.B. Feb. 13, 2020) (precedential).

Yeh was not considered by the Examiner, EX1001, 1-2, and showed the features Halliburton alleged were missing during prosecution. The Examiner allowed the claims because she found the claimed high- and low-pressure sand screen assemblies installed in the heel and toe of the well, respectively, were not taught or suggested by the prior art of record. EX1002, 578, 585. But Yeh disclosed this arrangement. *Supra* § II.D.6.

XI. CONCLUSION

Weatherford requests judgment cancelling claims 1-12 and 14-23 of the '007 Patent.

XII. GROUNDS FOR STANDING

Weatherford hereby certifies that the '007 Patent is available for IPR and meets the requirements of 37 C.F.R. § 42.101.

XIII. MANDATORY NOTICES

Pursuant to 37 C.F.R. 42.8(a)(1), the mandatory notices identified in 37 C.F.R. 42.8(b) are provided below as part of this Petition.

A. Real Party-In-Interest (37 C.F.R. § 42.8(b)(1))

Petitioner Weatherford U.S., L.P. and Weatherford International PLC are the real parties-in-interest.

B. Related Matters (37 C.F.R. 42.8(b)(2))

Petitioner is currently aware of the following matter related to the '007 Patent: *Halliburton Energy Services et al. v. Weatherford U.S.*, No. 24-cv-00090 (W.D. La. 2024).

C. Lead and Backup Counsel (37 C.F.R. 42.8(b)(3))

Petitioner provides the following designation of counsel:

Lead Counsel	Backup Counsel
Douglas R. Wilson (Reg. No. 54,542) doug.wilson@armondwilson.com	Michelle E. Armond (Reg. No. 53,954) michelle.armond@armondwilson.com

<u>Postal and Hand-Delivery Address:</u> ARMOND WILSON LLP 13785 Research Blvd., Suite 125 Austin, Texas 78750 Telephone: (512) 267-1663	Monica Arnold (Reg. No. 77,262) monica.arnold@armondwilson.com <u>Postal and Hand-Delivery Address:</u> ARMOND WILSON LLP 4685 MacArthur Court, Suite 390 Newport Beach, CA 92660 Telephone: (949) 932-0778
--	---

Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney accompanies this Petition.

D. Service Information (37 C.F.R. 42.8(b)(4))

Service information for lead and backup counsel is above. Petitioner hereby additionally consents to service by email at the following email address: ipr@armondwilson.com.

ARMOND WILSON LLP

Dated: May 30, 2024

By: /Douglas R. Wilson/
Douglas R. Wilson (Reg. No. 54,542)
Michelle E. Armond (Reg. No. 53,954)
Monica Arnold (Reg. No. 77,262)
Attorneys for Weatherford U.S., L.P.

CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that foregoing **PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 11,333,007**, exclusive of the parts exempted as provided in 37 C.F.R. § 42.24(a), contains 13,979 words and therefore complies with the type-volume limitations of 37 C.F.R. § 42.24(a).

ARMOND WILSON LLP

Dated: May 30, 2024

By: /Douglas R. Wilson/
Douglas R. Wilson (Reg. No. 54,542)
Michelle E. Armond (Reg. No. 53,954)
Monica Arnold (Reg. No. 77,262)
Attorneys for Weatherford U.S., L.P.

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing **PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 11,333,007** and **EXHIBITS 1001-1041**, are being served on May 30, 2024, via overnight mail on the Patent Owner at the correspondence address of record for U.S. Patent No. 11,333,007, as addressed below:

Halliburton Energy Services
P.O. Box 819052
Dallas, TX 75381-9052

Haynes and Boone, LLP
IP Section
2801 N. Harwood St., Suite 2300
Dallas, TX 75201

A courtesy copy is also being served by electronic mail on counsel for the Patent Owner in the pending litigation:

JENNER & BLOCK LLP
Amr O. Aly (aaly@jenner.com)
Rémi J.D. Jaffre (rjaffre@jenner.com)
Yusuf Esat (yesat@jenner.com)

BREAUD & MEYERS
Alan K. Breaud (alan@breaudlaw.com)

ARMOND WILSON LLP

Dated: May 30, 2024

By: /Douglas R. Wilson/
Douglas R. Wilson (Reg. No. 54,542)
Michelle E. Armond (Reg. No. 53,954)
Monica Arnold (Reg. No. 77,262)
Attorneys for Weatherford U.S., L.P.