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PATENT TRIAL AND APPEAL BOARD

Intelligent Wellhead Systems

Petitioner

v.

Downing Wellhead Equipment, LLC

Patent Owner

Case No. 2025-00002
Patent No. 12,134,952

DECLARATION OF DR. ROBERT DURHAM

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	DECLARATION PARTS - EXPLANATION	2
	DECLARATION PART 1	3
III.	EXPERIENCE AND QUALIFICATIONS	3
IV.	TASK SUMMARY AND MATERIALS REVIEWED	8
V.	LIST OF EXHIBITS	8
VI.	SUMMARY OF CONCLUSIONS AND GROUNDS FOR CHALLENGE	16
VII.	LEGAL STANDARDS	17
	A. Level of Ordinary Skill in the Art	17
	B. Legal Standard for Claim Construction	17
	C. Patent Eligible Subject Matter.....	19
	D. Specification Requirements.....	20
	E. Anticipation	21
	F. Obviousness.....	21
	G. Priority Date	24
	H. Independent and Dependent Claim Analysis	26
VIII.	OVERVIEW OF THE CHALLENGED PATENT.....	26
	A. The Subject Matter of the Challenged Patent	27
	B. The Challenged Claims of the '952 Patent	29
	C. Prosecution History of the '952 Patent	29
	D. Priority Date of the '952 Patent.....	32
	E. Comparison of Asserted References to Prior Art Discussed During Prosecution.....	35
IX.	LEVEL OF ORDINARY SKILL IN THE ART	38
X.	CLAIM CONSTRUCTION.....	38
XI.	TECHNOLOGY BACKGROUND AND STATE OF THE ART	39
	A. History of Hydraulic Fracturing	39

B.	Types of Pumps – Fracturing Pump Chain	41
C.	Simultaneous or Sequential Fracturing (Simulfrac or zipper frac).....	45
D.	Continuous Pumping Fracturing	52
E.	Operation Parameters for Fracturing.....	56
F.	Testing	60
XII.	OVERVIEW OF THE PRIOR ART	62
A.	Krupa (Ex. 1022).....	62
B.	Christie (Ex. 1018)	69
C.	Al-Salmani (Ex 1020)	73
D.	<i>FS-Video</i> (Exs. 1026-1035).....	75
E.	<i>Pitcher</i> (Ex. 1021).....	77
XIII.	Ground 1: Patent Eligibility	80
XIV.	Grounds 2-5: Lack of Written Description and IMproper Dependency.....	80
A.	Has Satisfied One or More Conditions	80
B.	“Pressure” Conditions	82
C.	Dashboard Claims	84
D.	Determining Conditions are Satisfied	86
	DECLARATION PART 2	88
XV.	PRIOR ART GROUNDS	88
A.	<i>GROUND 6: CHRISTIE ALONE RENDERS ALL CLAIMS OBVIOUS</i>	<i>88</i>
1.	Independent Claim 1	88
2.	Dependent Claim 2: “The method of claim 1, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.”	133
3.	Dependent Claim 3.....	135
4.	Dependent Claim 4: “The method of claim 1, further comprising: determining that the at least a portion of fluid	

communicated via the manifold has satisfied the one or more conditions.”	146
5. Dependent Claim 5: “The method of claim 1, wherein the one or more conditions include the flow rate of the at least a portion of fluid communicated via the manifold.”	150
6. Dependent Claims 6-8: Flow Rate Thresholds	151
7. Dependent Claim 9: “The method of claim 1, wherein the one or more conditions include the pressure of the at least a portion of the fluid communicated via the manifold.”	161
8. Dependent Claims 10-12: Pressure Thresholds	164
9. Dependent Claim 13	171
10. Dependent Claim 14 The method of claim 1, further comprising: hydraulically fracturing the first well; and hydraulically fracturing the second well; wherein the fluid, which is continuously communicated via the manifold during the CP swap, is hydraulic fracturing fluid.	172
11. Dependent Claim 15: “The method of claim 14, wherein the hydraulic fracturing fluid comprises sand.”	173
12. Dependent Claim 16	174
13. Dependent Claim 17: “The method of claim 16, wherein the dashboard further comprises: a first visual indicator associated with the visual reference of the first valve, the first visual indicator indicating that the state of the first valve is open to permit communicating fluid to the first well via the manifold and the first valve.”	177
14. Dependent Claim 18: “The method of claim 17, wherein the dashboard further comprises: a visual reference of a first wellhead in communication with the first well.”	178
15. Dependent Claim 19: “The method of claim 17, wherein the dashboard further comprises: a second visual indicator associated with the visual reference of the second valve, the second visual indicator being different from the first visual indicator to indicate that the state of the second valve is closed.”	181
16. Independent Claim 20	182

17. Dependent Claim 21	186
18. Dependent Claim 22	186
19. Dependent Claim 23: “The non-transitory computer readable medium of claim 20, wherein the operations further comprise: determining that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.”	187
20. Dependent Claim 24: “The non-transitory computer readable medium of claim 20, wherein the one or more conditions include the flow rate of the at least a portion of fluid communicated via the manifold.”	187
21. Claims 25 – 27	188
22. Dependent Claim 28	188
23. Claims 29 – 31	188
24. Dependent Claims 32 – 38	188
25. Independent Claim 39	189
26. Dependent Claim 40	204
27. Dependent Claim 41	204
28. Dependent Claim 42: “The system of claim 39, wherein the one or more controllers are further configured to: determine that the at least a portion of the communicated via the manifold has satisfied the one or more conditions.”	206
29. Dependent Claims 43 : “The system of claim 39, wherein the one or more conditions include the flow rate of the at least a portion of the fluid communicated via the manifold.”	207
30. Dependent Claims 44 - 46	207
31. Dependent Claim 47: “The system of claim 39, wherein the one or more conditions include the pressure of the at least a portion of fluid communicated via the manifold.”	207
32. Dependent Claims 48 - 50	208
33. Dependent Claim 51	208
34. Dependent Claims 52 – 57	208
35. Independent Claim 58	209

36. Dependent Claim 59: “The method of claim 58, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.”	213
37. Dependent Claims 60 – 61	214
38. Dependent Claim 62: “The method of claim 58, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.”	214
39. Dependent Claims 63 – 64	214
40. Independent Claim 65	215
41. Dependent Claim 66: “The non-transitory computer readable medium of claim 65, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.”	219
42. Dependent Claim 67: “The non-transitory computer readable medium of claim 65, further comprising: determining that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.”	219
43. Dependent Claims 68 – 69	219
44. Dependent Claims 70 – 71	220
45. Independent Claim 72	220
46. Dependent Claim 73: “The system of claim 72, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.”	224
47. Dependent Claim 74: “The system of claim 72, wherein the one or more controllers are further configured to: determine that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.”	225
48. Dependent Claim 75: “The system of claim 72, wherein the one or more conditions include a flow rate condition of the at least a portion of fluid communicated via the manifold.”	225
49. Dependent Claim 76: “The system of claim 72, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.”	225

50.	Dependent Claim 77: “The system of claim 72, wherein the fluid, which is continuously communicated via the manifold during the CP swap, is hydraulic fracturing fluid.”	226
51.	Dependent Claim 78: “The system of claim 77, wherein the hydraulic fracturing fluid comprises sand.”	226
B.	GROUND 7: <i>CHRISTIE</i> IN VIEW OF <i>PITCHER</i> , FURTHER IN VIEW OF <i>AL-SAMANI</i> RENDERS ALL CLAIMS OBVIOUS	226
1.	Independent Claim 1	234
2.	Dependent Claims 2 - 3: “The method of claim 1, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.”	241
3.	Dependent Claim 4: “The method of claim 1, further comprising: determining that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.”	242
4.	Dependent Claims 5 – 12 (Thresholds)	244
5.	Dependent Claim 13.....	251
6.	Claims 14 – 15 (Fracturing Fluid and Fracturing Fluid Containing Sand).....	251
7.	Dependent Claim 16.....	253
8.	Dependent Claim 17: “The method of claim 16, wherein the dashboard further comprises: a first visual indicator associated with the visual reference of the first valve, the first visual indicator indicating that the state of the first valve is open to permit communicating fluid to the first well via the manifold and the first valve.”	257
9.	Dependent Claim 18: “The method of claim 17, wherein the dashboard further comprises: a visual reference of a first wellhead in communication with the first well.”	258
10.	Dependent Claim 19: “The method of claim 17, wherein the dashboard further comprises: a second visual indicator associated with the visual reference of the second valve, the second visual indicator being different from the first visual	

indicator to indicate that the state of the second valve is closed.”	260
11.Independent Claim 20:	261
12.Dependent Claims 21 - 22.....	266
13.Dependent Claim 23: “The non-transitory computer readable medium of claim 20, wherein the operations further comprise: determining that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.”	266
14.Dependent Claim 24: “The non-transitory computer readable medium of claim 20, wherein the one or more conditions include the flow rate of the at least a portion of fluid communicated via the manifold.”	267
15.Claims 25 – 27	267
16.Dependent Claim 28.....	267
17.Claims 29 – 31	267
18.Dependent Claims 32 – 38	268
19.Independent Claim 39	268
20.Dependent Claim 40.....	271
21.Dependent Claim 41.....	271
22.Dependent Claim 42: “The system of claim 39, wherein the one or more controllers are further configured to: determine that the at least a portion of the communicated via the manifold has satisfied the one or more conditions.”	272
23.Dependent Claims 43 : “The system of claim 39, wherein the one or more conditions include the flow rate of the at least a portion of the fluid communicated via the manifold.”	272
24.Dependent Claims 44 - 46.....	273
25.Dependent Claim 47: “The system of claim 39, wherein the one or more conditions include the pressure of the at least a portion of fluid communicated via the manifold.”	273
26.Dependent Claims 48 - 50.....	273
27.Dependent Claim 51.....	273

28. Dependent Claims 52 – 57	274
29. Independent Claim 58	274
30. Dependent Claim 59: “The method of claim 58, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.”	279
31. Dependent Claims 60 – 61	279
32. Dependent Claim 62: “The method of claim 58, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.”	279
33. Dependent Claims 63 – 64	280
34. Independent Claim 65	280
35. Dependent Claim 66: “The non-transitory computer readable medium of claim 65, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.”	284
36. Dependents Claim 67 – 68	285
37. Dependent Claim 69: “The non-transitory computer readable medium of claim 65, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.”	285
38. Dependent Claims 70 – 71	285
39. Independent Claim 72	286
40. Dependent Claim 73: “The system of claim 72, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.”	291
41. Dependent Claims 74 - 75	291
42. Dependent Claim 76: “The system of claim 72, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.”	291
43. Dependent Claims 77 - 78	292

	DECLARATION PART 3	293
C.	GROUND 8 AND 9: <i>KRUPA</i> ANTICIPATES OR RENDERS OBVIOUS ALL CLAIMS	293
1.	Independent Claim 1	296
2.	Dependent Claim 2: “The method of claim 1, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.”	322
3.	Dependent Claim 3.....	327
4.	Dependent Claim 4: “The method of claim 1, further comprising: determining that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.”	341
5.	Dependent Claim 5: “The method of claim 1, wherein the one or more conditions include the flow rate of the at least a portion of fluid communicated via the manifold.”.....	342
6.	Dependent Claim 6: “The method of claim 5, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the flow rate is below an upper threshold.”	343
7.	Dependent Claim 7: “The method of claim 5, wherein the at least a portion of the fluid communicated via the manifold has satisfied the one or more conditions when the flow rate is above a lower threshold.”	345
8.	Dependent Claim 8: “The method of claim 5, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the flow rate is both below an upper threshold and above a lower threshold.”	346
9.	Dependent Claim 9: “The method of claim 1, wherein the one or more conditions include the pressure of the at least a portion of the fluid communicated via the manifold.”.....	347
10.	Dependent Claims 10-12.....	350
11.	Dependent Claim 13.....	354
12.	Dependent Claim 14 The method of claim 1, further comprising: hydraulically fracturing the first well; and hydraulically fracturing the second well; wherein the fluid,	

which is continuously communicated via the manifold during the CP swap, is hydraulic fracturing fluid.	357
13. Dependent Claim 15: “The method of claim 14, wherein the hydraulic fracturing fluid comprises sand.”	359
14. Dependent Claim 16.....	360
15. Dependent Claim 17: “The method of claim 16, wherein the dashboard further comprises: a first visual indicator associated with the visual reference of the first valve, the first visual indicator indicating that the state of the first valve is open to permit communicating fluid to the first well via the manifold and the first valve.”	363
16. Dependent Claim 18: “The method of claim 17, wherein the dashboard further comprises: a visual reference of a first wellhead in communication with the first well.”	364
17. Dependent Claim 19: “The method of claim 17, wherein the dashboard further comprises: a second visual indicator associated with the visual reference of the second valve, the second visual indicator being different from the first visual indicator to indicate that the state of the second valve is closed.”	366
18. Independent Claim 20	368
19. Dependent Claim 21: “The non-transitory computer readable medium of claim 20, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.”	373
20. Dependent Claim 22.....	373
21. Dependent Claim 23: “The non-transitory computer readable medium of claim 20, wherein the operations further comprise: determining that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.”	373
22. Dependent Claim 24: “The non-transitory computer readable medium of claim 20, wherein the one or more conditions include the flow rate of the at least a portion of fluid communicated via the manifold.”	374
23. Claims 25 – 27	374

24. Dependent Claim 28.....	374
25. Claims 29 – 31	374
26. Dependent Claims 32 – 38	375
27. Independent Claim 39	375
28. Dependent Claim 40: “The system of claim 39, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.”	380
29. Dependent Claim 41	380
30. Dependent Claim 42: “The system of claim 39, wherein the one or more controllers are further configured to: determine that the at least a portion of the communicated via the manifold has satisfied the one or more conditions.”	381
31. Dependent Claim 43: “The system of claim 39, wherein the one or more conditions include the flow rate of the at least a portion of the fluid communicated via the manifold.”	381
32. Dependent Claims 44 - 46	382
33. Dependent Claim 47: “The system of claim 39, wherein the one or more conditions include the pressure of the at least a portion of fluid communicated via the manifold.”	382
34. Dependent Claims 48-50	382
35. Dependent Claim 51	382
36. Claims 52 - 57	383
37. Independent Claim 58	383
38. Dependent Claim 59: “The method of claim 58, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.”	389
39. Dependent Claims 60 - 61	389
40. Dependent Claim 62: “The method of claim 58, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.”	389
41. Dependent Claims 63 - 64	390
42. Independent Claim 65	390

43. Dependent Claim 66: “The non-transitory computer readable medium of claim 65, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.”	395
44. Dependent Claims 67 - 68	395
45. Dependent Claim 69: “The non-transitory computer readable medium of claim 65, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.”	395
46. Dependent Claims 70 - 71	396
47. Independent Claim 72	396
48. Dependent Claim 73: “The system of claim 72, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.”	400
49. Dependent Claims 74 - 75	401
50. Dependent Claim 76: “The system of claim 72, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.”	401
51. Dependent Claims 77 - 78	401
D. GROUND 10: <i>KRUPA</i> IN VIEW OF <i>FS-VIDEO</i> FURTHER IN VIEW OF <i>AL-SALMANI</i> RENDER OBVIOUS ALL CLAIMS	402
1. Independent Claim 1	406
2. Dependent Claim 2: “The method of claim 1, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.”	423
3. Dependent Claim 3	425
4. Dependent Claim 4: “The method of claim 1, further comprising: determining that the at least a portion of the fluid communicated via the manifold has satisfied the one or more conditions.”	431
5. Dependent Claims 5 – 12	432
6. Dependent Claim 13	437

7. Dependent Claims 14 – 15 (Fracuring Fluid and Fracturing Fluid Containing Sand)	439
8. Dependent Claim 16.....	440
9. Dependent Claim 17: “The method of claim 16, wherein the dashboard further comprises: a first visual indicator associated with the visual reference of the first valve, the first visual indicator indicating that the state of the first valve is open to permit communicating fluid to the first well via the manifold and the first valve.”	444
10. Dependent Claim 18: “The method of claim 17, wherein the dashboard further comprises: a visual reference of a first wellhead in communication with the first well.”	446
11. Dependent Claim 19: “The method of claim 17, wherein the dashboard further comprises: a second visual indicator associated with the visual reference of the second valve, the second visual indicator being different from the first visual indicator to indicate that the state of the second valve is closed.”	448
12. Independent Claim 20	449
13. Dependent Claim 21: “The non-transitory computer readable medium of claim 20, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.”	454
14. Dependent Claim 22.....	454
15. Dependent Claim 23: “The non-transitory computer readable medium of claim 20, wherein the operations further comprise: determining that the at least a portion of the fluid communicated via the manifold has satisfied the one or more conditions.”	455
16. Dependent Claim 24: “The non-transitory computer readable medium of claim 20, wherein the one or more conditions include the flow rate of the at least a portion of the fluid communicated via the manifold.”	455
17. Dependent Claims 25 - 27.....	455
18. Dependent Claim 28: “The non-transitory computer readable medium of claim 20, wherein the one or more conditions	

include the pressure of the at least a portion of the fluid communicated via the manifold.”	456
19.Dependent Claims 29 - 31	456
20.Dependent Claims 32 - 38.....	456
21.Independent Claim 39	456
22.Dependent Claim 40: “The system of claim 39, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.”	461
23.Dependent Claim 41	461
24.Dependent Claim 42: “The system of claim 39, wherein the one or more controllers are further configured to: determine that the at least a portion of communicated via the manifold has satisfied the one or more conditions.”	462
25.Dependent Claim 43: “The system of claim 39, wherein the one or more conditions include the flow rate of the at least a portion of fluid communicated via the manifold.”	462
26.Dependent Claims 44 - 46.....	463
27.Dependent Claim 47: “The system of claim 39, wherein the one or more conditions include the pressure of the at least a portion of the fluid communicated via the manifold.”.....	463
28.Dependent Claims 48 - 50.....	463
29.Dependent Claim 51	463
30.Dependent Claims 52 - 57.....	464
31.Independent Claim 58	464
32.Dependent Claim 59: “The method of claim 58, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.”	469
33.Dependent Claims 60 - 61	469
34.Dependent Claim 62: “The method of claim 58, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.”	470
35.Dependent Claims 63 - 64.....	470
36.Independent Claim 65	470

37.	Dependent Claim 66: “The non-transitory computer readable medium of claim 65, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.”	475
38.	Dependent Claims 67 - 68.....	475
39.	Dependent Claim 69: “The non-transitory computer readable medium of claim 65, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold”	476
40.	Dependent Claims 70 - 71	476
41.	Independent Claim 72	476
42.	Dependent Claim 73: “The system of claim 72, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.”	481
43.	Dependent Claims 74 - 75.....	481
44.	Dependent Claim 76: “The system of claim 72, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.”	482
45.	Dependent Claims 77 - 78.....	482
XVI.	SECONDARY CONSIDERATIONS	483
XVII.	CONCLUSION	483

CLAIMS LISTING

Claim / Limitation	Claim Language from '952 Patent
1.1	A method of hydraulically fracturing a plurality of wells, the plurality of wells comprising first and second wells, the method comprising:
1.2	communicating fluid from one or more pumps to the first well via a manifold and a first valve, wherein the first valve is associated with both the first well and the manifold so that the first valve is: in fluid communication with the manifold; and fluidically positioned between the first well and the one or more pumps; and
1.3	executing a continuous pumping ("CP") swap to transition from hydraulically fracturing the first well to hydraulically fracturing the second well, the CP swap comprising:
1.3.1	opening a second valve while fluid is communicated from the one or more pumps to the first well via the first valve and the manifold, wherein the second valve is associated with both the second well and the manifold so that the second valve is: in fluid communication with the manifold; and fluidically positioned between the second well and the one or more pumps from which fluid is communicated to the first well via the manifold and the first valve, wherein opening the second valve causes fluid to be communicated from the one or more pumps to the second well via the manifold and the second valve, and
1.3.2	wherein the second valve is opened in response to at least a portion of fluid communicated via the manifold satisfying one or more conditions, which one or more conditions include a flow rate, and/or a pressure, of the at least a portion of fluid communicated via the manifold; and
1.3.3	closing the first valve: after the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions, which one or more conditions include the flow rate,

Claim / Limitation	Claim Language from '952 Patent
	and/or the pressure, of the at least a portion of fluid communicated via the manifold, and
1.3.4	while fluid is communicated from the one or more pumps to the second well via the second valve and the manifold;
1.4	wherein, during the CP swap, fluid is continuously communicated from the one or more pumps via the manifold.
2	The method of claim 1, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.
3.1	The method of claim 1, wherein the plurality of wells further comprises third and fourth wells, and the method further comprises:
3.2	communicating fluid to the third well via the manifold and a third valve, wherein the third valve is associated with both the third well and the manifold;
3.3	wherein executing the CP swap further transitions from hydraulically fracturing the third well to hydraulically fracturing the fourth well, the CP swap further comprising:
3.3.1	opening a fourth valve while fluid is communicated to the third well via the third valve and the manifold, wherein the fourth valve is associated with both the fourth well and the manifold, wherein opening the fourth valve causes fluid to be communicated to the fourth well via the manifold and the fourth valve, and
3.3.2	wherein the fourth valve is opened in response to the at least a portion of fluid communicated via the manifold satisfying the one or more conditions, which one or more conditions include the flow rate, and/or the pressure, of the at least a portion of fluid communicated via the manifold; and

Claim / Limitation	Claim Language from '952 Patent
3.3.3	closing the third valve: after the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions, which one or more conditions include the flow rate, and/or the pressure, of the at least a portion of fluid communicated via the manifold, and
3.3.4	while fluid is communicated to the fourth well via the fourth valve and the manifold.
4	The method of claim 1, further comprising: determining that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.
5	The method of claim 1, wherein the one or more conditions include the flow rate of the at least a portion of fluid communicated via the manifold.
6	The method of claim 5, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the flow rate is below an upper threshold.
7	The method of claim 5, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the flow rate is above a lower threshold.
8	The method of claim 5, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the flow rate is both below an upper threshold and above a lower threshold.
9	The method of claim 1, wherein the one or more conditions include the pressure of the at least a portion of fluid communicated via the manifold.

Claim / Limitation	Claim Language from '952 Patent
10	The method of claim 9, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the pressure is below an upper threshold.
11	The method of claim 9, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the pressure is above a lower threshold.
12	The method of claim 9, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the pressure is both below an upper threshold and above a lower threshold.
13.1	The method of claim 1, wherein the plurality of wells further comprises a third well, and the method further comprises:
13.2	communicating fluid to the third well via the manifold and a third valve, wherein the third valve is associated with both the third well and the manifold; and
13.3	executing another CP swap to transition from hydraulically fracturing the third well to hydraulically fracturing the first well, the another CP swap comprising:
13.3.1	opening the first valve while fluid is communicated to the third well via the third valve and the manifold, wherein opening the first valve causes fluid to be communicated to the first well via the manifold and the first valve, and
13.3.2	wherein the first valve is opened in response to at least another portion of fluid communicated via the manifold satisfying one or more conditions, which one or more conditions include a flow rate, and/or a pressure, of the at least another portion of fluid communicated via the manifold; and

Claim / Limitation	Claim Language from '952 Patent
13.3.3	closing the third valve: after the at least another portion of fluid communicated via the manifold has satisfied the one or more conditions, which one or more conditions include the flow rate, and/or the pressure, of the at least another portion of fluid communicated via the manifold, and
13.3.4	while fluid is communicated to the first well via the first valve and the manifold;
13.4	wherein, during the another CP swap, fluid is continuously communicated via the manifold.
14	The method of claim 1, further comprising: hydraulically fracturing the first well; and hydraulically fracturing the second well; wherein the fluid, which is continuously communicated via the manifold during the CP swap, is hydraulic fracturing fluid.
15	The method of claim 14, wherein the hydraulic fracturing fluid comprises sand.
16.1	The method of claim 1, further comprising: displaying a dashboard, which dashboard comprises:
16.2	a visual reference of the first valve; and a visual reference of the second valve;
16.3	wherein the display of the dashboard visually communicates respective states of the first and second valves.
17	The method of claim 16, wherein the dashboard further comprises: a first visual indicator associated with the visual reference of the first valve, the first visual indicator indicating that the state of the first valve is open to permit communicating fluid to the first well via the manifold and the first valve.

Claim / Limitation	Claim Language from '952 Patent
18	The method of claim 17, wherein the dashboard further comprises: a visual reference of a first wellhead in communication with the first well.
19	The method of claim 17, wherein the dashboard further comprises: a second visual indicator associated with the visual reference of the second valve, the second visual indicator being different from the first visual indicator to indicate that the state of the second valve is closed.
20.1	A non-transitory computer readable medium having stored thereon computer-readable instructions executable by one or more processors to perform operations for hydraulically fracturing a plurality of wells, the plurality of wells comprising first and second wells, the operations comprising:
20.2	communicating fluid from one or more pumps to the first well via a manifold and a first valve, wherein the first valve is associated with both the first well and the manifold so that the first valve is: in fluid communication with the manifold; and fluidically positioned between the first well and the one or more pumps;
20.3	executing a continuous pumping ("CP") swap to transition from hydraulically fracturing the first well to hydraulically fracturing the second well, the CP swap comprising:
20.3.1	opening a second valve while fluid is communicated from the one or more pumps to the first well via the first valve and the manifold, wherein the second valve is associated with both the second well and the manifold so that the second valve is: in fluid communication with the manifold; and fluidically positioned between the second well and the one or more pumps from which fluid is communicated to the first well via the manifold and the first valve; wherein opening the second valve causes fluid to be communicated from the one or more pumps to the second well via the manifold and the second valve, and

Claim / Limitation	Claim Language from '952 Patent
20.3.2	wherein the second valve is opened in response to at least a portion of fluid communicated via the manifold satisfying one or more conditions, which one or more conditions include a flow rate, and/or a pressure, of the at least a portion of fluid communicated via the manifold; and
20.3.3	closing the first valve: after the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions, which one or more conditions include the flow rate, and/or the pressure, of the at least a portion of fluid communicated via the manifold, and
20.3.4	while fluid is communicated from the one or more pumps to the second well via the second valve and the manifold;
20.4	wherein, during the CP swap, fluid is continuously communicated from the one or more pumps via the manifold.
21	The non-transitory computer readable medium of claim 20, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.
22.1	The non-transitory computer readable medium of claim 20, wherein the plurality of wells further comprises third and fourth wells, and the operations further comprise:
22.2	communicating fluid to the third well via the manifold and a third valve, wherein the third valve is associated with both the third well and the manifold;
22.3	wherein executing the CP swap further transitions from hydraulically fracturing the third well to hydraulically fracturing the fourth well, the CP swap further comprising:

Claim / Limitation	Claim Language from '952 Patent
22.3.1	opening a fourth valve while fluid is communicated to the third well via the third valve and the manifold, wherein the fourth valve is associated with both the fourth well and the manifold, wherein opening the fourth valve causes fluid to be communicated to the fourth well via the manifold and the fourth valve, and
22.3.2	wherein the fourth valve is opened in response to the at least a portion of fluid communicated via the manifold satisfying the one or more conditions, which one or more conditions include the flow rate, and/or the pressure, of the at least a portion of fluid communicated via the manifold; and
22.3.3	closing the third valve: after the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions, which one or more conditions include the flow rate, and/or the pressure, of the at least a portion of fluid being communicated via the manifold, and
22.3.4	while fluid is communicated to the fourth well via the fourth valve and the manifold.
23	The non-transitory computer readable medium of claim 20, wherein the operations further comprise: determining that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.
24	The non-transitory computer readable medium of claim 20, wherein the one or more conditions include the flow rate of the at least a portion of fluid communicated via the manifold.
25	The non-transitory computer readable medium of claim 24, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the flow rate is below an upper threshold.

Claim / Limitation	Claim Language from '952 Patent
26	The non-transitory computer readable medium of claim 24, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the flow rate is above a lower threshold.
27	The non-transitory computer readable medium of claim 24, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the flow rate is both below an upper threshold and above a lower threshold.
28	The non-transitory computer readable medium of claim 20, wherein the one or more conditions include the pressure of the at least a portion of fluid communicated via the manifold.
29	The non-transitory computer readable medium of claim 28, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the pressure is below an upper threshold.
30	The non-transitory computer readable medium of claim 28, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the pressure is above a lower threshold.
31	The non-transitory computer readable medium of claim 28, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the pressure is both below an upper threshold and above a lower threshold.
32.1	The non-transitory computer readable medium of claim 20, wherein the plurality of wells further comprises a third well, and the operations further comprise:

Claim / Limitation	Claim Language from '952 Patent
32.2	communicating fluid to the third well via the manifold and a third valve, wherein the third valve is associated with both the third well and the manifold; and
32.3	executing another CP swap to transition from hydraulically fracturing the third well to hydraulically fracturing the first well, the another CP swap comprising:
32.3.1	opening the first valve while fluid is communicated to the third well via the third valve and the manifold, wherein opening the first valve causes fluid to be communicated to the first well via the manifold and the first valve, and
32.3.2	wherein the first valve is opened in response to at least another portion of fluid communicated via the manifold satisfying one or more conditions, which one or more conditions include a flow rate, and/or a pressure, of the at least another portion of fluid communicated via the manifold; and
32.3.3	closing the third valve: after the at least another portion of fluid communicated via the manifold has satisfied the one or more conditions, which one or more conditions include the flow rate, and/or the pressure, of the at least another portion of fluid communicated via the manifold, and
32.3.4	while fluid is communicated to the first well via the first valve and the manifold;
32.4	wherein, during the another CP swap, fluid is continuously communicated via the manifold.
33	The non-transitory computer readable medium of claim 20, wherein the operations further comprise: hydraulically fracturing the first well; and hydraulically fracturing the second well; and wherein the fluid, which is continuously communicated via the manifold during the CP swap, is hydraulic fracturing fluid.

Claim / Limitation	Claim Language from '952 Patent
34	The non-transitory computer readable medium of claim 33, wherein the hydraulic fracturing fluid comprises sand.
35.1	The non-transitory computer readable medium of claim 20, wherein the operations further comprise: displaying a dashboard, which dashboard comprises:
35.2	visual reference of the first valve; and a visual reference of the second valve; and
35.3	wherein the display of the dashboard visually communicates respective states of the first and second valves.
36	The non-transitory computer readable medium of claim 35, wherein the dashboard further comprises: a first visual indicator associated with the visual reference of the first valve, the first visual indicator indicating that the state of the first valve is open to permit communicating fluid to the first well via the manifold and the first valve.
37	The non-transitory computer readable medium of claim 36, wherein the dashboard further comprises: a visual reference of a first wellhead in communication with the first well.
38	The non-transitory computer readable medium of claim 36, wherein the dashboard further comprises: a second visual indicator associated with the visual reference of the second valve, the second visual indicator being different from the first visual indicator to indicate that the state of the second valve is closed.
39.1	A system for hydraulically fracturing a plurality of wells, the plurality of wells comprising first and second wells, the system comprising:

Claim / Limitation	Claim Language from '952 Patent
39.2	a manifold via which fluid is adapted to be communicated from one or more pumps;
39.3	a first valve via which fluid is adapted to be communicated from the one or more pumps to the first well, the first valve being associated with both the first well and the manifold so that the first valve is: in fluid communication with the manifold; and fluidically positioned between the first well and the one or more pumps;
39.4	a second valve via which fluid is adapted to be communicated the one or more pumps to the second well, the second valve being associated with both the second well and the manifold so that the second valve is: in fluid communication with the manifold; and fluidically positioned between the second well and the one or more pumps from which fluid is adapted to be communicated to the first well via the manifold and the first valve; and
39.5	one or more controllers configured to execute a continuous pumping ("CP") swap, during which CP swap fluid is continuously communicated via the manifold, to transition from hydraulically fracturing the first well to hydraulically fracturing the second well, by:
39.5.1	opening the second valve: while fluid is communicated from the one or more pumps to the first well via the first valve and the manifold, to cause fluid to be communicated from the one or more pumps to the second well via the manifold and the second valve, and
39.5.2	in response to at least a portion of fluid communicated via the manifold satisfying one or more conditions, which one or more conditions include a flow rate, and/or a pressure, of the at least a portion of fluid communicated via the manifold; and

Claim / Limitation	Claim Language from '952 Patent
39.5.3	closing the first valve: after the at least a portion of fluid communicated via the manifold has satisfied one or more conditions, which one or more conditions include the flow rate, and/or the pressure, of the at least a portion of fluid communicated via the manifold, and
39.5.4	while fluid is communicated from the one or more pumps to the second well via the second valve and the manifold.
40	The system of claim 39, wherein: the first valve is a first zipper valve; and/or the second valve is a second zipper valve.
41.1	The system of claim 39, wherein: the plurality of wells further comprises third and fourth wells; the system further comprises:
41.2	a third valve via which fluid is adapted to be communicated from the manifold to the third well, the third valve being associated with both the third well and the manifold; and
41.3	a fourth valve via which fluid is adapted to be communicated from the manifold to the fourth well, the fourth valve being associated with both the fourth well and the manifold; and
41.4	the one or more controllers are further configured to execute the CP swap, during which CP swap fluid is continuously communicated via the manifold, to transition from hydraulically fracturing the third well to hydraulically fracturing the fourth well, by:
41.4.1	opening the fourth valve: while fluid is communicated to the third well via the third valve and the manifold, to cause fluid to be communicated to the fourth well via the manifold and the fourth valve, and

Claim / Limitation	Claim Language from '952 Patent
41.4.2	in response to the at least a portion of fluid communicated via the manifold satisfying the one or more conditions, which one or more conditions include the flow rate, and/or the pressure, of the at least a portion of fluid communicated via the manifold; and
41.4.3	closing the third valve: after the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions, which one or more conditions include the flow rate, and/or the pressure, of the at least a portion of fluid communicated via the manifold, and
41.4.4	while fluid is communicated to the fourth well via the fourth valve and the manifold.
42	The system of claim 39, wherein the one or more controllers are further configured to: determine that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.
43	The system of claim 39, wherein the one or more conditions include the flow rate of the at least a portion of fluid communicated via the manifold.
44	The system of claim 43, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the flow rate is below an upper threshold.
45	The system of claim 43, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the flow rate is above a lower threshold.
46	The system of claim 43, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the flow rate is both below an upper threshold and above a lower threshold.

Claim / Limitation	Claim Language from '952 Patent
47	The system of claim 39, wherein the one or more conditions include the pressure of the at least a portion of fluid communicated via the manifold.
48	The system of claim 47, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the pressure is below an upper threshold.
49	The system of claim 47, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the pressure is above a lower threshold.
50	The system of claim 47, wherein the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions when the pressure is both below an upper threshold and above a lower threshold.
51.1	The system of claim 39, wherein: the plurality of wells further comprises a third well; the system further comprises
51.2	a third valve via which fluid is adapted to be communicated from the manifold to the third well, the third valve being associated with both the third well and the manifold;
51.3	the one or more controllers are further configured to execute another CP swap, during which CP swap fluid is continuously communicated via the manifold, to transition from hydraulically fracturing the third well to hydraulically fracturing the first well, by:
51.3.1	opening the first valve: while fluid is communicated to the third well via the third valve and the manifold, to cause fluid to be communicated to the first well via the manifold and the first valve, and
51.3.2	in response to at least another portion of fluid communicated

Claim / Limitation	Claim Language from '952 Patent
	via the manifold satisfying one or more conditions, which one or more conditions include a flow rate, and/or a pressure, of the at least another portion of fluid communicated via the manifold; and
51.3.3	closing the third valve: after the at least another portion of fluid communicated via the manifold has satisfied the one or more conditions, which one or more conditions include the flow rate, and/or the pressure, of the at least another portion of fluid communicated via the manifold, and
51.3.4	while fluid is communicated to the first well via the first valve and the manifold.
52	The system of claim 39, wherein the fluid, which is continuously communicated via the manifold during the CP swap, is hydraulic fracturing fluid.
53	The system of claim 52, wherein the hydraulic fracturing fluid comprises sand.
54.1	The system of claim 39, further comprising: a dashboard adapted to be displayed, which dashboard comprises:
54.2	a visual reference of the first valve; and a visual reference of the second valve; and
54.3	wherein the display of the dashboard visually communicates respective states of the first and second valves.
55	The system of claim 54, wherein the dashboard further comprises: a first visual indicator associated with the visual reference of the first valve, the first visual indicator indicating that the state of the first valve is open to permit communicating fluid to the first well via the manifold and the first valve.
56	The system of claim 55, wherein the dashboard further comprises:

Claim / Limitation	Claim Language from '952 Patent
	a visual reference of a first wellhead in communication with the first well.
57	The system of claim 55, wherein the dashboard further comprises: a second visual indicator associated with the visual reference of the second valve, the second visual indicator being different from the first visual indicator to indicate that the state of the second valve is closed.
58.1	A method of hydraulically fracturing a plurality of wells, the plurality of wells comprising first and second wells, the method comprising:
58.2	communicating fluid from the one or more pumps to the first well via a manifold and a first valve, wherein the first valve is associated with both the first well and the manifold so that the valve is: in fluid communication with the manifold; and fluidically positioned between the first well and the one or more pumps;
58.3	displaying a dashboard, which dashboard comprises:
58.3.1	a visual reference of the first valve;
58.3.2	a first visual indicator associated with the visual reference of the first valve, the first visual indicator indicating that a state of the first valve is open to permit communicating fluid to the first well via the manifold and the first valve;
58.3.3	a visual reference of a second valve,
58.3.4	wherein the second valve is associated with both the second well and the manifold so that the second valve is: in fluid communication with the manifold; and fluidically positioned between the second well and the one or

Claim / Limitation	Claim Language from '952 Patent
	more pumps from which fluid is communicated to the first well via the manifold and the first valve; and
58.3.5	a second visual indicator associated with the visual reference of the second valve, the second visual indicator being different from the first visual indicator to indicate that a state of the second valve is closed; and
58.4	executing a continuous pumping ("CP") swap to transition from hydraulically fracturing the first well to hydraulically fracturing the second well, the CP swap comprising:
58.4.1	opening the second valve while fluid is communicated from the one or more pumps to the first well via the first valve and the manifold, wherein opening the second valve causes fluid to be communicated from the one or more pumps to the second well via the manifold and the second valve, and
58.4.2	wherein the second valve is opened in response to at least a portion of fluid communicated via the manifold satisfying one or more conditions; and
58.4.3	closing the first valve: after the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions,
58.5	wherein the display of the dashboard visually communicates the respective states of the first and second valves; and
58.6	wherein fluid is continuously communicated via the manifold during the CP swap.
59	The method of claim 58, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.
60	The method of claim 58, further comprising:

Claim / Limitation	Claim Language from '952 Patent
	determining that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.
61	The method of claim 58, wherein the one or more conditions include a flow rate condition of the at least a portion of fluid communicated via the manifold.
62	The method of claim 58, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.
63	The method of claim 58, further comprising: hydraulically fracturing the first well; and hydraulically fracturing the second well; wherein the fluid, which is continuously communicated via the manifold during the CP swap, is hydraulic fracturing fluid.
64	The method of claim 63, wherein the hydraulic fracturing fluid comprises sand.
65.1	A non-transitory computer readable medium of hydraulically fracturing a plurality of wells, the plurality of wells comprising first and second wells, the method comprising:
65.2	communicating fluid from one or more pumps to the first well via a manifold and a first valve, wherein the first valve is associated with both the first well and the manifold so that the first valve is: in fluid communication with the manifold; and fluidically positioned between the first well and the one or more pumps;
65.3	displaying a dashboard, which dashboard comprises:
65.3.1	a visual reference of the first valve;
65.3.2	first visual indicator associated with the visual reference of the first valve, the first visual indicator indicating that a state of the

Claim / Limitation	Claim Language from '952 Patent
	first valve is open to permit communicating fluid to the first well via the manifold and the first valve;
65.3.3	a visual reference of a second valve,
65.3.4	wherein the second valve is associated with both the second well and the manifold so that the second valve is: in fluid communication with the manifold; and fluidically positioned between the second well and the one or more pumps from which fluid is communicated to the first well via the manifold and the first valve; and
65.3.5	a second visual indicator associated with the visual reference of the second valve, the second visual indicator being different from the first visual indicator to indicate that a state of the second valve is closed; and
65.4	executing a continuous pumping ("CP") swap to transition from hydraulically fracturing the first well to hydraulically fracturing the second well, the CP swap comprising:
65.4.1	opening the second valve while fluid is communicated from the one or more pumps to the first well via the first valve and the manifold, wherein opening the second valve causes fluid to be communicated from the one or more pumps to the second well via the manifold and the second valve, and
65.4.2	wherein the second valve is opened in response to at least a portion of fluid communicated via the manifold satisfying one or more conditions; and
65.4.3	closing the first valve: after the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions;

Claim / Limitation	Claim Language from '952 Patent
65.5	wherein the display of the dashboard visually communicates the respective states of the first and second valves; and
65.6	wherein fluid is continuously communicated via the manifold during the CP swap.
66	The non-transitory computer readable medium of claim 65, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.
67	The non-transitory computer readable medium of claim 65, further comprising: determining that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.
68	The non-transitory computer readable medium of claim 65, wherein the one or more conditions include a flow rate condition of the at least a portion of fluid communicated via the manifold.
69	The non-transitory computer readable medium of claim 65, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.
70	The non-transitory computer readable medium of claim 65, further comprising: hydraulically fracturing the first well; and hydraulically fracturing the second well; wherein the fluid, which is continuously communicated via the manifold during the CP swap, is hydraulic fracturing fluid.
71	The non-transitory computer readable medium of claim 70, wherein the hydraulic fracturing fluid comprises sand.
72.1	A system for hydraulically fracturing a plurality of wells, the plurality of wells comprising first and second wells, the system comprising:

Claim / Limitation	Claim Language from '952 Patent
72.2	a manifold via which fluid is adapted to be communicated from one or more pumps;
72.3	a first valve via which fluid is adapted to be communicated from the one or more pumps to the first well, the first valve being associated with both the first well and the manifold so that the first valve is: in fluid communication with the manifold; and fluidically positioned between the first well and the one or more pumps;
72.4	a second valve via which fluid is adapted to be communicated from the one or more pumps to the second well, the second valve being associated with both the second well and the manifold so that the second valve is: in fluid communication with the manifold; and fluidically positioned between the second well and the one or more pumps from which fluid is adapted to be communicated to the first well via the manifold and the first valve;
72.5	a dashboard adapted to be displayed, which dashboard comprises:
72.5.1	a visual reference of the first valve;
72.5.2	a first visual indicator associated with the visual reference of the first valve, the first visual indicator indicating that a state of the first valve is open to permit communicating fluid to the first well via the manifold and the first valve;
72.5.3	a visual reference of the second valve; and
72.5.4	a second visual indicator associated with the visual reference of the second valve, the second visual indicator being different from the first visual indicator to indicate that a state of the second valve is closed; and

Claim / Limitation	Claim Language from '952 Patent
72.6	one or more controllers configured to execute a continuous pumping ("CP") swap, during which CP swap fluid is continuously communicated via the manifold, to transition from hydraulically fracturing the first well to hydraulically fracturing the second well, by:
72.6.1	opening the second valve: while fluid is communicated from the one or more pumps to the first well via the first valve and the manifold,
72.6.2	in response to at least a portion of fluid communicated via the manifold satisfying one or more conditions, and
72.6.3	to cause fluid to be communicated from the one or more pumps to the second well via the manifold and the second valve; and
72.6.4	closing the first valve: after the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions;
72.7	wherein the display of the dashboard visually communicates the respective states of the first and second valves.
73	The system of claim 72, wherein the dashboard further comprises a visual reference of a first wellhead in communication with the first well.
74	The system of claim 72, wherein the one or more controllers are further configured to: determine that the at least a portion of fluid communicated via the manifold has satisfied the one or more conditions.
75	The system of claim 72, wherein the one or more conditions include a flow rate condition of the at least a portion of fluid communicated via the manifold.

Claim / Limitation	Claim Language from '952 Patent
76	The system of claim 72, wherein the one or more conditions include a pressure condition of the at least a portion of fluid communicated via the manifold.
77	The system of claim 72, wherein the fluid, which is continuously communicated via the manifold during the CP swap, is hydraulic fracturing fluid.
78	The system of claim 77, wherein the hydraulic fracturing fluid comprises sand.

I. INTRODUCTION

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

2. I have been asked to provide technical assistance in the post grant review of U.S. Patent No. 12,134,952, which I may abbreviate as the “’952 Patent” or “Challenged Patent.” This declaration is a statement of my opinions on issues related to the unpatentability of claims of the ’952 Patent. I am being compensated at my standard rate of \$305 per hour for my analysis and expense reimbursement. My compensation does not depend on the content of my opinions or the outcome of this proceeding.

II. DECLARATION PARTS - EXPLANATION

For convenience and ease of reference, I've divided my declaration into three parts that correspond to various subject matters/grounds, as follows:

Declaration Part	Summary	Description
Part 1 (Ex.1002-1)	Intro	Introduction, Experience & Qualifications, Legal Standards etc.
	Patent Summary	Overview of Challenged Patent, Level of Ordinary Skill
	Tech Background	Technology Background
	Prior Art	<i>Christie, Pitcher, Al-Salmani, Krupa, and FS-Video</i>
	Grounds 1-5	Patent-ineligibility, Lack of Written Description & New Matter, Improper Dependent Claims
Part 2 (Ex. 1002-2)	Ground 6	<i>Christie</i> (§ 103 against All Claims)
	Ground 7	<i>Christie, Pitcher, and Al-Salmani</i> (§ 103 against All Claims)
Part 3 (Ex. 1002-3)	Grounds 8-9	<i>Krupa</i> (§§ 102/103 against All Claims)
	Ground 10	<i>Krupa, FS-Video, and Al-Salmani</i> (§ 103 against All Claims)

DECLARATION PART 1

This section of my declaration addresses introductory issues and Grounds 1-5, as follows:

Declaration Part	Summary	Description
Part 1 (Ex.1002-1)	Intro	Introduction, Experience & Qualifications, Legal Standards etc.
	Patent Summary	Overview of Challenged Patent, Level of Ordinary Skill
	Tech Background	Technology Background
	Prior Art	<i>Christie, Pitcher, Al-Salmanni, Krupa, and FS-Video</i>
	Grounds 1-5	Patent-ineligibility, Lack of Written Description & New Matter, Improper Dependent Claims

III. EXPERIENCE AND QUALIFICATIONS

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

4. I am a consulting engineer with experience in several technical areas. I have expertise in the electrification of the oil and gas industry from drilling and completion to downstream. I have worked with oil field production companies, refining and chemical plants, equipment manufacturers, and technology development companies for nearly twenty years as a consultant. My work relates to the subject matter of the Challenged Patents, which I describe below in Section VII (“Overview of the Challenged Patents”).

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

6. I have also served in leadership positions in the Petroleum and Chemical Industry Committee (PCIC) of the Institute of Electrical and Electronics Engineers (IEEE) for nearly twenty years. IEEE is the world’s largest technical professional association. The PCIC is the premier forum for exchanging electrical applications technology related to the petroleum and chemical industry. From 2005 to 2012, I served as Secretary, Vice Chair, and ultimately Chair of the Production Subcommittee of the PCIC. The Production Subcommittee is the primary method for PCIC members to communicate technical papers related to drilling, wellhead,

and facilities operations of oil and gas wells. In 2013, I was appointed Vice Chair of the Standards Subcommittee of the PCIC, a role which I transitioned to Chair in 2014. I served as Chair until 2022. The Standards Subcommittee of the PCIC is the Sponsor of IEEE standards relating to electrification and electrical equipment operations in the Oil and Gas Industry. The PCIC Standards Subcommittee sponsors nearly 50 electrical, oil, and gas-related standards. In September 2022, I was elected as an Executive Officer of the PCIC. I will serve as an Executive Officer for eight years, serving two-year terms in each position: Secretary, Vice Chair, Chair, and Chair of Advisory and Awards.

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

8. After a brief stint as Vice President for EDG Power Group, responsible for Engineering and Project Management of generation and co-generation facilities across the U.S., I transitioned to consulting engineer. In that role, I have worked in designing, constructing, and analyzing all kinds of power and fluid systems, especially those in the oil and gas industry. This has included the design and

selection of equipment and the analysis of equipment failures in the oil and gas field from drilling/completion sites to production facilities, midstream, and downstream (refinery) locations.

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

10. I have been familiar with oil and gas drilling, fracturing (fracking), and completion operations for nearly twenty years. In addition to being responsible for interfacing with drilling and fracturing operations about electrical needs as an employee of New Dominion, LLC (NDL), I have been further educated about drilling, fracturing, and operations as I have consulted and investigated incidents on multiple well drilling, fracturing, and completion pad sites over my engineering consulting engagements. Over the last ~ 20 years, I have consulted with numerous clients ranging from utilities to oil and gas development and production companies on designing, upgrading, and maintaining generation and power distribution facilities.

11. I am a Principal Scientist of THE WAY Labs. Part of my responsibilities include overseeing the Health Safety and Environmental (HSE) program at THE WAY Labs, including establishing policies and procedures

commensurate with Occupational Safety and Health Administration (“OSHA”) requirements at all locations, including requirement for oil and gas sites. I am familiar with OSHA and its responsibilities at oil and gas locations. I have consulted and investigated incidents on multiple oil and gas sites where OSHA has also investigated injuries and fatalities at oil and gas locations, including drilling, fracturing, and completion operations.

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

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

14. Therefore, based on my education, professional experience of over 30 years, and scholarly books and publications, I am an expert in the relevant field of the Challenged Patent at issue here and have been an expert in this field since before the Challenged Patent was filed with the United States Patent and Trademark Office (“USPTO”). I am familiar with how a person having ordinary skill in the art would

have understood and used the terminology found in the '952 Patent at the time of its filing.

IV. TASK SUMMARY AND MATERIALS REVIEWED

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

V. LIST OF EXHIBITS

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

Exhibit	Description
Exhibit 1001	U.S. Patent No. 12,134,952 ("952 Patent")
Exhibit 1002	Declaration of Dr. Robert Durham in Support of Petition in PGR2025-00002
Exhibit 1003	'952 Patent's Prosecution History
Exhibit 1004	U.S. Patent No. 11,560,770 ("770 Patent") and Prosecution History
Exhibit 1005	U.S. Patent No. 11,401,779 ("779 Patent") and Prosecution

Exhibit	Description
	History
Exhibit 1006	U.S. Provisional No. 63/189,663 (“’663 Provisional”)
Exhibit 1007	’952 Claim Comparison and Grouping Chart
Exhibit 1008	Patent Family Priority Diagram
Exhibit 1009	Patent Family Specification Comparisons
Exhibit 1010	Comparison of ’122 Original Application Claims and ’952 As-Issued Claim 1
Exhibit 1011	First Amended Complaint for Patent Infringement, Permanent Injunctive Relief Requested and Demand for Jury Trial, (ECF No. 29); Downing Wellhead Equipment, LLC v. Intelligent Wellhead Systems, Inc., et al., No. 1:23-cv-01180 (D. Colo.) (“the Litigation”)
Exhibit 1012	Pre-litigation letter from IWS to Downing, dated Oct. 6, 2022
Exhibit 1013	Downing’s Supplemental Objections and Responses to IWS’s First Set of Interrogatories in the Litigation, dated Dec. 15, 2023
Exhibit 1014	Order on Administrative Closing of The Litigation, dated Oct. 21, 2024
Exhibit 1015	Excerpts of Downing’s Patent Owner Preliminary Response in Inter Partes Review of U.S. Patent No. 11,401,779 (Intelligent Wellhead Systems, Inc. v. Downing Wellhead Equipment, LLC, IPR2024-00256, Paper 9)
Exhibit 1016	Excerpts of Downing’s Patent Owner Preliminary Response in Inter Partes Review of U.S. Patent No. 11,560,770 (Intelligent Wellhead Systems, Inc. v. Downing Wellhead Equipment, LLC, IPR2024-00300, Paper 8)

Exhibit	Description
Exhibit 1017	Excerpt from Evans, Harry B.; “Water Distribution in Ancient Rome: The Evidence of Frontinus”, University of Michigan Press, (Introduction pages 1-12) 1997
Exhibit 1018	U.S. Pub. No. US2021/0025267 A1 by Christie et al. entitled “Coordinated Pumping Operations” published January 28, 2021 (“ <i>Christie</i> ”)
Exhibit 1019	Christie Provisional, entitled “Coordinated Pumping Operations,” filed July 24, 2019 (“ <i>Christie Provisional</i> ”)
Exhibit 1020	U.S. Publication 2020/0149389 A1 by Al-Salmani et al., entitled “Surface Completion System for Operations and Monitoring,” published May 14, 2020 (“ <i>Al-Salmani</i> ”)
Exhibit 1021	U.S. Publication 2014/0352968 A1 by Pitcher et al., entitled “Multi-Well Simultaneous Fracturing System,” published December 4, 2014 (“ <i>Pitcher</i> ”)
Exhibit 1022	U.S. Patent Publication 2022/0268141 A1 by Andrew Krupa et al. entitled “System and Method for an Automated and Intelligent Frac Pumping,” filed February 18, 2022, (“ <i>Krupa</i> ”) (claiming priority to identical provisional (U.S. Provisional No. 63/153,607) filed February 25, 2021).
Exhibit 1023	U.S. Provisional No. 63/153,607, filed February 25, 2021, entitled “System and Method for an Automated and Intelligent Frac Pumping” (“ <i>Krupa Provisional</i> ”)
Exhibit 1024	Comparison of <i>Krupa</i> and <i>Krupa Provisional</i>
Exhibit 1025	Exhibit 2001 from IPR2024-00256 and IPR2024-00300 (Excerpt from Downing Webpage Relied on by Downing) (“ <i>Downing’s Webpage</i> ”)
Exhibit 1026	“FS Completion System: How it Works” Screenshot of YouTube post, dated March 5, 2019, available at https://www.youtube.com/watch?v=X0m9DcnZczE

Exhibit	Description
	(accessed on 09-19-2024)
Exhibit 1027	YouTube Video of “FS Completion System: How it Works,” dated March 5, 2019 (FS-Completion-System-How-it-Works-F1651087F.mp4) (“ <i>FS-Video</i> ”)
Exhibit 1028	“FS Completion System: How it Works” PageVault PDF of YouTube post, dated March 5, 2019, available at https://www.youtube.com/watch?v=X0m9DcnZczE titled (accessed on 09-19-2024)
Exhibit 1029	“FS Completion System: How it Works” Screenshot of Facebook Post, dated August 27, 2019, available at https://www.facebook.com/downing.us/videos/2227726754168991 (accessed 09-19-2024)
Exhibit 1030	“FS Completion System: How it Works” PageVault PDF of Facebook Post, dated August 27, 2019, available at https://www.facebook.com/downing.us/videos/2227726754168991 (accessed on 09-19-2024)
Exhibit 1031	Facebook Video of “FS Completion System: How it Works,” dated August 27, 2019 (FS-Completion-System-How-it-Works-F1651112F.mp4) (Facebook version of <i>FS-Video</i>)
Exhibit 1032	Declaration and CV of James KempVanEe Authenticating YouTube and Facebook Publications of <i>FS-Video</i>
Exhibit 1033	Screen Recording of Scrolling Through Downing Facebook Posts to <i>FS-Video</i>
Exhibit 1034	Transcript of <i>FS-Video</i>
Exhibit 1035	Declaration of Lisa E. Margonis
Exhibit 1036	PCT International Patent Application Publication WO2020/145978 A1 by Beuterbaugh, et al. entitled

Exhibit	Description
	“Simulfrac Pulsed Treatment” (“ <i>Beuterbaugh</i> ”)
Exhibit 1037	Jacobs, Trent. “The Shale Evolution: Zipper Fracture Takes Hold,” J Pet Technol 66 (2014): 60–67 (available at https://doi.org/10.2118/1014-0060-JPT)
Exhibit 1038	Video titled “Riglock: The Industry's First and Only Hands-Free Wellhead Connection,” dated July 16, 2019 (“ <i>RigLock Video</i> ”)
Exhibit 1039	Wayback Machine Affidavit of Nathaniel E Frank-White, dated July 6, 2024, Authenticating <i>RigLock Video</i>
Exhibit 1040	Michael Morton, “Unlocking the Earth: A Short History of Hydraulic Fracturing,” GEO ExPro, Vol. 10, No. 6, December 2013 (available at https://geoexpro.com/unlocking-the-earth-a-short-history-of-hydraulic-fracturing/) (last accessed November 30, 2023)
Exhibit 1041	B.A. Wells and K.L. Wells. “Shooters – A “Fracking” History.” American Oil & Gas Historical Society, originally published September 1, 2007 (available at https://aoghs.org/technology/hydraulic-fracturing) (last accessed November 30, 2023)
Exhibit 1042	Carl T. Montgomery and Michael B. Smith, “Hydraulic Fracturing: History of an Enduring Technology,” <i>Journal of Petroleum Technology</i> , Vol. 62, Issue 12 (Dec. 2010)
Exhibit 1043	Excerpt from Bourgoyne, A. T., Jr., K. K. Millheim, M. E. Chenevert and F. S. Young, Jr., <u>Applied Drilling Engineering</u> , Society of Petroleum Engineers (1986) (page 351 -353 (Chapter 8)
Exhibit 1044	Excerpt from Vassiliou, M. S., <u>Historical Dictionary of the Petroleum Industry</u> , Rowman & Littlefield (2018) (pages xxv-xliii, 146-149, 174-175, 186-187)

Exhibit	Description
Exhibit 1045	U.S. Patent Application Publication No. 2013/0306322 to Sanborn et al., entitled “System and Process for Extracting Oil and Gas by Hydraulic Fracturing,” published November 21, 2013 (“Sanborn”)
Exhibit 1046	U.S. Patent Publication No. 2012/0255734 to Coli <i>et al.</i> entitled “Mobile, Modular, Electrically Powered System for Use in Fracturing Underground Formations,” published October 11, 2012 (“Coli”)
Exhibit 1047	Waters, George, Dean, Barry, Downie, Robert, Kerrihard, Ken, Austbo, Lance, and Bruce McPherson, “Simultaneous Hydraulic Fracturing of Adjacent Horizontal Wells in the Woodford Shale,” Paper presented at the SPE Hydraulic Fracturing Technology Conference, The Woodlands, Texas, January 2009 (available at https://doi.org/10.2118/119635-MS) (“Waters”)
Exhibit 1048	Pearson, C.M., Bond, A.J., Eck, M.E., and J.H. Schmidt. "Results of Stress-Oriented and Aligned Perforating in Fracturing Deviated Wells." J Pet Technol 44 (1992): 10–18 (available at https://doi.org/10.2118/22836-PA) (“Pearson”)
Exhibit 1049	Mutalik, P N, and Bob Gibson. "Case History of Sequential and Simultaneous Fracturing of the Barnett Shale in Parker County." Paper presented at the SPE Annual Technical Conference and Exhibition, Denver, Colorado, USA, September 2008 (available at https://doi.org/10.2118/116124-MS) (“Mutalik”)
Exhibit 1050	Mayerhofer, M. J., Lolon, E. P., Warpinski, N. R., Cipolla, C. L., Walser, D., and C. M. Rightmire. "What is Stimulated Reservoir Volume (SRV)?" Paper presented at the SPE Shale Gas Production Conference, Fort Worth, Texas, USA, November 2008 (available at https://doi.org/10.2118/119890-MS) (“Mayerhofer”)

Exhibit	Description
Exhibit 1051	Roussel, Nicolas P., and Mukul M. Sharma. “Optimizing Fracture Spacing and Sequencing in Horizontal-Well Fracturing.” SPE Prod & Oper 26 (2011): 173–184 (available at https://doi.org/10.2118/127986-PA) (“ <i>Roussel</i> ”)
Exhibit 1052	K. R. Webster, W. C. Goins, Jr., and S. C. Berry, "A Continuous Multistage Tracing Technique," Journal of Petroleum Technology, vol. 17, no. 06, pp. 619-625, 1965 (available at https://doi.org/10.2118/977-PA) (“ <i>Webster</i> ”)
Exhibit 1053	A. Casero, G. Pace, B. Malone, F. Cantaloube, L. Tealdi, H. Malonga, and R. Seale, “Continuous Pumping, Multistage, Hydraulic Fracturing in Kitina Field, Offshore Congo, West Africa,” in SPE International Symposium and Exhibition on Formation Damage Control, 2008, vol. All Days (available at https://doi.org/10.2118/112442-MS) (“ <i>Casero</i> ”)
Exhibit 1054	S. Rassenfoss, “A Look Into What Fractures Really Look Like,” Journal of Petroleum Technology, vol. 70, no. 11, pp. 28-36, 2018 (available at https://doi.org/10.2118/1118-0028-jpt) (“ <i>Rassenfoss</i> ”)
Exhibit 1055	R. Oberhofer, “Application of Ball-Drop Technology to Improve Efficiency and Stimulation of Limited Entry Completion Systems,” in Abu Dhabi International Petroleum Exhibition & Conference, 2016, vol. Day 2 Tue, November 08, 2016 (available at https://doi.org/10.2118/183427-MS) (“ <i>Oberhofer</i> ”)
Exhibit 1056	Tolman, R. C., et al. (2009), “Method and Apparatus for Simultaneous Stimulation of Multi-Well Pads,” SPE Hydraulic Fracturing Technology Conference (“ <i>Tolman Article</i> ”).
Exhibit 1057	G. R. Holzhausen and R. P. Gooch, "Impedance of Hydraulic Fractures: Its Measurement and Use for

Exhibit	Description
	Estimating Fracture Closure Pressure and Dimensions," in SPE/DOE Low Permeability Gas Reservoirs Symposium, 1985, vol. All Days (available at https://doi.org/10.2118/13892-MS) (“Holzhausen”)
Exhibit 1058	R. W. Paige, L. R. Murray, and J. D. M. Roberts, "Field Application of Hydraulic Impedance Testing for Fracture Measurement," SPE Production & Facilities, vol. 10, no. 01, pp. 7-12, 1995 (available at https://doi.org/10.2118/26525-pa) (“Paige”).
Exhibit 1059	L. V. Massaras, A. Dragomir, and D. Chiriac, “Enhanced Fracture Entry Friction Analysis of the Rate Step-Down Test,” in SPE Hydraulic Fracturing Technology Conference, 2007, vol. All Days (available at https://doi.org/10.2118/106058-MS) (“Massaras”)
Exhibit 1060	S. Mondal, “Pressure transients in wellbores: Water hammer effects and implications for fracture diagnostics,” 2010 (“Mondal”)
Exhibit 1061	<i>Christie/Christie Provisional Citation Correlation</i>
Exhibit 1062	Excerpts of Downing’s Patent Owner Response in <i>Inter Partes</i> Review of U.S. Patent No. 11,560,770 (<i>Intelligent Wellhead Systems, Inc. v. Downing Wellhead Equipment, LLC</i> , IPR2024-00300, Paper 20)

17. Other than prosecution histories, Ex 1003-1005, all citations to exhibits reference original page numbers found in the underlying document, and all emphases are added.

VI. SUMMARY OF CONCLUSIONS AND GROUNDS FOR CHALLENGE

18. After reviewing the materials identified in the List of Exhibits, I have concluded that each of the Challenged Claims of the '952 Patent would have been anticipated and/or obvious to a person of ordinary skill in the art based on the following grounds. I also provide other opinions relating to other grounds of unpatentability that Petitioner has presented in the Petition. The table below provides a Summary of the grounds. I explain and show below why each of the Challenged Claims is unpatentable in the detailed discussion of Grounds. I've considered each claim as a whole but have addressed each subpart separately for ease of discussion.

Ground	'952 Claims	Basis for Challenge
1	All Claims	Patent Ineligible
2	All Claims	Lack of Written Description and New Matter
3	1-57, 62, 69, 76	Lack of Written Description and New Matter
4	16-19, 35-38, 54-78	Lack of Written Description and New Matter
5	4, 23, 42, 60, 67, and 74	Improper Dependent Claims
6	All Claims	Obvious over <i>Christie</i>
7	All Claims	Obvious over <i>Christie</i> in view of <i>Pitcher</i> and <i>Al-Salmani</i>
8	All Claims	Anticipated by <i>Krupa</i>
9	All Claims	Obvious over <i>Krupa</i>
10	All Claims	Obvious over <i>Krupa</i> in view of <i>FS-Video</i> and <i>Al-Salmani</i>

VII. LEGAL STANDARDS

A. LEVEL OF ORDINARY SKILL IN THE ART

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

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

B. LEGAL STANDARD FOR CLAIM CONSTRUCTION

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

22. I have been instructed by counsel on the law regarding claim construction and patent claims, and I understand that a patent may include two types

of claims: independent claims and dependent claims. An independent claim stands alone and includes only the limitations it recites. A dependent claim can depend from an independent claim, or it can further depend from another dependent claim. I understand that a dependent claim includes all the limitations that it recites, in addition to all the limitations recited in the claim(s) from which it depends.

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

24. I understand that to determine how a person of ordinary skill would have understood a claim term, one should look to those sources available that show what a person of skill in the art would have understood the disputed claim language to mean. I understand that, in construing a claim term, one looks primarily to the intrinsic patent evidence, including the words of the claims themselves, the remainder of the patent, and the patent’s prosecution history. I understand that extrinsic evidence, which is evidence external to the patent and the prosecution history, may also be useful in interpreting patent claims when the intrinsic evidence itself is insufficient.

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

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

C. PATENT ELIGIBLE SUBJECT MATTER

27. I understand that a patent may be obtained for inventions of any new and useful process, machine, manufacture, or composition of matter, or any new or useful improvement to a process, machine, manufacture, or composition of matter.

28. I understand that patent claims that are directed to abstract ideas are not eligible for patenting. I understand that determining whether a claim recites patent eligible subject matter is a question of law.

D. SPECIFICATION REQUIREMENTS

29. I understand that a patent claim is invalid if the specification fails to meet the written description requirement. I understand that for a claim to be supported by a sufficient written description, the original disclosure in the application must reasonably convey to those skilled in the art that the inventor had possession of the claimed subject matter as of the filing date.

30. I understand that to satisfy the written description requirement, the specification must describe every claim limitation such that a person of ordinary skill, reading the specification, would inherently, necessarily, or immediately envisage the claimed invention.

31. I further understand that while no particular form of disclosure is required or that the specification recite the claimed invention in the exact same words, a description that merely renders the claimed invention obvious does not satisfy the written description requirement. In other words, it not sufficient for purposes of the written description requirement that the disclosure, when combined with the knowledge in the art, would lead one to speculate as to modifications that the inventor might have envisioned, but failed to disclose.

32. Further, I understand that mere textual support for each individual claim limitations without a description of the specifically claimed combination or actual

functioning of the invention that the individual claim limitations together define is not a sufficient disclosure to meet the written description requirement.

33. I understand that dependent claims are supposed to further limit the scope of the independent claims, and if they do not, they are invalid.

E. ANTICIPATION

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

F. OBVIOUSNESS

35. I understand that the prior art may render a patent claim “obvious.” I understand that two or more prior art references (e.g., prior art articles, patents, or

publications) that each disclose fewer than all elements of a patent claim may nevertheless be combined to render a patent claim obvious if the combination of the prior art collectively discloses all elements of the claim and one of ordinary skill in the art at the time would have been motivated to combine the prior art in such a way. I understand that this motivation to combine need not be explicit in any of the prior art but may be inferred from the knowledge of one of ordinary skill in the art at the time the patent was filed. I also understand that one of ordinary skill in the art is not an automaton but is a person having ordinary creativity. I further understand that one or more prior art references, articles, patents or publications that disclose fewer than all of the elements of a patent claim may render a patent claim obvious if including the missing element would have been obvious to one of skill in the art (e.g., the missing element represents only an insubstantial difference over the prior art or a reconfiguration of a known system).

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

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

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

- a long felt but unmet need in the prior art that was satisfied by the claimed invention;
- commercial success of processes claimed by the patent;
- unexpected results achieved by the invention;
- praise of the invention by others skilled in the art;
- the taking of licenses under the patent by others; and
- deliberate copying of the invention.

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

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

- the claimed subject matter is simply a combination of prior art elements according to known methods to yield predictable results;
- the claimed subject matter is a simple substitution of one known element for another to obtain predictable results;
- the claimed subject matter uses known techniques to improve similar devices or methods in the same way;

- the claimed subject matter applies a known technique to a known device or method that is ready for improvement to yield predictable results;
- the claimed subject matter would have been “obvious to try” choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- there is known work in one field of endeavor that may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to a POSITA;
- there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent’s claims; and
- there is some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed subject matter.

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

G. PRIORITY DATE

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

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

44. I understand that in order to satisfy the written description requirement the earlier application must reasonably convey to those skilled in the art that the inventors had possession of the subject matter of the patent as of the filing date of the earlier application. I have been informed that it is the disclosures of the earlier patent application that count, and that while the meaning of terms, phrases, or diagrams in the earlier patent application must be interpreted from the vantage point of one skilled in the art, all of the claimed limitations must appear in the

specification. Further, I understand that this analysis is not a question of whether one skilled in the art might be able to construct the claimed invention from the teachings of the disclosure or whether a claimed invention is an obvious variant of that which is disclosed in the specification; rather, I understand that an earlier application must itself describe each of the claim limitations.

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

H. INDEPENDENT AND DEPENDENT CLAIM ANALYSIS

46. I understand that an independent claim does not refer to any preceding claim. The '952 Patent includes numerous dependent claims that refer to the independent claims. Further, I understand that each dependent claim depends from an independent claim or from another dependent claim. I understand that, as a result, each dependent claim incorporates all of the elements of the claim(s) that it refers to. Therefore, in my analysis of the dependent claims, my analysis of the claim(s) from which they depend is also incorporated.

VIII. OVERVIEW OF THE CHALLENGED PATENT

47. I have reviewed the '952 Patent, which is entitled "Hydraulic Fracturing Plan and Execution of Same" (Ex. 1001). I have also reviewed the prosecution history of the '952 Patent (Ex. 1003). I understand that the patent was filed on

January 23, 2023, and issued on November 5, 2024. The '952 Patent claims priority to several other documents. Still, as I discuss below in the “Priority Date of the '952 Patent” section, those earlier documents do not support all claim limitations of the '952 Patent.

A. THE SUBJECT MATTER OF THE CHALLENGED PATENT

48. The '952 Patent describes a conventional multi-well hydraulic fracturing system, where fracturing fluid is pressurized and directed from pumps through a discharge manifold to a zipper manifold, which communicates the pressurized, discharged fracturing fluid to the “frac legs” (wellheads) of each well:¹

¹ Ex. 1001, 5:45-65.

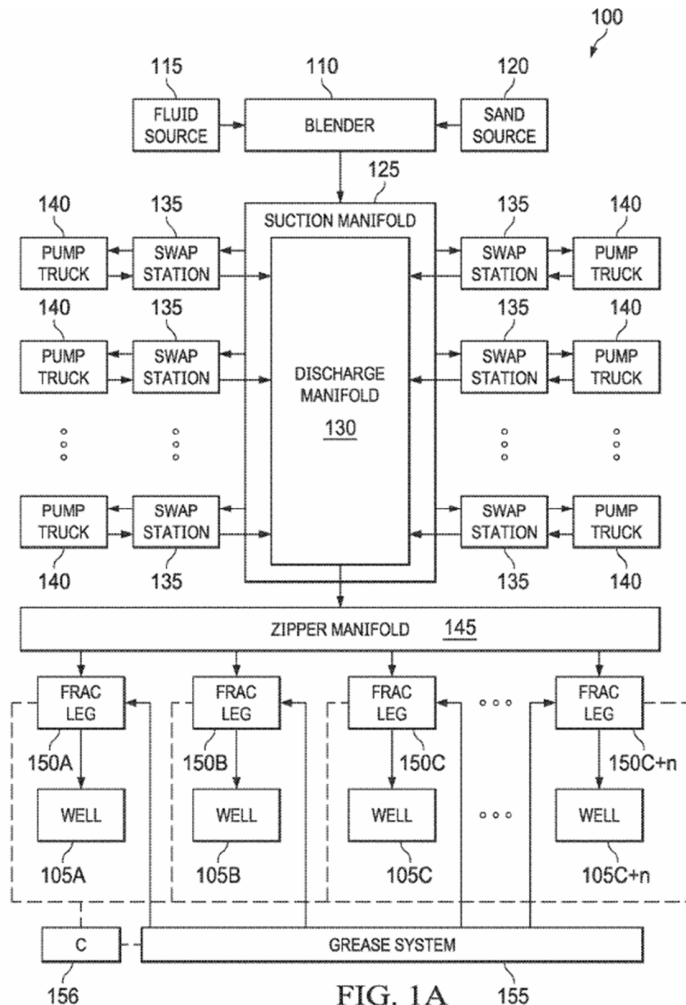


FIG. 1A

49. The '952 Patent is directed to steps for switching from wireline/perforating, isolating, and fracturing each well, which include greasing and operating valves in a wireline and equalization assembly on the well's frac leg.² Operation of the wireline and equalization assembly allows one well to be prepared

² Ex. 1001, 6:48-58, Fig. 1B.

for a fracturing stage while another well is being fractured, so that fracturing fluid can be continuously pumped to well(s) while the next well is prepared.³

50. The Challenged Claims are completely silent as to the actual technology described in the '952 Patent. Instead, the Challenged Claims are directed to a valve operation sequence based on fluid flow to a well during pumping, performed using any conventional zipper fracturing system.

B. THE CHALLENGED CLAIMS OF THE '952 PATENT

51. The Challenged Claims of the '952 Patent, which are Claims 1-78, are set forth in the Claims Listing. Some of the claim elements have been further subdivided (and labeled as part "1.1", "1.2," or similar, where the first number indicates the claim number, and the decimals refer to sub-parts of that claim) for ease of reference. The Claims recite substantial overlapping or same subject matter. Accordingly, when addressing Claims or limitations with duplicative or overlapping subject matter, I may reference previously presented analysis of such subject matter.

C. PROSECUTION HISTORY OF THE '952 PATENT

52. I have reviewed the prosecution history of the '952 Patent. The '952 Patent was filed as U.S. Application No. 18/158,122 (the "'122 Application") on January 23, 2023, as a continuation application of U.S. Application No. 17/878,493

³ Ex. 1001, 6:58-7:24.

(the “’493 Application”), filed on August 1, 2022, which issued as U.S. Patent No. 11,480,770 (the “’770 Patent”). The ’770 Patent is a continuation of U.S. Application No. 17/388,716 (the “’716 Application”), filed on July 29, 2021, which issued as U.S. Patent No. 11,401,779 (the “’779 Patent”). The ’716 Application claims priority to Provisional Application No. 63/189,663 (the “’663 Provisional”), filed on May 17, 2021.

53. In the only Office Action presented during the prosecution of the ’122 Application, the Examiner rejected all but three of the originally-filed claims as being “not patentably distinct” from the ’770 and ’779 Patents “because the claims...merely remove limitations and/or have minor obvious changes in claim language.”⁴ In response, the Applicant filed a terminal disclaimer.

54. The Examiner then issued a first Notice of Allowance (NOA), stating that the closest prior art, US2017/0275980 (“Kajaria”), discloses opening/closing first and second valves to associated first and second wells, but does not disclose “the key features of” closing another well’s valve after opening a first well’s valve while hydraulic fracturing fluid flows to the first well.⁵

55. The Applicant then filed a Request for Continued Examination (RCE) with an Information Disclosure Statement (IDS), citing *Krupa* (discussed below) and

⁴ Ex. 1003, 349.

⁵ Ex. 1003, 309-310.

amending the independent claims to include “in response to” and “continuous pumping (‘CP’)” limitations similar to the ’770 and ’779 Patents and new never-before-seen “pressure” limitations, and adding twenty-six more claims.⁶

56. Twenty-two days later, the examiner issued a second NOA, in which the Examiner maintained Kajaria as the closest prior art of record.⁷

57. The Applicant then filed another RCE, this time adding thirty-two more claims, reciting substantially the same subject matter as the existing claims plus new never-before-seen “dashboard” limitations.⁸ An IDS was also submitted citing references from the co-pending litigation of the ’770 and ’779 Patents.⁹

58. The Examiner then issued a third NOA, maintaining Kajaria as the closest prior art of record.¹⁰

59. The Applicant then filed a third RCE, submitting another IDS citing references from the co-pending ’770 and ’779 Patents’ IPRs, and amending claims to specify arrangement/function of conventional pumps.¹¹

⁶ Ex. 1003, 278-297.

⁷ Ex. 1003, 230.

⁸ Ex. 1003, 196-222.

⁹ Ex. 1003, 178-184.

¹⁰ Ex. 1003, 150-151.

¹¹ Ex. 1003, 131-141.

60. The Examiner then issued a fourth NOA, and the '122 Application was issued as the '952 Patent on November 5, 2024.¹²

D. PRIORITY DATE OF THE '952 PATENT

61. I have reviewed the filing history of the '952 Patent and related applications. For the '952 Patent, the Application Data Sheet (ADS) filed along with the '122 Application indicated that the application was a continuation of the '493 Application (the '770 Patent), filed August 1, 2022, which was a continuation of the '716 Application (the '779 Patent), filed July 29, 2021, which claimed the benefit of the '663 Provisional (filed May 17, 2021).

62. The '770 and '779 Patents share substantially the same specifications as the '952 Patent. I understand that Downing has admitted that the “earliest effective filing date” of the '770 and '779 Patents is the '663 Provisional’s filing date, May 17, 2021.¹³ The '770 and '779 Patents and '663 Provisional are collectively referred to as the “Parent applications.”

63. The ADS also indicated that the '716 Application was a “continuation-in-part” of U.S. Application No. 17/319,854 (“the '854 Application”), which was filed May 13, 2021, and which claimed the benefit of a long family chain including seven non-provisional applications, each being related through CIP filings, and nine

¹² Ex. 1003, 001-002, 019-020.

¹³ See Ex. 1013.

provisional applications. The '854 Application and its family chain are collectively referred to as the "CIP parent applications."

64. Except for some generic background language, the '770, '779, and '952 Patents do not contain any copied portions of the CIP parent applications. Instead, the specifications of the '770, '779, and '952 Patents contain originally drafted descriptions of valve operations for a plurality of wells and fracturing systems and methods, including detailed descriptions of frac legs and associated valves and wells, and operations thereof.

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

66. I understand that to rely on a parent application's filing date, the parent application must disclose each element of the claim to an extent where it is clear the

inventor had possession of the claimed invention at the time of the parent application. I have also been instructed that only subject matter which is actually or inherently disclosed in a parent application is entitled to the parent application's filing date. The subject matter that is obvious over the parent application's disclosure is not entitled to the parent application's filing date.

67. Because the CIP parent applications do not disclose all the limitations in claims of the '952 Patent, the Challenged Claims are not entitled to any of the claimed earlier filing dates of the CIP parent applications.

68. Further, the '952 Patent is not entitled to the filing dates of any of the '770 Patent, '779 Patent, '663 Provisional, or even its own filing date, because the Challenged Claims include new matter not found in any of these applications' specifications. As discussed above in the Prosecution History, after the first NOA, the Applicant added new pressure limitations and claims to the '122 Application, which specified that the second valve is opened in response to "one or more conditions include[ing]... pressure." However, neither the '952 Patent's own specification nor any of the '952 Patent's earlier-filed parent applications describe using pressure as a condition for opening a valve in a "CP swap."

69. Additionally, after the second NOA, the Applicant added new dashboard claims to the '122 Application, which specified using a dashboard to display visual references of the valves and visual indicators of the valves' open or

closed state. However, none of the '952 Patent's specification or the '952 Patent's earlier-filed parent applications describe these dashboard limitations. Instead, only Appendix A of the '663 Provisional mentions a dashboard, but it is silent as to any valve visual references or visual indicators.

70. Because there is no written description support for the pressure condition limitations (Claims 1-57, 62, 69, 76) or for the dashboard limitations (Claims 16-19, 35-38, 54-57, 58-78) in the '952 Patent or any of its earlier-filed related applications, the '952 Patent does not have an effective filing date. However, I have been informed that if a filing date is to be assigned, it could only possibly be the filing date of the '952 Patent, January 23, 2023.

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

71. I have been asked to analyze the technical references that I understand Petitioner is asserting as prior art (*Christie*, *Krupa*, *FS-Video*, *Al-Salmani*, and *Pitcher*) and to compare them to the references cited during prosecution of the '952 Patent.

72. **Primary references:** I have relied upon *Christie* and, alternatively, *Krupa* as the base (or primary) references.

73. **Secondary references:** I have relied upon *FS-Video*, *Al-Salmani*, and *Pitcher* as the secondary references, along with the knowledge of a person of ordinary skill in the art, which are used in combination with the primary references.

74. *Christie*, *FS-Video*, and *Al-Salmani* were not before the Examiner during prosecution of the '952 Patent, and these references do not appear to be cumulative of other references considered by the Examiner. While *Krupa* and *Pitcher* were in the record, the Examiner erred by overlooking these references.

75. *Krupa* was submitted in a late-stage IDS, after the '122 Application's first NOA. Less than a month later, the Examiner issued a second NOA, without mentioning *Krupa*. Later, in another IDS with over fifty references, Downing submitted documents from the IPRs of the related '770 and '779 Patents in which Downing admits that *Krupa* discloses the relevant continuous pumping limitations, but instead argues that *Krupa* should be disqualified as prior art because Downing published this concept prior to *Krupa*.¹⁴

76. Instead of addressing *Krupa* or Downing's claims of its disqualification, the Examiner issued another NOA, in which the Examiner claimed two other unrelated references were the closest prior art of record. Given the undisputed, substantial overlap between *Krupa* and the '952 Patent claims, and the Examiner's silence on the subject, I believe the Examiner overlooked *Krupa* and Downing's admissions.

¹⁴ Ex. 1015-1016.

77. Additionally, in the only claim rejections in the '122 Application's only office action, the Examiner stated that the claims were not patentably distinct from the '770 and '779 Patent claims because the '122 Application's claims "merely remove limitations and/or have minor obvious changes in claim language."¹⁵ One such "remove[d] limitation[]" was the limitation from the '779 Patent's claims that "the flow rate of fluid being pumped into the first well is below a flow rate threshold and has been below the flow rate threshold for a threshold amount of time." However, the Examiner failed to consider that by removing this limitation, *Pitcher*, which had been previously relied on in the '779 Patent's prosecution, was highly relevant. As noted by Downing in a '779 Patent's IPR document submitted to the Examiner in a '122 Application IDS, "[t]he Examiner correctly recognized" during the '779 Patent prosecution, "that Pitcher's disclosure is not sufficient to meet the specific claim requirement of... the flow rate of the fluid being... below a flow rate threshold... for a threshold amount of time."¹⁶ However, it is undisputed that "Pitcher teaches using the desired flow rate and desired time as thresholds to trigger a subsequent fracturing stage."¹⁷ "Specifically, the next stage is triggered when it is determined (via a sensor) that the flow rate is at the desired flow rate for the desired

¹⁵ Ex. 1003, 349.

¹⁶ Ex. 1015.

¹⁷ Ex. 1015 (citing Pitcher, ¶ [0037]).

amount of time.”¹⁸ Thus, because the ’952 Patent omits the ’779 Patent’s threshold limitation, but instead merely states that the second valve is opened “in response to the fluid... satisfying one or more conditions,” *Pitcher* is highly relevant. The Examiner erred by overlooking *Pitcher*.

IX. LEVEL OF ORDINARY SKILL IN THE ART

78. A person of ordinary skill in the art would have a Bachelor of Science in Engineering and at least two years of academic or industry experience in the oil and gas industry, including well-related operations experience, such as well drilling, completion, or production. Additional education could offset experience and vice versa. I meet this standard.

X. CLAIM CONSTRUCTION

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

80. I do not believe any claim terms of the ’952 Patent need to be construed to assess whether the prior art reads on the challenged claims.¹⁹

¹⁸ Ex. 1015.

¹⁹ I reserve the right to raise or address claim construction of the claims of the ’952 Patent and other arguments in district court. For example, all challenges to the ’952 Patent are not raised in the petition, including, for example, validity under 35 U.S.C. 112, and controversies may arise during litigation that require resolution through

XI. TECHNOLOGY BACKGROUND AND STATE OF THE ART

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

A. HISTORY OF HYDRAULIC FRACTURING

82. Fracturing hydrocarbon-bearing formations is a technique that has been used to increase or speed up oil and gas production for nearly as long as oil and gas production has existed.²⁰ Hydraulic fracturing, in its modern form of pumping using pumps and valves to control fluids and proppants (*e.g.*, sand) pumped into the formation, began in the 1940s using a process developed by Stanolind Oil and commercialized by Halliburton in the mid-continent region.²¹

claim construction not presented here because of the similarities between the prior art and the '952 Patent.

²⁰ *Morton*.

²¹ *Wells; Montgomery*, 27.



83. In oil and gas exploration, directional drilling is a technique for accessing hydrocarbon-bearing formations (oil and gas formations) that includes deviating the wellbore from the vertical to reach previously inaccessible formation locations, to expose more of the hydrocarbon-bearing formation to the wellbore, or to drill several wells from a single surface location, such as an offshore platform or a land-based drilling pad.²²

84. By at least 1986, horizontal drilling techniques were well-known and heavily developed. In 1986, a multifracture horizontal well was drilled using directional drilling to cause the wellbore to enter a more or less horizontal orientation (parallel to the surface of the earth), combined with advanced hydraulic fracturing techniques to not only expose large lengths of the hydrocarbon formation to the wellbore, but also to create artificial cracks or “fractures” in the formation from

²² *Bourgoyne*, 351.

multiple locations to allow the hydrocarbons to “leak” out of the formation into the wellbore.²³ The use of horizontal drilling and fracturing systems in shale formations has vastly increased since the 1980s and continuing to the present day.²⁴

85. As more formation is exposed to be fractured, horizontal wells use much higher volumes of fracturing fluid and proppant than vertical wells. This requires the use of more and bigger blending and pumping systems, typically triplex or quintuplex positive displacement (plunger) type pumps, though pumps with more plungers have been used.²⁵

B. TYPES OF PUMPS – FRACTURING PUMP CHAIN

86. The basics of hydraulic fracturing have not changed significantly since 1949 when Halliburton first commercialized the “hydrafrack” process. Hydraulic fracturing still involves pumping water (or another fluid) blended with a proppant (*e.g.*, sand) and other chemicals into the downhole reservoir at a sufficient pressure to crack (fracture) the downhole rock. The sand-water mixture is then forced into the cracks, where the sand keeps the cracks (fractures) open to allow hydrocarbons, such as oil and natural gas, to flow out of the formation into the well bore. What has

²³ *Vassiliou*, xliii.

²⁴ *Wells*, 9.

²⁵ *Sanborn*, [0005]; Ex. 1046 (*Coli*), [0011], [0049], FIG.2.

changed are the pressures and flow rate of the fracturing jobs, the sizes of equipment and the particular proppants, chemicals, and liquids used.

87. A modern fracturing process requires multiple pumps operating together as a system to provide fracturing fluid with the suitable composition at the right flow rate²⁶, and at a pressure sufficient to fracture the formation. At the beginning of the pumping chain are the water transfer pumps. These pumps operate at a relatively low pressure to move water from storage (e.g., ponds, tanks) to the blender or the hydration unit.

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

89. Once the fracturing slurry is blended to the proper makeup and consistency, it is transferred to the fracturing pumps using a blender discharge pump.

²⁶ “Flowrate,” “flow rate,” and “flow-rate” are used interchangeably in the industry and herein.

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

90. In a piston (plunger) pump, pistons are connected along a shaft, which is rotated by an external power source (*e.g.*, an engine or electric motor), where rotational motion of the shaft is translated into the linear motion of the pistons. As the shaft rotates, the piston (plunger) moves away from the head, creating suction which draws the slurry into the piston chamber. As the piston (plunger) moves toward the head, pressure is created which drives the fluid out of the chamber and down the line to and into the wellbore. A key characteristic of these fracturing pumps is that the same amount of liquid is discharged from the pump with every stroke, largely independent of the pressure downstream. The result is that flow at a particular pump speed is relatively constant, while pressure changes as downstream conditions change. Accordingly, as fracturing begins, reducing the downstream impedance of the fluid flow system, pressure tends to drop as flow rate stays relatively constant. Conversely, pressure rises with a relatively stable flow rate as

downstream impedance increases. As a boundary condition, if a valve is closed downstream of a fracturing pump, flow rate through the pump will remain relatively constant while pressure rises extremely fast. Pressure will continue to rise until some condition reduces the downstream impedance, *e.g.*, equipment failure, such as pump seals, piping failure, or rupturing of valve bodies.

91. If suction pressure in a pump drops below the vapor pressure of the incoming fluid, *e.g.*, by an insufficient volume of incoming slurry, then bubbles form in the liquid—a condition known as cavitation. When the bubbles collapse, such as when the piston reaches the bottom of its stroke, noise, vibration and damaging forces are created. To avoid cavitation and the associated problems, the suction pressure must be maintained higher than the vapor pressure of the pump's incoming fluid (*e.g.*, slurry) (*i.e.*, maintaining a Net Positive Suction Head (NPSH)), even during the intake phase of the piston.

92. As would have been known to a POSITA, the slurry (*e.g.* water containing sand) would cause erosion damage to the fluid flow components, particularly the valves and valves and seats on the pumps. One method of reducing this damage is to pump proppant-free fluid (pad fluid or flush fluid) into the formation at the beginning of the fracturing process. This pad fluid pressures up the well and initiates fractures in the formation, and is accordingly a fracturing fluid. Once the formation fractures have, at least, begun to open, then proppant-laden fluid

is pumped into the fractures and the proppant is deposited to “hold open” the fractures. Once sufficient fluid and proppant have flowed into the formation, proppant free fluid (pad fluid or flush fluid) is pumped into the wellbore to flush the proppant out of the surface equipment and the wellbore into the formation. In this way, the wellbore is cleaned of proppant and the risk of screenouts is reduced. Further, the surface equipment is also cleaned of proppant allowing for longer service life.

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

93. For most of its history, hydraulic fracturing has been performed one well at a time, potentially with several stages (zones) being fractured in a single well. With the increased popularity of horizontal drilling in the 1990s and 2000s, the number of fracturing stages in a well increased dramatically as the “pay zone” (the hydrocarbon-bearing formation) in which the well exposed increased from tens to hundreds of feet to several thousand feet. The goal, as always, was to create fractures that expose the hydrocarbon-bearing formation to the wellbore, allowing the hydrocarbons to flow into the wellbore.

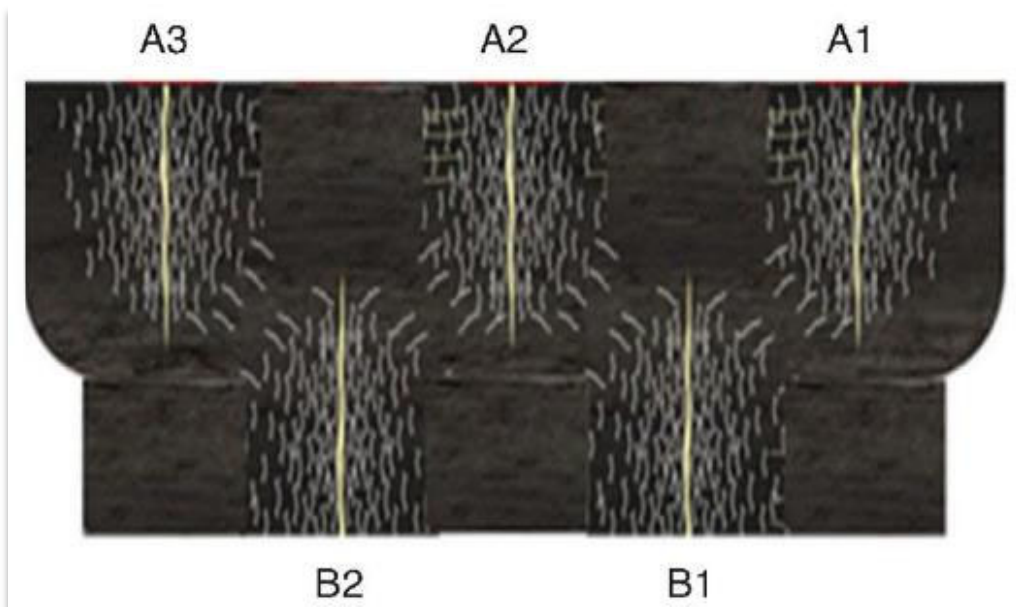
94. In the mid-2000s, operators began experimenting with and then using a technique dubbed “zipper fracturing,” in which multiple wells, closely spaced in the formation and often drilled from the same pad, were fractured simultaneously or sequentially. The result was that the fractures formed in one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

the pressures and fractures in another well, leading to so-called “zipper fractures” that were longer, multidirectional, and exposed more formation to the wellbores than single well fracturing produced. Valves have always been used to control fluid flow from the pumps to a well during fracturing. As with operation of valves in any other fluid system, valves used with well systems are operated (e.g., opened or closed) to control where fluid flows and its properties, such as flowrate and pressure, to achieve a desired outcome in the system. Since the beginning of using valves, valves have been operated to control fluid flow (e.g., to alter the flow direction and/or flow conditions, as desired) based on current conditions of the fluid system. These conditions are commonly determined using sensors, or just by observing fluid flowing through the valve system. In fact, it would be unlikely that a valve in a well system would be operated without knowing or having a good idea of the fluid conditions through the valve, as well systems such as fracturing systems are often flowing high pressure fluids through valves and unexpectedly closing such valves may be dangerous and/or damage equipment. In the case of fracturing a well, valves may be used, for example, to stop the flow of fluid to a well or section of a well, increase pressure in a well (e.g., for fracturing), and/or slow the flow of fluid to a well, just to name a few, all of which may be decided based on current well operating conditions. In the case of fracturing multi-well systems, as with zipper fracturing,

valves have long been used for directing fluid to one or more of the wells in the system. Valves used with zipper fracturing are often referred to as “zipper valves.”

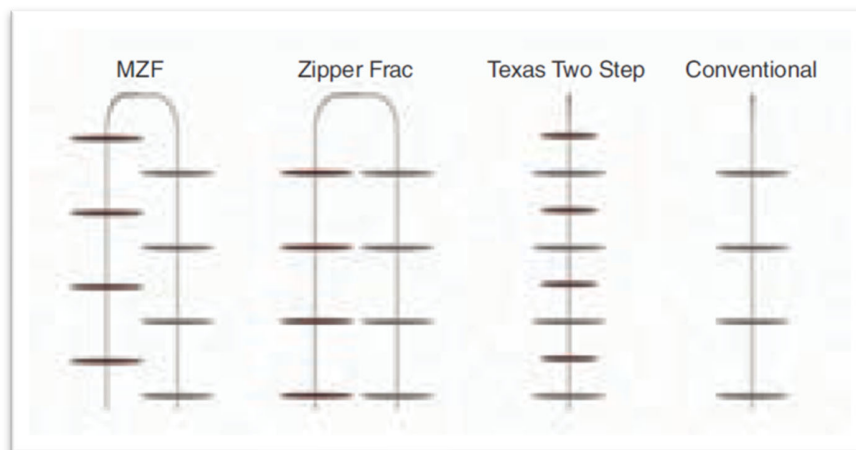
95. The image below was captured from *Jacobs*²⁷ and shows the influence that simultaneous or sequencing fracturing has on the fractures caused by wells. For the fractures nearest the wellbores, the fractures show a typical pattern of being aligned with the perforations, as shown in the below figure where A1-A3 are perforations and associated fractures from a first horizontal wellbore, and B1-B2 are the perforations/fractures from a second parallel wellbore. However, for fractures near other wellbores, the fracture lengthens and turns, creating a zipper-like pattern to the fracture. This exposes more of the formation to the wellbore and allows for earlier and more complete recovery of hydrocarbons from the formation.

²⁷ *Jacobs*, 64.



96. The figure²⁸ below (with the wellbores represented vertically) shows various types of fracturing configurations, beginning with conventional fracking (to the right) and ending with modified zipper fracturing (MZF) on the left. The changes in the location of the perforation and fracturing operations are intended to increase the development of zipper fractures and expand the interface with the hydrocarbon-bearing formation.

²⁸ *Jacobs*, 61.



97. Developing zipper fractures involves maintaining pressure in the formation from one wellbore while initiating fractures by pressuring up a proximate wellbore. “In ultra-low permeability reservoirs such as shales, the stimulations do not necessarily have to occur concurrently. Since little to no fluid leaks off into the rock matrix the fracture systems will remain pressurized until flown back. This pressurized system can provide the diversion [zipper fracture] desired when the adjacent lateral is stimulated subsequent to the initial stimulation.”²⁹

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

²⁹ *Waters*, 8.

or in an alternating arrangement, allowing for faster completion of the fracturing process.³⁰

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

99. The advantages of zipper fractures have been known for decades.³¹ For example, *Pearson* reports “results of stress-oriented and aligned perforating of deviated wells,” where “perforation alignment and spacing are calculated for each well so the fractures from individual perforations link to produce a single ‘zipper’ fracture plane along the deviated [horizontal] wellbore.”³²

100. The Zipper-frac process (alternating perforations and pressurization of adjacent wells) has been well-known in the industry since at least 2008, *e.g.*, as shown in *Waters* and *Mutalik*.³³ For example, *Mutalik* describes:³⁴

³⁰ *Waters*, 8.

³¹ *Pearson*.

³² *Pearson*, Summary.

³³ *Waters*; *Mutalik*.

³⁴ *Mutalik*, Background.

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

101. Although simultaneous frac processes may require more coordination and logistics, “they are cost-effective as the frac equipment is being utilized more efficiently and two wells are being completed in one week instead of two weeks.”³⁵ By 2008, operators were experimenting with expanding simultaneous fracturing “with triple fracs (‘trifectas’) or even quad-fracs in some cases.”³⁶

102. In addition, *Mayerhofer* discusses, “it may be more beneficial to drill laterals at closer spacing, with the chance of overlapping SRVs” (Stimulated Reservoir Volume).³⁷ “This is the reason for the so-called “simul-fracs” and “zipper-fracs” in shale reservoirs where multiple parallel wellbores are either stimulated simultaneously or in short alternating sequence from one lateral to the next.”³⁸

³⁵ *Mutalik*, Background.

³⁶ *Mutalik*, Background.

³⁷ *Mayerhofer*, 12.

³⁸ *Mayerhofer*, 12.

103. *Roussel* teaches that “[t]he numerical calculation of the fracture spacing required to avoid fracture deviation during propagation, for all three fracturing techniques, demonstrate the potential advantages of alternate fracture sequencing and zipper-fracs to improve the performance of stimulation treatments in horizontal wells.”³⁹

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

A horizontal well completion method known as zipper fracturing has been rapidly adopted over the last couple of years by companies in the Eagle Ford shale of south Texas. Instead of drilling and hydraulically fracturing one well at a time, the zipper method involves drilling multiple wells from a pad site and then hydraulically fracturing a stage in one well, while getting ready for the next, as wireline and perforation operations take place in another. The multiwell completion method earns its name from the zipper-like configuration of the fracture stages from wells drilled with relatively tight spacing.⁴⁰

D. CONTINUOUS PUMPING FRACTURING

105. As hydraulic fracturing has increased in the number of stages and wells treated, various techniques have been employed to meet the overall goal of reducing financial costs and non-productive time (NPT) at the well site. At the same time, techniques were developed to minimize wear and damage to the high-horsepower

³⁹ *Roussel*, 1.

⁴⁰ *Jacobs*, 60.

pumps, valves, and related equipment. One technique that furthers both goals is continuous pumping to treat multiple stages in a well or multiple wells simultaneously or sequentially.

106. Early continuous pumping techniques from at least the 1960s were directed toward treating multiple zones (stages) in a well without stopping the pumps.⁴¹ By at least 2007, continuous pumping equipment and techniques were well-known and practiced internationally. For example, *Casero* described the completion of three wells using an earlier-developed “Continuous Pumping Multi-State System (CPMSS) technique,” which “allows pumping multiple hydraulic fracturing treatments without the need of intermediate operation such as bridge plugs or proppant plugs.”⁴² *Casero* further teaches multiple benefits of a continuous pumping system, including faster completion time. *Rassenfoss* observed that wells drilled in 2015 were fractured using “zipper fracturing,” which could “fracture even more wells at once,” “by allowing continuous pumping” and reducing the risk of frac hits.⁴³ *Rassenfoss* further observes, “Simultaneous fracturing is likely to create stronger connections [between wells] because the time between stages is relatively short.”⁴⁴

⁴¹ *Webster*.

⁴² *Casero*, 2.

⁴³ *Rassenfoss*, 36.

⁴⁴ *Rassenfoss*, 36.

107. Further, *Christie* teaches continuous pumping in order to reduce NPT at the fracturing location. *Christie* teaches “coordinated pumping operations” at a multi-well fracturing site. *Christie* teaches coordinating valve operations, along with other operations to implement optimal wellsite equipment coordination across multiple well services, including well preparation (e.g., plug and perf operations) and well stimulation operations (e.g., fracturing) “to minimize time between pumping stages and to increase personnel safety,” “with the goal of performing continuous pumping downhole.”⁴⁵ By continuously pumping, *Christie* discloses reductions in NPT for the pumping system from 8-12 hours a day to 4 or less hours per day.

108. *Beuterbaugh* teaches, with regard to its hydraulic fracturing system, continuously running high pressure pumps at a constant rate to provide a substantially constant pressure of fracturing fluid to switching valves ⁴⁶ *Beuterbaugh*’s “switching valves” are used to switch (i.e. swap) from delivering fracturing fluid to the first well to delivering fracturing fluid to the second well.⁴⁷ *Beuterbaugh* further teaches that continuous pumping significantly reduces the wear and tear on the pumps.

⁴⁵ *Christie*, [0098].

⁴⁶ *Beuterbaugh*, [0018].

⁴⁷ See, e.g., *Beuterbaugh*, [0021].

109. *RigLock* teaches a wireline lubricator attachment system which eliminates “the need for people to work by the wellhead”.⁴⁸ Not only does this increase safety, but also “wireline can jump from one well to another while pumping operations continuous uninhibited.”⁴⁹ A POSITA would have recognized uninhibited pumping operations to be continuous pumping operations.

110. Accordingly, it was known in the industry, prior to the '952 patent, to perform continuous pumping operations to save time, reduce wear and tear on equipment and increase worker safety. It was also known in the industry to use remotely operated valves, e.g., as shown in *Christie and Beuterbaugh*, to control the flow of fluid through the system while continuously pumping. By remotely operating the valves, personnel can avoid dangerous high-pressure areas while fluid is being pumped. As it follows, the operation of remotely operated valves also routinely relied on threshold parameters to make sure fluid pressure does not reach dangerous levels and to make sure fluid is being directed and controlled in the manner commensurate with the well operation objectives. For example, valves are manufactured with certain ratings for the maximum pressure that can be applied before the valve would fail (rupture). Accordingly, remotely operated valves are at a minimum operated within its ratings in well operations. Remotely operated valves

⁴⁸ *Riglock*, 4:54.

⁴⁹ *Riglock*, 4:58.

are further routinely operated according to numerous other preset thresholds, including flowrate and pressure thresholds, in order to achieve a desired well operational goal. For example, with well fracturing, valves are commonly operated within flowrate and pressure thresholds for controlling a desired volume and pressure of fluid into a section of the well to be fractured, where the thresholds would be selected to provide enough fluid and pressure to fracture the formation but not too much to where the wellbore or surface/downhole equipment would be damaged or other adverse consequence.

E. OPERATION PARAMETERS FOR FRACTURING

111. Whether part of a zipper fracturing operation and/or continuous pumping operation, a hydraulic fracturing operation includes operational parameters such as fluid flow and pressure specific to the operation. For example, during a fracturing stage, as the fracturing stage is complete, flowrate and pressure are reduced once the fracture propagation goal has been met. Operational parameters such as the injected fluid's flowrate and pressure are often monitored to determine when new fractures are no longer being formed (indicating the end of the well's fracturing stage) in an effort to optimize efficiency, e.g., avoid wasting materials and time. Further, these parameters are monitored to indicate when mechanical

operations can safely be performed.⁵⁰ For example, *Casero* discusses reducing the flow rate between stages to allow for the mechanical execution of the frac job. Using the CPMSS technique, a mechanical operation includes dropping a degradable ball from the surface where it lands on a packer sleeve. The ball performs two functions. First, it acts as a seal to isolate the stages below the ball (like a valve). After the ball lands, the pump rate is increased again, and the differential pressure across the ball/seat causes activation of a sleeve, opening access to the perforations to be fractured.⁵¹

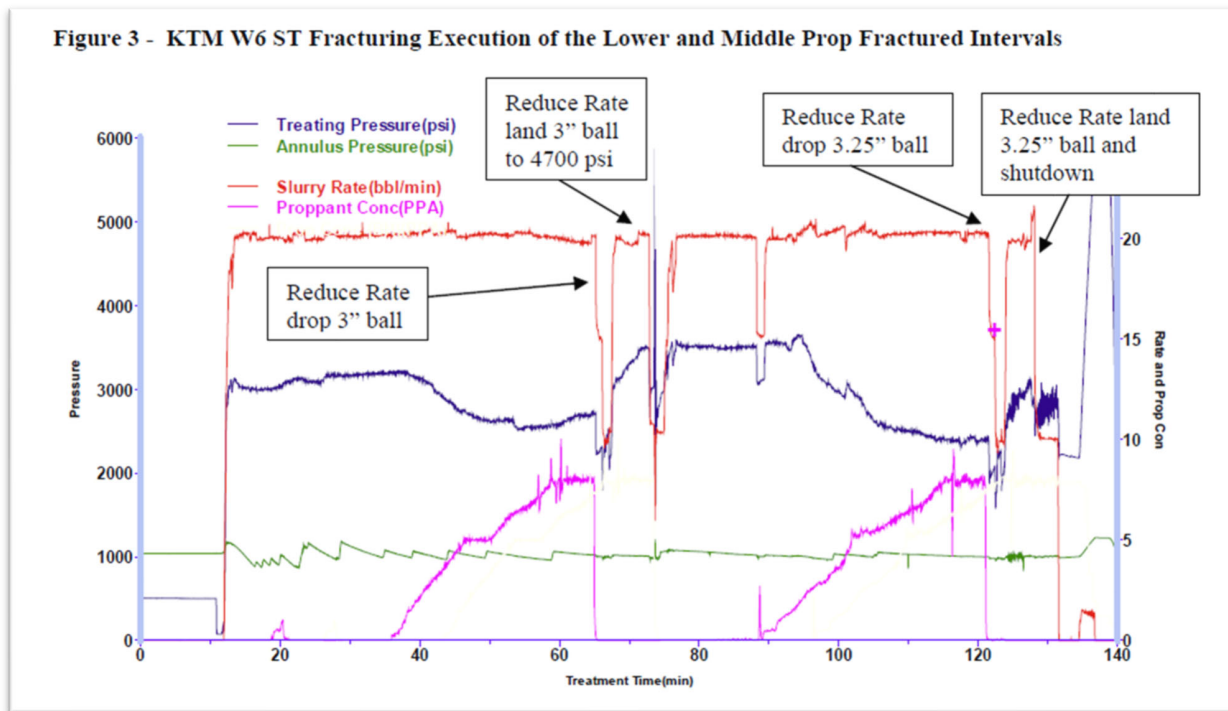
112. Before the mechanical functions are completed, *Casero* describes, “[t]he pumping rate is consistent at 20 bpm until the rate is reduced to have a controlled launch of the frac ball on the surface and then again when the ball is calculated to land at the fracture port”.⁵² *Casero*’s Figure 3 shows the rate reduction used to complete the mechanical action.⁵³

⁵⁰ *Casero*, 5, 6, Fig. 3.

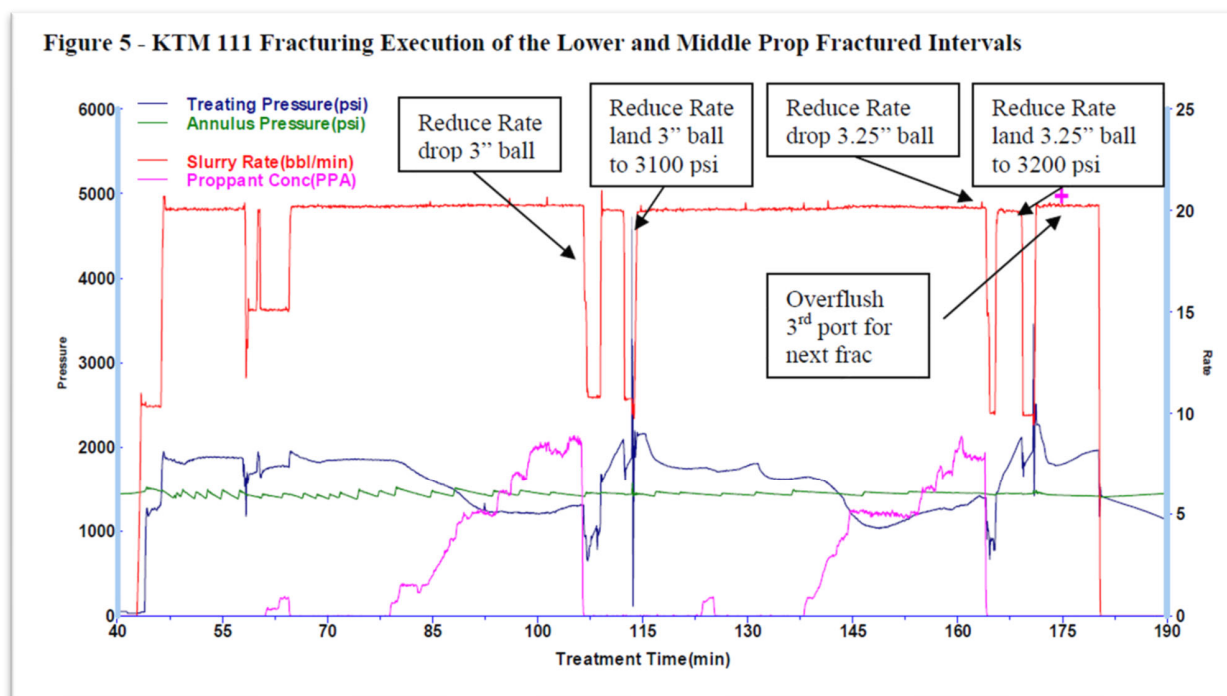
⁵¹ *Oberhofer*, 4.

⁵² *Casero*, 5.

⁵³ *Casero*, 16.



113. Figure 3 shows not only the reduction in rates necessary for controlled mechanical operations but also the increase and then decaying pressures consistent with a fracturing operation taking place when using positive displacement pumps. As further teaching, Figure 5 of *Casero* shows similar rate reductions to undertake mechanical operations. At the end of the fracturing stage, the fluid's flowrate ("slurry rate"/orange line) and treating pressure are reduced to end the fracturing. These parameters are commonly monitored, e.g., to confirm the operation is going according to plan, for use with fracture analysis, and for safety. Confirmation that the stage is ending as desired also provides confirmation that the well operation may continue as planned.



114. The *Tolman Article* describes another “Method and Apparatus Associated for Simultaneous Stimulation of Multi-Well Pads” in which multiple wells from a single pad were simultaneously stimulated while drilling additional wells.⁵⁴ Like *Casero*, the *Tolman Article* teaches suspending mechanical operations during high flow (high pressure) operations.⁵⁵ In the system described in the *Tolman Article*, where the pumps are continuously operating, the “high pressure pumping” resulting in/from high flow pumping must be reduced for mechanical operations, such as valve manipulations, to occur.

⁵⁴ *Tolman Article*.

⁵⁵ *Tolman Article*, 4.

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

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

F. TESTING

117. It has also long been established to vary and monitor operational parameters to conduct performance testing for fracturing operations, such as during

rate step tests (RST)⁵⁶ or during measurement of water hammer in order to characterize fractures in the downhole formation, which is performed by reducing flowrate and measuring variations in pressure. For example, since at least the 1980s, the value of measuring oscillations in the pressure of a fracturing system to indicate the extent of the fractures downhole has been known. Oscillations in the well are created in two primary ways. First, during flowing conditions, if the flow is suddenly changed (reduced) either through shutting a valve or a reduction in rate, the momentum of the flowing fluid creates a natural oscillation called a water hammer. Second, during some well tests, an intentional pressure transient or spike is created by suddenly opening and then closing a valve or by the forced oscillations of the positive displacement pumps. The changes in the pressure oscillations, either natural or artificial, provide information about the extent of the fractures downhole.⁵⁷ In tests that include operationally reducing flow at the end of the fracture stage, the reduction in flow would need to be held steady for a period of time necessary to capture sufficient oscillations to determine resulting fracture information.⁵⁸ Thus,

⁵⁶ *Massaras*.

⁵⁷ *Holzhausen*.; Ex. 1058 (*Paige*); Ex. 1059 (*Massaras*); Ex. 1060 (*Mondal*), 12.

⁵⁸ *Holzhausen*

it was common in well testing to vary and monitor operational parameters over a period of time to assess the effects in the well.⁵⁹

XII. OVERVIEW OF THE PRIOR ART

A. KRUPA (EX. 1022)

118. U.S. Patent Publication No. 2022/0268141A1 (“*Krupa*”) was filed on February 18, 2022, and published on August 25, 2022. *Krupa* properly claims priority to its identical U.S. Provisional App. No. 63/153,607, which was filed on February 25, 2021. *Krupa* is prior art to the ’952 Patent because *Krupa*’s effective filing date (February 25, 2021) is before the ’952’s priority date (May 17, 2021). *Krupa* is entitled, “System and Method for an Automated and Intelligent Frac Pumping.”

119. *Krupa* describes “continuous pumping operations” for multi-well fracturing systems, which may be executed using a computer controller according to “a fracturing pumping plan provided on a software application.”⁶⁰ References to continuous pumping can be found throughout *Krupa*.⁶¹ *Krupa*’s fracturing plans to perform “continuous pumping operations” “include a sequence of valve operations to direct fluid flow through a selected path into the one or more wells.”⁶² Further,

⁵⁹ *Paige*.

⁶⁰ Ex. 1022 (*Krupa*) at Abstract.

⁶¹ *See, e.g.*, Ex. 1022 (*Krupa*) [0016], [0017], [0042]-[0045], [0046], [0058]-[0059], cl 1, cl 10-14, cl 20.

⁶² Ex. 1022 (*Krupa*) at Abstract.

Krupa discloses these “fracturing plans may include automating valves within the hydraulic fracturing system to have a valve sequencing (e.g., opening and closing) to direct fluids (e.g., frac fluid) in a selected path and/or control pressure and pump rates within the system.”⁶³ *Krupa* also discloses “[a] wide variety of hydraulic fracturing equipment is used in oil and natural gas fields,”⁶⁴ and describes this equipment to include “many gauges and meters for *flow rate*, fluid density, treating *pressure*, etc.”⁶⁵ Further, *Krupa* points out that these “sensors work[] in conjunction with built hydraulic fracturing system[s]” to “streamline and improve efficiency[] due, in part, to reducing or eliminating human interaction with the hydraulic fracturing systems by automating fracturing operations for continuous pumping in one or more wells.”⁶⁶

120. *Krupa*’s continuous pumping hydraulic fracturing system comprises “a first wellhead assembly 201a of a first well, a second wellhead assembly 201b of a second well, a third wellhead assembly 201c of a third well, and a fourth wellhead assembly 201d of a fourth well,” (wellhead assemblies and wells annotated in red

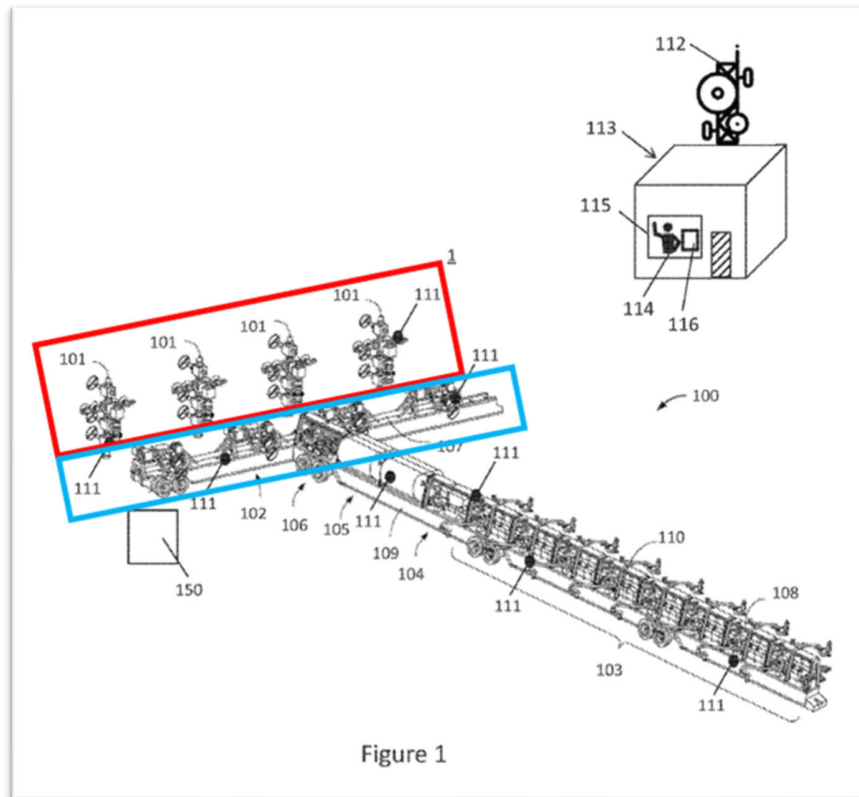
⁶³ Ex. 1022 (*Krupa*), [0018].

⁶⁴ Ex. 1022 (*Krupa*), [0002].

⁶⁵ Ex. 1022 (*Krupa*), [0002] (emphasis added); *see also* [0014].

⁶⁶ Ex. 1022, [0016].

below) along with valves associated with each wellhead and well.⁶⁷ Figure 1 of *Krupa* shows one arrangement of the wellheads and valves, each “coupled to at least one time and efficiency (TE) or zipper manifold 102 [(annotated in blue)] through one or more flow lines (not shown).”⁶⁸

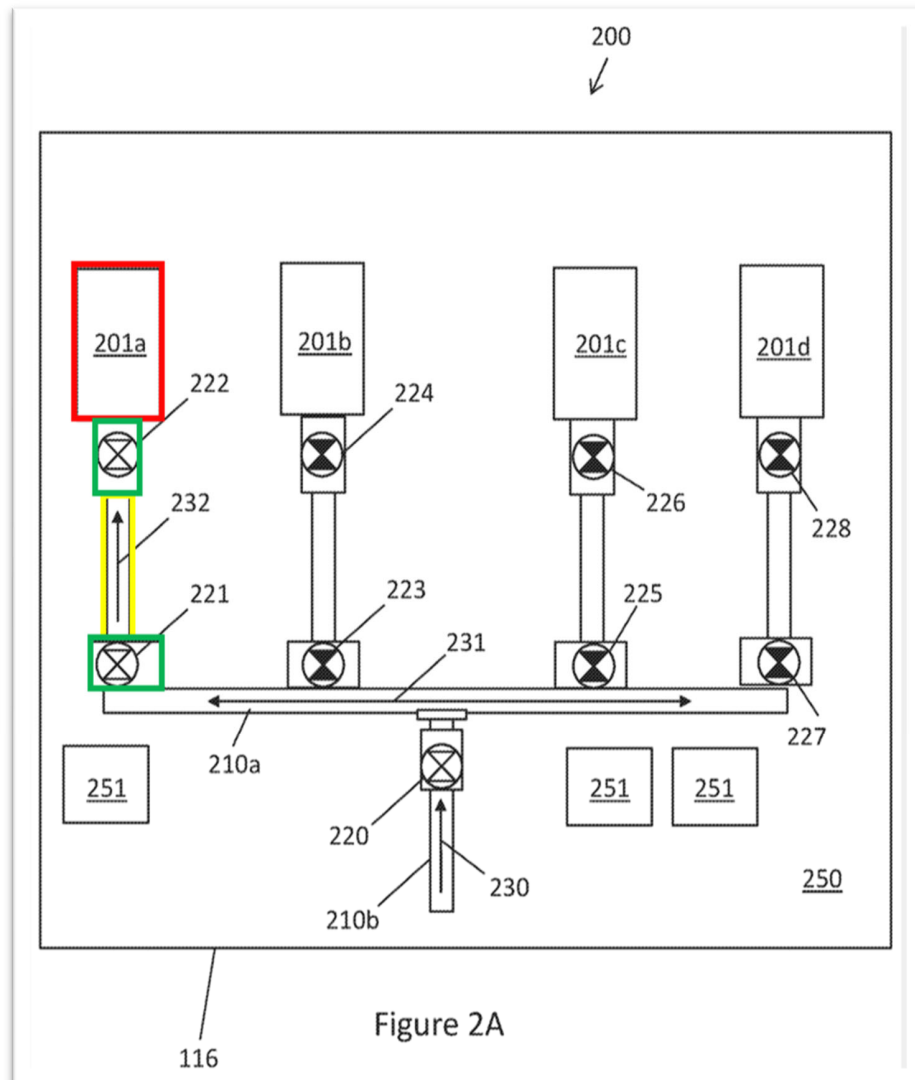


121. *Krupa* discloses specific examples of valve switching and sequencing to hydraulically fracture the wells while continuously pumping. As an example, Fig. 2A shows opening a first set of valves 221 and 222 (annotated in green) between a

⁶⁷ Ex. 1022, [0038].

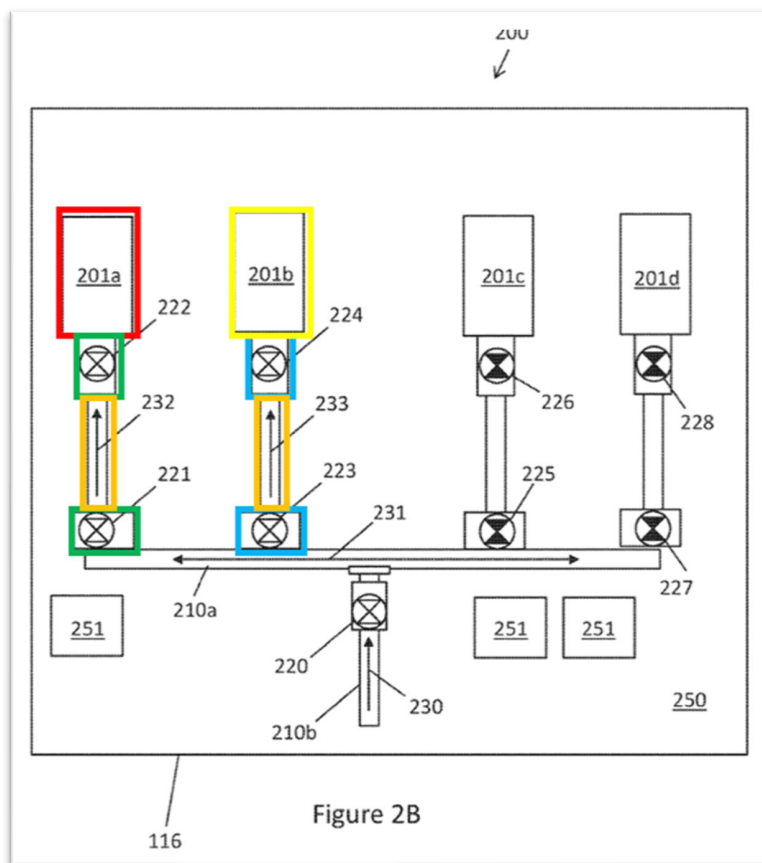
⁶⁸ Ex. 1022 (*Krupa*), [0019].

first well and a manifold in a hydraulic fracturing pumping system 200 to allow “fluid flow (see arrow 232) to the first wellhead assembly 201a [annotated in red]”.⁶⁹



⁶⁹ Ex. 1022, [0042]; *see also* [0040] “for illustration purposes closed valves are shown as blacked out while open valves are shown having no fill, thereby indicating the available path of fluid flow (see arrows 230-235) through the system.”

122. Based, at least partly, on sensing a reduced pump flowrate and that the “pressure has stabilized at the reduced pump rate”, *Krupa*’s system moves to the next step of the continuous pumping fracturing operation, where fluids are pumped “into a second well via the at least one pump manifold while continuously pumping the fluids into the first well by opening a second set of valves [223 and 224],”⁷⁰ as shown in Fig. 2B.

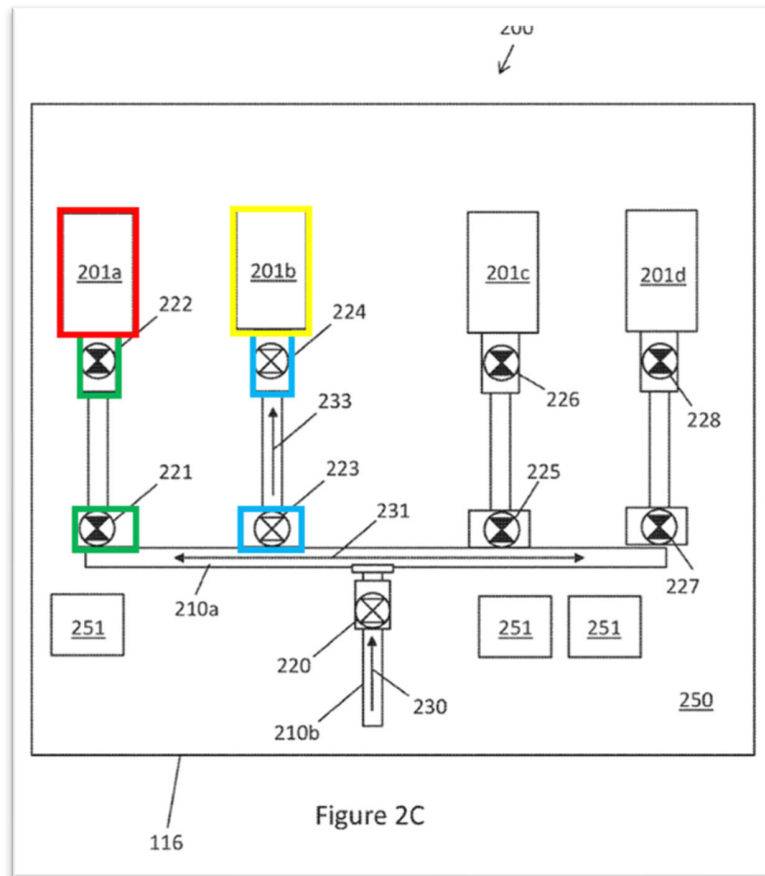


⁷⁰ Ex. 1022, [0005], [0042].

123. After establishing flow into both wells, “[t]he method further includes closing the first set of valves to stop pumping the fluids into the first well and isolating and continuously pumping the fluids into the second well.”⁷¹ This configuration is shown in Fig. 2C, in which the first set of valves 221 and 222 are closed and the second set of valves 223 and 224 remain open. In this manner, “automatic hydraulic fracturing pumping may be used for continuous non-stop pumping for one or more wells.”⁷²

⁷¹ Ex. 1022, [0005].

⁷² Ex. 1022, [0017].



124. *Krupa*'s teaching of opening and closing (sequencing) valves continues through the third well (201c) and fourth well (201d) by opening and closing the appropriate valves based, at least in part, on sensing flow in specific ranges or thresholds. These switching sequences are further depicted in Fig. 2D – Fig. 2G of *Krupa*. Although *Krupa* uses language such as first and second well in order to keep track of the steps of the method, it is clear from the disclosure of *Krupa* that the teachings of switching from first well to the second well are equally applicable to switching from second well to first well and would further apply to teaching of the third well and fourth well, and vice versa. *Krupa* discloses: "While it is noted that

FIGS. 2A-2G describe the sequence of the fracturing pumping plan from the first wellhead assembly 201a to the fourth wellhead assembly 201d, the sequence may be conducted between any of the wellhead assemblies 201a-201d in any order.”⁷³ “Further, the sequence may be conducted from one wellhead assembly to a plurality of wellhead assemblies,” or may transition “operations from two wells to two wells, etc. (one or more transitioning to one or more while continuously pumping).”⁷⁴

B. CHRISTIE (EX. 1018)

125. U.S. Publication No. 2021/0025267 (“*Christie*,” Ex. 1018) was filed July 24, 2020 and published January 28, 2021. *Christie* properly claims priority to U.S. Provisional No. 62/877,994 (“*Christie’s Provisional*,” Ex. 1019), filed July 24, 2019.⁷⁵ To the extent *Christie’s Provisional’s* date needs to be relied on, *Christie’s* disclosures relied on in the Grounds are also supported by *Christie’s Provisional*, as shown by citations to both *Christie’s Provisional* and *Christie* throughout the discussion in the Grounds. *Christie* is prior art to the ’952 Patent because *Christie’s* effective filing date (July 24, 2019) is before the ’952’s priority date (May 17, 2021). *Christie* is entitled, “Coordinated pumping operations.”

⁷³ Ex. 1022, [0046].

⁷⁴ Ex. 1022, [0046].

⁷⁵ *Christie* and *Christie’s Provisional*.

126. *Christie* discloses multi-well systems and methods that “enable coordinated pumping operations” to selectively pump fluids into one or more wells for wellbore stimulation jobs.⁷⁶ A “wellbore stimulation job” includes “pumping and wireline operations (e.g., pump-down and perforating operations) between each stimulation stage (e.g., hydraulic fracturing).”⁷⁷ *Christie*’s Figure 1 shows an example multi-well system using coordinated pumping, where a pump-down system (e.g., including a conveyance device 184) and a treatment fluid system (e.g., including pumps 150/152) may be selectively fluidly connected and disconnected to a selected one or more of the wellbores 102.⁷⁸

⁷⁶ *Christie*, Abstract; *Christie Provisional*, Abstract.

⁷⁷ *Christie*, [0004], [0007]; *Christie Provisional*, [0001].

⁷⁸ *Christie*, [0039], [0041], [0043]; *Christie Provisional*, [0022], [0024], [0026].

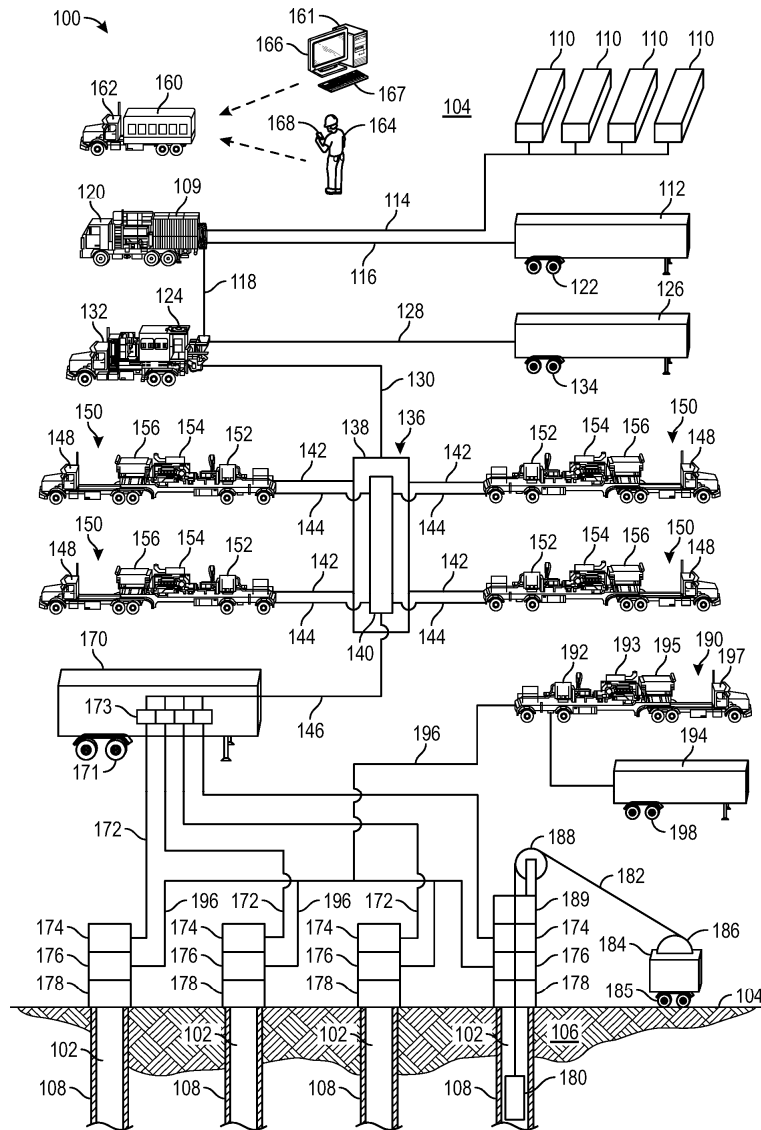


FIG. 1

127. During a “stimulation stage,” “treatment fluids,” such as fracturing fluids, are pumped from pumps 150/152 through a fracturing manifold 170 (“known in the art as a zipper manifold”), “which may selectively distribute the treatment fluid between the wellbores 102 via a plurality of corresponding fluid conduits 172

extending between the fracturing manifold 170 and each wellbore 102.”⁷⁹ A plurality of valves, including “frac valves” 173 in the fracturing manifold and valves 174, 176 in each well’s “frac tree,” “may collectively form a fluid flow control valve system configured to fluidly connect (and disconnect) one of the treatment fluid system and a pump-down system, as described herein, to (and from) a selected one or more of the wellbores 102.”⁸⁰ The valves may each be “remotely operable to fluidly connect (and disconnect) the fluid conduit 146 to (and from) a selected one or more of the fluid conduits 172 and, thus, facilitate injection of the treatment fluid into a selected one or more of the wellbores 102” to hydraulically fracture the well(s).⁸¹

128. *Christie* uses a controller to 1) “monitor operational status of the treatment fluid system, the pump-down system, and the fluid valve system,” e.g., valve positions and sensor data, including pressure and flowrate; and 2) “control operations of the treatment fluid system, the pump-down system, and the fluid valve system based at least in part on the operational status of the treatment fluid system, the pump-down system, and the fluid valve system” such that the well services “may be performed in a coordinated manner.”⁸² The “controller may be further configured

⁷⁹ *Christie*, [0039]-[0040], [0144], Fig. 1.

⁸⁰ *Christie*, [0040]-[0041].

⁸¹ *Christie*, [0039]-[0040].

⁸² *Christie*, Abstract, [0093]-[0094], [0108], [0143].

to operate the fluid valve system to simultaneously” “fluidly connect the treatment fluid system to the first wellbore 102 to permit pumping of the treatment fluid into the first wellbore 102” and “fluidly disconnect the treatment fluid system from the second wellbore 102.”⁸³ Christie uses the term “simultaneously” “to mean certain operations that are performed at generally the same time (e.g., concurrently). In other words, simultaneous operations are intended to mean operations that at least partially overlap in time.”⁸⁴ *Christie*’s coordinated pumping operations include swapping from fracturing one well to the next “with the goal of performing continuous pumping downhole.”⁸⁵

C. AL-SALMANI (EX 1020)

129. U.S. Publication No. 2020/0149389 (“*Al-Salmani*,” Ex. 1020) was filed July 24, 2020 and published May 14, 2020. *Al-Salmani* is prior art to the ’952 Patent because *Al-Salmani* was filed before and published before the ’952’s priority date (May 17, 2021). *Al-Salmani* is entitled, “Surface completion system for operations and monitoring.”

130. *Al-Salmani* discloses wellhead monitoring systems that include a fracturing tree valve conversion assembly “for modifying an operating mode of a

⁸³ *Christie*, [0150].

⁸⁴ *Christie*, [0033].

⁸⁵ *Christie*, [0098], [0101].

valve from manual to remote” and sensors associated with the fracturing tree and/or the conversion assembly for monitoring operating conditions.⁸⁶ The sensors may monitor valve positions, pressure, and “flow into and out of the wellbore,” which “may be correlated to different stages of the fracturing operation,” which determination may then “drive additional operations.”⁸⁷

131. A control unit is adapted to receive information from the system’s sensors and present the information indicative of well operations on a display.⁸⁸ For example, as shown in Figure 7, a display may show “information regarding valve data for the wellheads,” where different icons 708 and/or color-coding may be used to show the open/closed status of the valves:

⁸⁶ *Al-Salmari*, Abstract.

⁸⁷ *Al-Salmari*, [0007], [0024], [0039], [0044].

⁸⁸ *Al-Salmari*, Abstract, [0049].

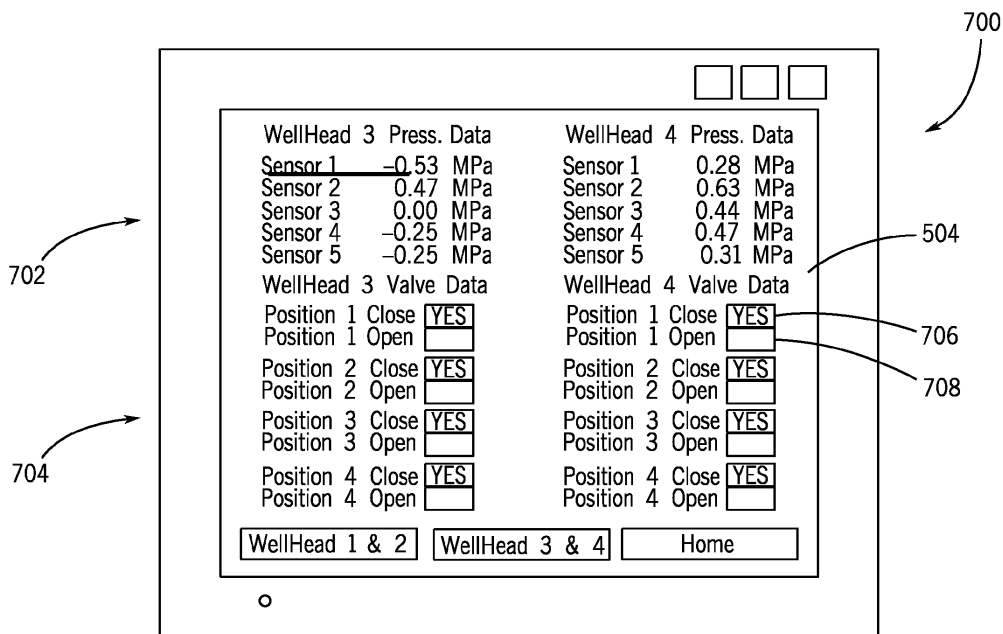


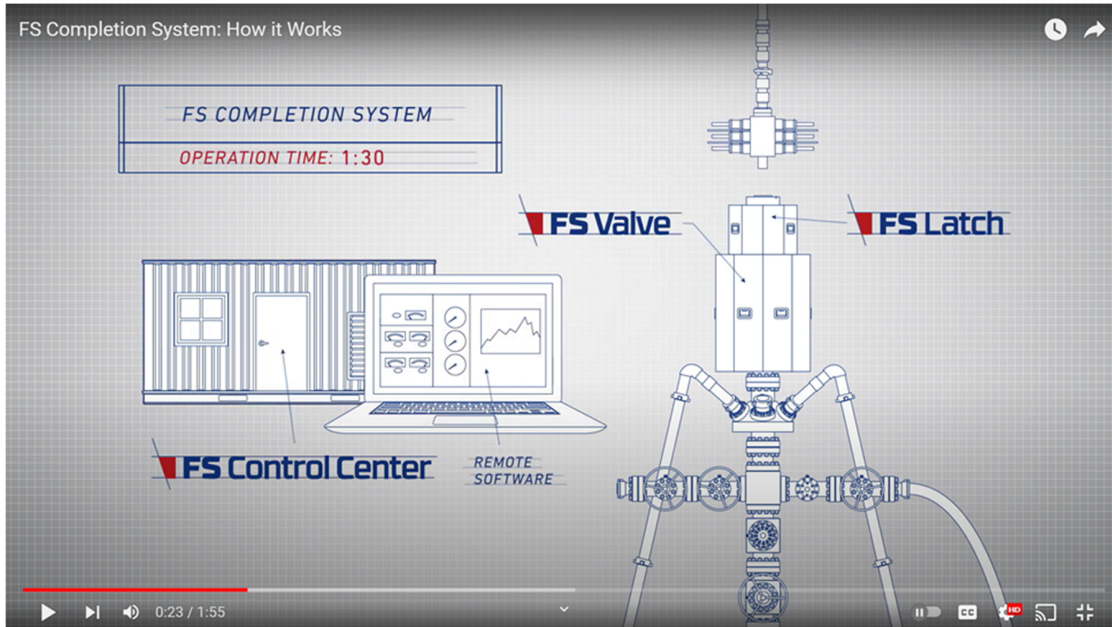
FIG. 7

D. FS-VIDEO (EXS. 1026-1035)

132. “FS Completion System: How it Works” (“*FS-Video*,” Ex. 1027; *see also* Exs.1026, 1028, 1032), was published on YouTube on March 5, 2019 (at <https://www.youtube.com/watch?v=X0m9DcnZczE>) and published on Facebook on August 27, 2019 (Ex. 1031; *see also* Exs. 1029, 1030, 1032-1035). *FS-Video* is prior art to the ’952 Patent because *FS-Video* was published more than one year before the ’952’s priority date (May 17, 2021).

133. *FS-Video* demonstrates use of Downing’s Freedom Series (“FS”) valve and latch completion system for “continuous zipper frac operations” to “swap” from

fracturing one well to another.⁸⁹ The FS valve and latch are shown in the 0:23 screenshot of *FS-Video*, during which *FS-Video* narrates that “the FS valve and FS latch system is an integrated remotely operated completion system” that “allow[s] tools to enter the wellbore without pressuring down the stack between stages.”⁹⁰



134. *FS-Video* shows two fracturing trees with an assembly of pipes and valves therebetween labeled “zipper” to show how “the FS valve and FS latch system gives you the benefit of continuous frac operations.”⁹¹ In the video, blue dots (representing fluid flow) move through the “zipper” to each of the wells “to illustrate [] fracking on one well” and swapping to the next well.⁹² The “swap” shows fluid

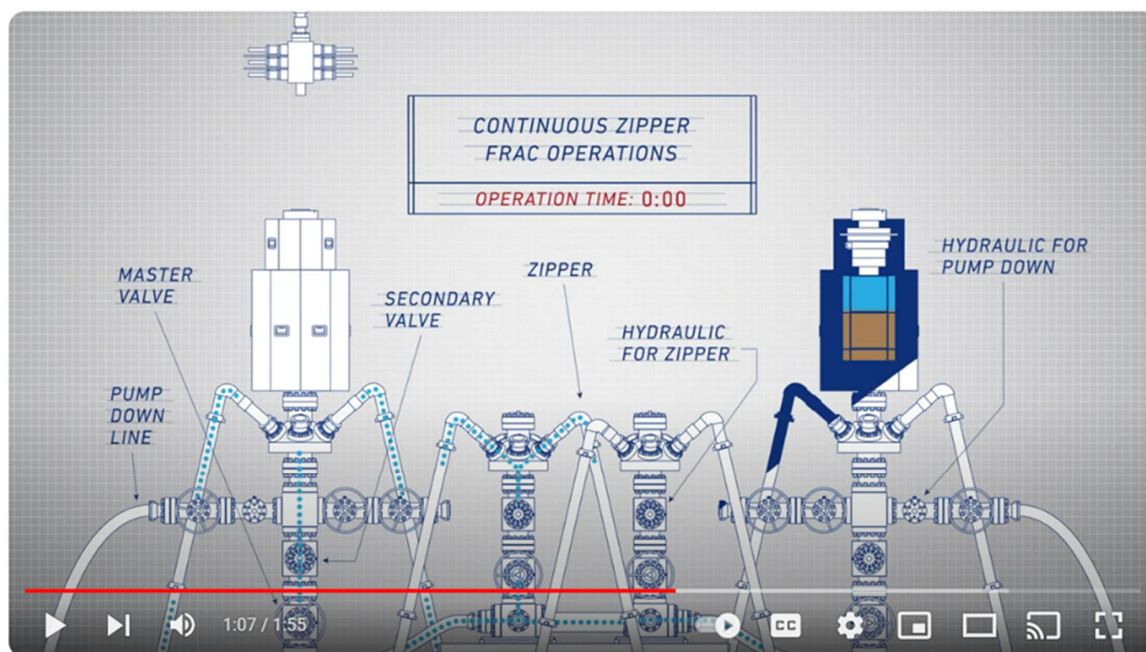
⁸⁹ *FS-Video*, 0:54-0:1:17; see also Ex. 1034.

⁹⁰ *FS-Video*, 0:20-0:37; see also Ex. 1034.

⁹¹ *FS-Video*, 0:55-1:06; see also Ex. 1034.

⁹² *FS-Video*, 1:07-1:17; see also Ex. 1034.

continuously flowing through the “zipper manifold” as the fluid is directed to only the first well, then to both the first and second well, and then to only the second well.⁹³



FS Completion System: How it Works

E. PITCHER (EX. 1021)

135. U.S. Publication No. 2014/0352968 (“*Pitcher*,” Ex. 1021) was filed June 3, 2013 and published December 4, 2014. *Pitcher* is prior art to the ’952 Patent because *Pitcher* was filed before and published before the ’952’s priority date (May 17, 2021). *Pitcher* is entitled, “Multi-well simultaneous fracturing system.”

⁹³ FS-Video, 1:07-1:33; see also Ex. 1034.

136. *Pitcher* discloses a “system for simultaneously fracturing multiple wells” (e.g., wells 12, 14 in Figure 1) that includes fracturing trees (e.g., part of wellhead assemblies 18) installed at each well and a fracturing manifold (e.g., part of fracturing supply system 22) connected to each fracturing tree.⁹⁴

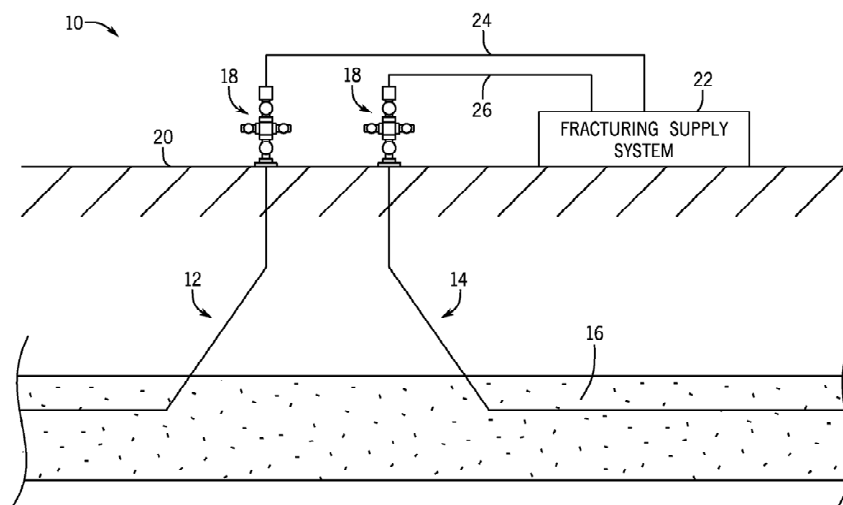


FIG. 1

137. As shown in *Pitcher*’s Figure 2, a controller is connected to output valves 48 of the fracturing manifold 44 “so that the controller can remotely operate the output valves to simultaneously fracture the multiple wells and independently control the volume of fracturing fluid entering each of the wells from the fracturing manifold.”

⁹⁴ *Pitcher*, Abstract, [0018]-[0019].

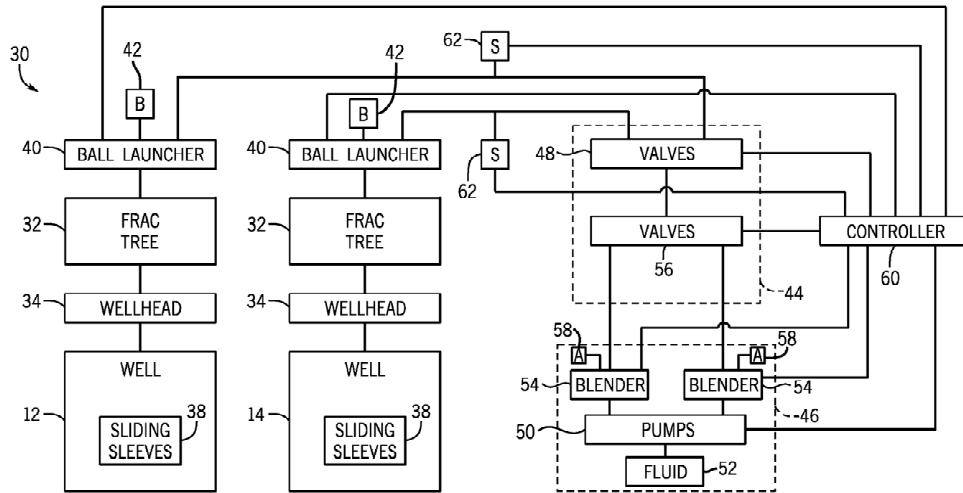


FIG. 2

138. *Pitcher* discloses monitoring fluid parameters of fracturing fluid pumped simultaneously into multiple wells, including flowrate and pressure measured using sensors 62 downstream from the fracturing manifold's output valves 48.⁹⁵ *Pitcher*'s methods further include "operating valves of the fracturing manifold 44 (e.g., output valves 46 and input valves 56) to control the fracturing fluid entering each of the wells connected to the manifold... based on fluid parameters monitored for each well."⁹⁶ For example, a fracturing manifold valve 48 to a first well 12 "could be closed once a desired volume of fracturing fluid has been pumped into the well 12 while additional fracturing fluid is pumped into well 14."⁹⁷

⁹⁵ *Pitcher*, [0030].

⁹⁶ *Pitcher*, [0030].

⁹⁷ *Pitcher*, [0038].

XIII. GROUND 1: PATENT ELIGIBILITY

139. Because patent eligibility is a question of law, I do not provide any opinions on patent eligibility. I have, however, been asked to provide my opinions as a POSITA regarding issues that may underlie the question of patent eligibility. Because many of these opinions relate to the conventionality of equipment, systems, and methods discussed in the '952 Patent, these opinions are discussed in my Technology Background Section and my analysis of the claims in Grounds 6-10.

XIV. GROUNDS 2-5: LACK OF WRITTEN DESCRIPTION AND IMPROPER DEPENDENCY

A. HAS SATISFIED ONE OR MORE CONDITIONS

140. The specification of the '952 Patent does not define what constitutes a “condition” or what it means for a “condition” to be “satisfied.” There is no explanation of these “conditions” beyond a single example involving flowrate thresholds.⁹⁸

141. Throughout the specification, the '952 Patent consistently refers to the opening and closing of valves based solely on fluid meeting unspecified flowrate thresholds. The '952 Patent fails to provide any reasoning behind why specific flowrate thresholds would be relevant for a “CP swap.” There is also no guidance for a POSITA on the required values of these thresholds or how they should be

⁹⁸ Ex. 1001.

selected. The only flowrate thresholds mentioned are a lower threshold of 0 bbls (indicating some flow) and an upper threshold of 10 bbls, with a CP swap allowed within this range. However, if the flowrate is below the lower threshold (i.e., no flow), a regular swap is allowed.⁹⁹ The specification does not explain why these specific thresholds were chosen for a “CP swap.”

142. Further, none of the earlier filed applications referenced by the ’952 Patent offer any clarity on this issue. The only “condition” mentioned in the related specifications is flowrate, including terms like “frac rate” and “idle rate.” These terms are consistently framed within the context of thresholds but provide no further explanation.¹⁰⁰

143. Although the claims of ’770 (the parent application of the ’952 Patent) mention “one or more conditions,” this phrasing is vague and fails to provide the necessary detail for a POSITA to understand what constitutes these conditions. Therefore, there is no written description support for the ’952 Patent’s “Conditions” limitations. The specification does not provide sufficient detail about what conditions or their thresholds, other than flowrate, leaving the term “condition” without clear meaning. As a result, there is no evidence that the ’952 Patent’s inventors possessed the claimed invention at the time of filing.

⁹⁹ Ex. 1001, 13:43-54.

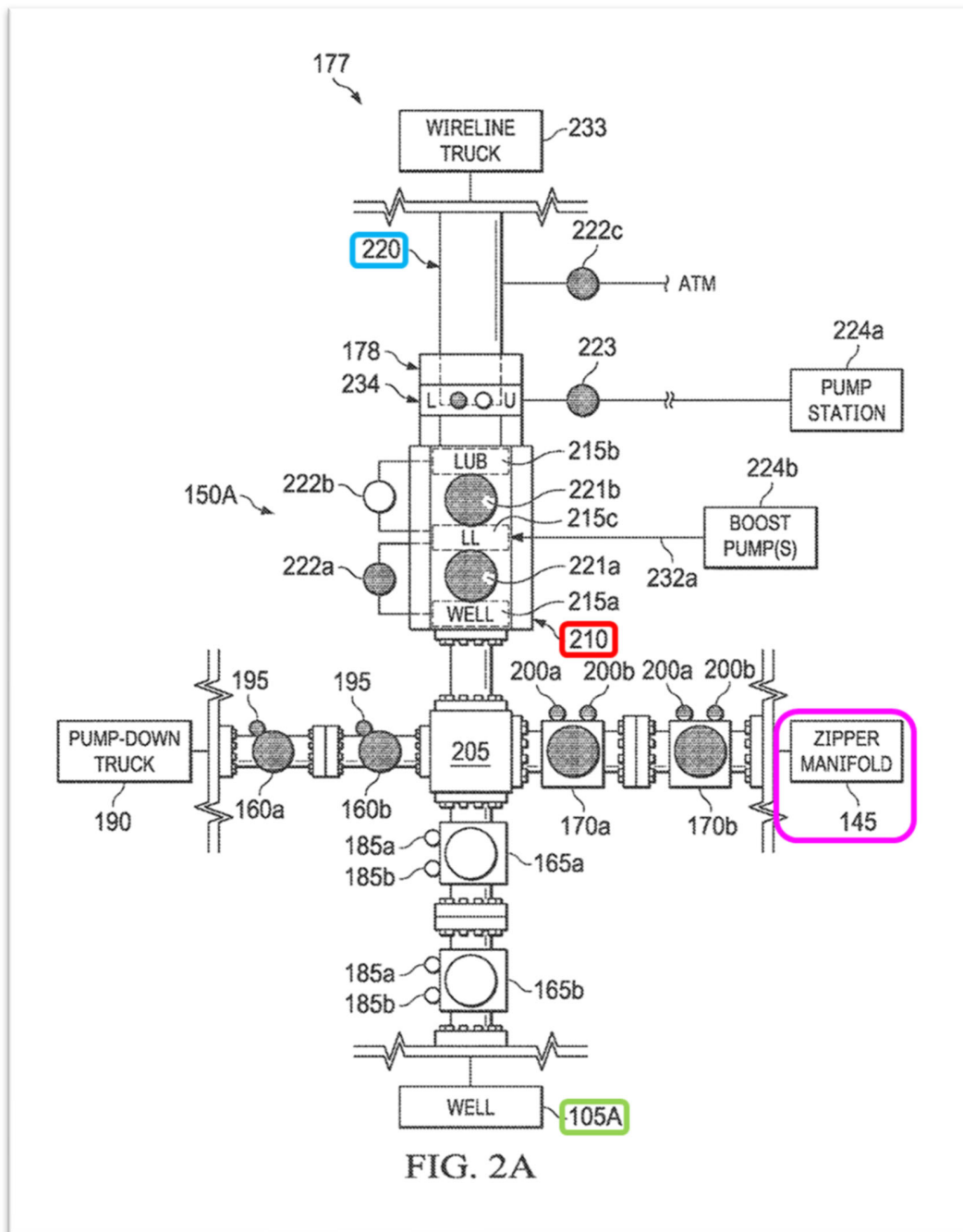
¹⁰⁰ Ex. 1001, 13:35-50.

B. “PRESSURE” CONDITIONS

144. Nowhere in the '952 Patent is there a mention of a “pressure” condition related to executing a “CP Swap,” nor is there any indication of specific pressure thresholds or criteria that would define such a condition.

145. While pressure is discussed in the context of “pressure equalization” and other unrelated aspects like lubricator operation¹⁰¹, these references are entirely unrelated to the claimed “pressure condition” for a “CP Swap.” The specification mentions “equalization (EQ) valves” in relation to the valve apparatus (210, annotated in red), which serve to equalize pressure between the lubricator (220, annotated in blue) and the well (105A, annotated in green) to facilitate tool access, as shown in Figure 2A.

¹⁰¹ '952 Patent, 7:22-24, 8:24-60, 9:49-56, 10:12-30, 11:47-56, 12:1-4, 21-33, 40-60, 14:4-8, 49-60, 15:6-40.



Ex. 1001 ('952 Patent) Fig. 2A (annotated)

146. As seen, the equalization valve 210 is not in the flow path of the fluid communicated via the zipper manifold (annotated in magenta). The pressure across

the valve apparatus is unrelated to the claimed process of “swapping” from fracturing one well to fracturing another. Further, a POSITA would have understood that equalizing the lubricator would occur during the wireline stage of fracturing operations and would occur only when the well is isolated from the fracturing fluid from the one or more pumps which is communicated via the manifold.

147. Moreover, the manifold and valves involved in the “CP Swap” are located in a different part of the system from the wireline and equalization assembly, and the wireline and equalization assembly does not receive the fluid involved in the CP Swap that is from the fracturing pumps and manifold. Therefore, the pressure across the EQ valves cannot be the same as the “pressures” related to the “fluid communicated via the manifold” during the “CP Swap.”

148. No earlier filed application, including the application leading to the ’952 Patent, discloses a method for executing a “CP Swap” based on a fluid pressure condition. A POSITA would not have understood the ’952 Patent’s inventors to have been in possession of such a method when the application was filed.

C. DASHBOARD CLAIMS

149. The Dashboard Claims refer to a system comprising:

- “a visual reference of the first valve;”
- “a first visual indicator associated with the visual reference of the first valve, [] indicating that a state of the first valve is open to permit

communicating fluid to the first well via the manifold and the first valve;”

- “a visual reference of a second valve;” and
- “a second visual indicator associated with the visual reference of the second valve, the second visual indicator being different from the first visual indicator to indicate that a state of the second valve is closed.”

150. These “dashboard” elements were first introduced in the claims on February 8, 2024, after the second NOA. The original application does not mention a “dashboard,” “visual indicators,” or “visual references” in its specification or drawings. Similarly, none of the related earlier filings, including the parent and grandparent applications or the ’663 Provisional, contain references to such elements. A POSITA would not have understood the ’952 Patent to disclose these concepts.

151. The only mention of a “dashboard” appears in the ’663 Provisional, where it refers to a system being integrated into an “operational dashboard,” but this reference is vague and unrelated to the specific dashboard claims in the ’952 application. The description merely suggests that control system algorithms know the state of the equipment and display generic well equipment and gauges, concepts which were conventional, routine and well understood long before the ’633 Provisional.

D. DETERMINING CONDITIONS ARE SATISFIED

152. Claims 4, 23, 42, 60, 67, and 74 essentially describe the process of “determining that...one or more conditions” have been met. In contrast, the independent claims already specify that the opening/closing of valves occurs “in response to...fluid...satisfying one or more conditions,” which requires determining whether the fluid meets the specified conditions, as recited in the dependent claims. If “determining” is not included within the scope of the independent claims, then it would be unclear whether “fluid communicated via the manifold” ever meets the claimed “satisfying one or more conditions,” and a POSITA would never know when or whether to carry out the step of opening the second valve. Thus, the independent claims include “determining that...one or more conditions” have been met, otherwise the independent claims would be hopelessly vague and indefinite. Because Claims 4, 23, 42, 60, 67, and 74 recite the same limitation, they are merely redundant to their respective independent claims (Claims 1, 20, 39, 58, 65, and 72). This redundancy means the dependent claims (4, 23, 42, 60, 67, and 74) do not further limit the independent claims.

153. Claims 5, 24, 43, 61, 68, and 75 are also redundant of their respective independent claims (Claims 1, 20, 39, 58, 65, and 72) because they similarly recite “wherein the one or more conditions include...flow rate....” As I discussed above, the independent claims already recite “one or more conditions,” and “one or more

conditions” can only include flowrate thresholds because “flow rate” is the only “condition” that could possibly be supported by the ’952 Patent’s specification. Therefore, Claims 5, 24, 43, 61, 68, and 75 do not further limit the independent claims.