

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GENERAC POWER SYSTEMS, INC.,
Petitioner,

v.

CHAMPION POWER EQUIPMENT, INC.,
Patent Owner.

Case No. IPR2025-01271
U.S. Patent No. 10,697,398

DECLARATION OF WILLIAM E. SINGHOSE, PH.D.
IN SUPPORT OF PATENT OWNER RESPONSE

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GLOSSARY

Abbreviation	Term
'145 Patent	U.S. Patent No. 11,143,145
'398 Patent	U.S. Patent No. 10,697,398
Board	Patent Trial and Appeal Board
Patent Owner or Champion	Champion Power Equipment, Inc.
Petition	Petition for Inter Partes Review of U.S. Patent No. 10,697,398 (Paper 4)
Petitioner or Generac	Generac Power Systems, Inc.
POSITA	Person of Ordinary Skill in the Art
USPTO	United States Patent & Trademark Office

I, Dr. William E. Singhose, do hereby declare under penalty of perjury that the following statements are made based on my personal knowledge and are true and correct:

I. INTRODUCTION

A. Scope of Engagement

1. I have been retained as an expert witness on behalf of Patent Owner Champion Power Equipment, Inc. to provide expert analysis and opinions in connection with Champion's Patent Owner Response to IPR2025-01271.

2. I understand that the Petition involves U.S. Patent No. 10,697,398 (the "'398 Patent"). [EX1001.] I have been asked to provide my opinions as to the validity of certain claims of the '398 Patent.

3. This Declaration sets forth the opinions that I have formed related to the '398 Patent based on my personal knowledge, education, research, personal and professional experience, and the information I have reviewed as of the date of this Declaration. In connection with my analysis, I have reviewed the Petition in IPR2025-01271 and all exhibits cited therein, as well as all exhibits cited in this declaration.

4. Between now and such time that I may be asked to testify, I expect to continue my review, evaluation, and analysis of evidence presented during this proceeding. I expressly reserve the right to amend or supplement this Declaration,

as appropriate. I have personal knowledge of the facts stated in the declaration, and I am willing to competently testify to them if and when called to do so. In the event that additional relevant information becomes available to me, I also reserve the right to review and consider that information in further developing or refining my opinions.

5. I have considered certain issues from the perspective of a person of ordinary skill in the art, as described below, as of the effective filing date of the '398 Patent, which I have been asked to assume is June 12, 2015. [EX1001, (63).]

B. Professional Qualifications and Experience

6. In formulating my opinions, I have relied upon my knowledge, training, and experience in the relevant art. My qualifications are stated more fully in my curriculum vitae, which has been provided as EX2079. Here, I provide a brief summary of my qualifications.

7. I am a mechanical engineer and professor of mechanical engineering at the Georgia Institute of Technology ("Georgia Tech"). I have substantial experience in the fields of, among others, product design, machinery, and controls.

8. I hold B.S. and Ph.D. degrees in mechanical engineering from the Massachusetts Institute of Technology ("MIT"), and a M.S. degree in mechanical engineering from Stanford University. From 1998 to 2004, I was an Assistant Professor of mechanical engineering at Georgia Tech. From 2004 to 2014, I was an

Associate Professor at Georgia Tech. From 2014 to the present, I have held my current position as Professor of Mechanical Engineering at Georgia Tech. During my tenure at Georgia Tech, I have had visiting appointments at MIT, Stanford, the Polytechnic University of Madrid, and the Tokyo Institute of Technology.

9. In my current position at Georgia Tech, I teach courses in mechanical design, system dynamics, and controls. I also lead teams of professors, post-docs, graduate students, and undergraduate students that conduct research in product design, mechanical design, dynamics, controls, automation, robotics, and human-machine interfaces. I am currently the director of the Center for Crane Safety Research.

10. Based on my work experience, described in my curriculum vitae and in more detail below, I am knowledgeable about the subject matter of the '398 Patent. Specifically, my qualifications as an expert in the fields of product design and mechanical engineering stem from my prior work experience, as well as my experience as a Professor at Georgia Tech performing research, teaching, and consulting.

11. Before starting my teaching career at Georgia Tech, I worked as a full-time mechanical engineer for several companies, including Walt Disney World, Apple Computers, Inc., and Convolve, Inc.

12. In my role at Walt Disney World, I designed and developed a number of structures and components for the parks' rides, including, but not limited to, operational control procedures for the Body Wars simulators. These simulators are rooms that hold about 40 people at a time. The entire rooms, and the guests seated within, are automatically manipulated through a series of preprogrammed motions using six large linear hydraulic cylinders. The machines were equipped with numerous valves and sensors that enabled accurate feedback control of the power drives.

13. For Convolve, Inc., I analyzed the dynamics of automated robots, satellites, and NASA high-altitude balloons. I also developed automated control systems for manufacturing machines, large-scale coordinate measuring machines, and laser interferometer sensors. One of my Convolve projects required the development and installation of a system to control a crane at the Savannah River Nuclear facility. The crane was a large overhead bridge structure that moved barrels of nuclear waste. The system we developed reduced the unwanted pendulum swing of the barrels.

14. The '398 Patent includes claim elements directed to components that enable multi-fuel use in generators such as carburetors, fuel lines, solenoid valves, and switches. I have experience working with all of these elements and combinations of these elements.

15. For example, I have worked on the control of valves since 1988. My first work in this area focused on the on-off control of thrusters used to reposition spacecraft. The primary goals of my work in this area were to control the oscillation [1–4] of the satellite structures and to control the amount of fuel used [1, 5–7]. In addition to working on thruster valve control, I also worked on projects controlling hydraulic valves when I worked at Disney World and during my career at Georgia Tech [8–10]. Furthermore, I have worked extensively with pneumatic valves [11–14]. As detailed on my CV, I have received numerous grants to conduct research and development on fluid power.¹

16. In addition to my research and work experience with valves, I have taught the use of pneumatic equipment, including on-off value control and quick-disconnect hoses, to my students at Georgia Tech for more than 20 years.

17. In terms of my experience with generators, I have used portable generators in the course of my work for decades. For example, I used portable generators in the timeframe from 1987-1990 when I worked in the construction industry as a machine operator. I have also designed machines that relied upon portable generators. For example, in the 2006-2007 timeframe, I designed and built

¹ The references cited in this paragraph are listed at the end of this declaration.

a small scale mobile robotic boom crane. The boom crane had a sophisticated control system that utilized a Programmable Logic Control (PLC) and numerous sensors. These electrical components were driven by electrical power that was provided by 110VAC. When used indoors, the crane was powered from wall outlets. However, when used outdoors, the crane was powered by an electrical generator that rode on a wagon towed by the crane. That wagon and generator are shown below.



Portable Generator for Robotic Mobile Boom Crane.

18. I have also worked on previous litigation matters wherein control of fluid into an engine was a central issue. For example, I worked on a patent case that involved control of air supply into an internal combustion engine. I have also worked on intellectual property litigation involving engine-powered machinery such as cranes, slip-form concrete pavers, road milling machines, as well as water pump flow control.

19. Although the '398 Patent does not claim, or even describe, the use of vaporizers, the prior art put forth by Petitioner requires the use of vaporizers to prepare liquid fuel for use in engines. I have also worked on several previous litigation matters wherein vaporizers were central and indispensable components. Therefore, I have considerable experience working with devices that heat up liquid to generate vapor.

20. In addition to my engineering experience as a professor and an engineer, I have commercialized technology developed in my research group at Georgia Tech by founding two companies: CAMotion Cranes and InVekTek. CAMotion Cranes designs and installs crane control systems that decrease payload swing, automatically avoid obstacles, and improve crane safety. These improvements are achieved through sensor systems and control methods that my research group developed, patented, and deployed. CAMotion Cranes was acquired by PAR Systems in 2013. InVekTek develops and commercializes control systems for robotic and industrial material-handling systems. The control systems are embedded in motor drives to reduce unwanted machine motion.

21. Finally, I am a named inventor on the following issued patents in the areas of mechanical engineering: U.S. Patent No. 5,638,267; 6,920,378; 7,970,521; 8,235,229; 8,975,853; and 9,776,838.

22. My CV provides further details about my degrees, employment history, teaching experience, publication list, scholarly accomplishments, professional contributions, grants, honors, and awards. [EX2079.]

23. Over the last five years, I have testified as an expert at trial or at a deposition in the following cases:

- a. K-fee System v. Nespresso, Case No. 2:21-cv-3402-GW-AGRx (C.D. CA);
- b. Exotec v. Opex, IPR 2024-00850 (United States Patent and Trademark Office);
- c. Champion v. Firman, Civil Action CV-23-2371-PHX-DWL (D. Ariz.);
- d. Gomaco v. Guntert and Zimmerman, IPR2024-00835, PGR2024-00026 (United States Patent and Trademark Office);
- e. US Conec v. Senko, ITC Inv. No. 33-TA-1399 (International Trade Commission);
- f. Juul v. NJOY: IPR2024-00160, IPR2024-00161 (United States Patent and Trademark Office);
- g. Lenovo v. Asus: ITC Investigation No. 337-TA-1382 (International Trade Commission);
- h. Juul v. NJOY: ITC Investigation No. 337-TA-1368 (International Trade Commission);
- i. LightGuide v. Amazon: IPR2023-01423 (United States Patent and Trademark Office);
- j. Bissell v. Tineco: ITC Investigation No. 337-TA-1304 (International Trade Commission);

- k. Opex v. HC Robotics: ITC Investigation No. 337-TA-1293 (International Trade Commission);
- l. Caterpillar Paving Products v. Wirtgen America: IPR2022-01264, IPR2022-01277, IPR2022-01278, IPR2022-01310 (International Trade Commission);
- m. DJI v. Textron: IPR2022-00162, IPR2022-00163, and IPR2022-00453 (United States Patent and Trademark Office);
- n. Boyd v. Elliott Equipment: Case No: 1684CV00822 (Superior Court of Massachusetts);
- o. iRobot v. SharkNinja: ITC Investigation No. 337-TA-1252 (International Trade Commission);
- p. Courkamp v. Fisher Price: Case No. CV-19-02689-PHX-GMS (D. Ariz.);
- q. Coleman Co. vs. Team Worldwide Corp: Case No. 2:20cv351-RGD-RJK (E.D. Va.);
- r. Gomaco v. Guntert and Zimmerman: IPR2020-01698, IPR2021-00050, IPR2021-00136, IPR2021-00234 (United States Patent and Trademark Office);
- s. Unicorn Global v. GoLabs: Case No. 3:20-cv-02023 (N.D. Tex.);
- t. Gamevice v. Nintendo, ITC Investigation No. 337-TA-1197 (International Trade Commission);
- u. Guntert and Zimmerman v. Gomaco, Case No. 5:20-cv-4007 (N.D. Iowa); and
- v. Wong et al. v. Morrow Equipment et al: Case No. 19-2-33286-7 SEA (Superior Court of Washington, King County).

C. Materials Considered

24. In connection with my analysis, I have reviewed the Petition in IPR2025-01271 and all exhibits cited therein, as well as all exhibits cited in this declaration. A complete list of exhibits is included below.

Ex.	Description
1001	U.S. Patent No. 10,697,398
1002	File History for U.S. Patent No. 10,697,398
1003	Declaration of Dr. Timothy Morse
1004	JPS61283734A (Original) (“Nakafushi”)
1005	Certified Translation of JPS61283734A (“Nakafushi”)
1006	Small Engine Technology, Second Edition, Schuster, William A, (1999) (“Schuster”)
1007	U.S. Patent No. 5,301,644 (“Olmr”)
1009	U.S. Patent No 1,931,698 (“Holzapfel”)
1012	Kubota DF972-E2 Workshop Manual (“Workshop Manual”)
1014	Declaration from Mr. James Strepek re Kubota Manuals
1015	Declaration from Mr. Scott Schlabach re Kubota Manuals
1018	U.S. Patent No. 5,809,979 (“Tsuda”)
1029	U.S. Patent No. 5,161,496 (“Matsushima”)
1030	U.S. Patent No. 7,549,403 (“Yamamoto”)
1031	U.S. Patent No. 4,776,988 (“Neal”)
1032	U.S. Patent No. 6,213,083 (“Winberg”)

1033	Champion's Infringement Contentions with Respect to Petitioner Generac's Model PM4500DF and GP7500E DF Generators
1034	Photos of Generac PM7500DF Generator
1035	Video 1 of Generac PM7500DF Generator
1036	Video 2 of Generac PM7500DF Generator
1037	Video 3 of Generac PM7500DF Generator
1038	Process Control, Instrument Engineers' Handbook, Liptak, Béla G., (1995) ("Liptak")
1039	U.S. Patent Pub. No. 2007/0137591 ("Sugimoto")
2079	Curriculum Vitae of Dr. William Singhose
2080	US2012/0104008 ("DeNardo")
2081	Propane 101 Internet Archive
2100	U.S. Patent No. 4,372,276 ("Bernhardsson")
2101	IPR2025-00805 Declaration of Dr. Timothy Morse
2126	U.S. Patent Pub. No. 2011/0100335A1 ("Parlatore")
2127	Timothy Morse Deposition Transcript
2128	U.S. Patent No. 3,465,740
2129	U.S. Patent No. 5,197,910
2130	U.S. Patent No. 4,707,017
2131	U.S. Patent No. 8,631,972 ("Kessler")

D. Compensation

25. I am being compensated at the hourly rate of \$875 for my work in this proceeding, including studying this matter, preparing this declaration, and providing

deposition and trial testimony. Travel time will be billed at a 50% rate. This is my standard hourly rate for engagements of this nature. My compensation is not contingent upon the outcome of this proceeding or the particular testimony or opinions that I express. I am also being reimbursed for expenses incurred as a result of activities performed as an expert in this matter.

26. I have no financial interest in Patent Owner. I similarly have no financial interest in the '398 Patent.

II. UNDERSTANDING OF APPLICABLE LEGAL PRINCIPLES

27. I use the legal principles below, which I understand from counsel, as a guide in formulating my opinions.

A. Scope of the Proceedings

28. I understand that a petition must identify in writing and with particularity (1) each claim challenged, (2) the grounds on which the challenge to each claim is based, and (3) the evidence that supports the grounds for the challenge to each claim.

29. I further understand that, with respect to IPR proceedings, the scope of the proceedings is limited to the grounds recited in the petition. Specifically, I understand that the petition is required to include a full statement of the reasons for relief requested, including a detailed explanation of the significance of the evidence and all material facts.

30. I further understand that the expedited nature of IPRs bring with it an obligation for a petitioner to make its case in its petition to institute. Rather than relying on vague conclusory statements to support unpatentability based on obviousness under 35 U.S.C. §103, the petitioner must provide specific reasoning supported by evidence.

31. Specifically, in order to satisfy its burden of proving obviousness, a petitioner cannot employ mere conclusory statements. Instead, a petitioner has the burden to submit facts to the record that show whether the prior art discloses a claim limitation, whether a skilled artisan would have been motivated to modify or combine teachings in the prior art, and whether the artisan would have had a reasonable expectation of success in doing so.

32. If the petition does not clearly demonstrate how the cited prior art meets each claim element, a petitioner will fail to meet its burden. Failure to prove the matter as required means that the party with the burden of persuasion loses on that point—thus, if the fact trier of the issue is left uncertain, the party with the burden (the petitioner) loses. Consequently, if the petition fails to particularly point out how the cited prior art meets each of the claimed elements of at least one claim as construed by the petitioner, the petitioner loses.

B. Claim Interpretation

33. My opinions concern what I believe the person having ordinary skill in the art would have understood the meaning of certain claim terms to be based on the patent documents.

34. I understand that assessing the validity of a patent claim requires a two-step analysis. The first step involves the proper interpretation, or construction, of the claim language in order to determine its scope and meaning. The second step requires comparing the claim, as properly construed, to the alleged prior art to determine whether the limitations of the claim are met by the prior art.

35. My methodology for determining the meaning of claim terms or phrases involved the following steps. My first step was to study the patent carefully. In particular, I studied the claims themselves, followed by the background, detailed specification, figures, and other patent content. Next, I reviewed the prosecution history and looked for any clarifications or limitations that might be attached to various claim terms.

36. I understand that in an inter partes review, claim terms are to be given their ordinary and customary meaning as understood by persons having ordinary skill in the art in the context of the entire disclosure at the time of the invention. I understand that one must be careful not to read a specific embodiment appearing in the written description into the claim if the claim language is broader than the

embodiment. I further understand that any special definition for a claim term must be set forth with reasonable clarity, deliberateness, and precision.

37. I further understand that a claim construction that gives meaning to all the terms of the claim is preferred over one that does not do so, and that a proposed construction is disfavored where it would render express claim limitations meaningless.

38. I have been informed that this standard is the same as that used in United States district courts, in which claim terms are given their ordinary and customary meaning as would be understood by persons having ordinary skill in the art at the time of the invention having taken into consideration the language of the claims, the specification, and the prosecution history of record under the *Phillips* claim construction standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005).

C. Prior Art

39. I understand that information that satisfies one of the categories of prior art set forth in 35 U.S.C. § 102 may be used in an invalidity analysis under §§ 102 or 103. If information is not properly classified as prior art under one of the subsections of § 102 of the Patent Code, then it may not form the basis of an anticipation or obviousness determination. It is also my understanding that, for inter partes review, applicable prior art is limited to patents and printed publications.

D. Anticipation

40. I understand that a patent claim is invalid due to anticipation under 35 U.S.C. § 102 if each and every element of the patent claim is disclosed in a single asserted prior art reference and that such disclosure may be either explicit or inherent. I also understand that a disclosure of an asserted prior art reference can be “inherent” if the missing element is necessarily present or is the inevitable outcome of the process and/or thing that is explicitly described in the asserted prior art reference.

41. I also understand that in order to anticipate the claimed invention, a prior art reference must disclose all elements of the claim within the four corners of the document, and it must disclose those elements arranged as in the claim. However, a reference can anticipate a claim even if it does not expressly spell out all the limitations arranged or combined as in the claim, if a person of skill in the art, reading the reference, would at once envisage the claimed arrangement or combination.

E. Obviousness

42. I also understand that a patent claim is invalid under 35 U.S.C. § 103 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 of the invention to persons having ordinary skill in the art to which the subject matter pertains. Obviousness, as

I understand, is determined based on the scope and content of the prior art; the level of ordinary skill in the art at the time of the alleged invention; differences between the alleged invention and the prior art; and objective evidence of non-obviousness.

43. I further understand that a party seeking to invalidate a patent on obviousness grounds must demonstrate by a preponderance of the evidence that a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so.

44. I understand that the pertinence of the prior art reference as a source of solution to the inventor's problem must be recognizable with the foresight of a person of ordinary skill, not with the hindsight of the inventor's successful achievement, and that a factfinder should be aware, of course, of the distortion caused by hindsight bias and must be cautious of arguments reliant upon ex post reasoning.

III. PETITIONER'S INVALIDITY CHALLENGES

45. I understand that Petitioner challenges various claims of the '398 Patent based on the following Grounds:

Ground	Claims	Basis	Primary Reference	Secondary Reference(s)
1	1, 3, 22, 57	102	Workshop Manual	-
2	2, 4-14, 19-21, 23, 32-42, 58	103	Workshop Manual	Matsushima, Yamamoto, and Olmr

3	1, 3, 22, 57	102	Nakafushi	-
4	2, 4-14, 19-21, 23, 32-42, 58	103	Nakafushi	Matsushima, Yamamoto, and Olmr
5	1, 15-16, 43-44	102	Holzapfel	-
6	43-46, 56	102	Neal	-
7	43-46, 53-54, 56	102	Winberg	-
8	17, 23-26	103	Holzapfel	Neal, Yamamoto
9	17, 23-26	103	Holzapfel	Winberg, Yamamoto

IV. SUMMARY OF OPINIONS

46. It is my opinion that Claims 1-17, 19-22, and 57-58 of the '398 Patent are not anticipated or otherwise rendered obvious by the combination of prior art suggested by Petitioners. I have not formed any opinions regarding the validity of any other claims of the '398 Patent.

V. Background

47. Liquified petroleum gas is commonly referred to as “LPG” or “propane.” [EX1001, 1:44-47.] Propane “is derived from the refining of oil and gas and is compressible to a liquid form for storage.” [*Id.*, *see also* EX2080 (U.S. Patent Pub. No. 2012/0104008), ¶[0003].]

48. Like virtually all forms of matter, LPG can exist in various different states that have very different properties. The terms “liquid propane” or “liquid LPG” are commonly used to describe LPG when present in a liquid state.

49. In my experience, the terms “propane vapor” and “gaseous LPG” are commonly used to describe LPG in a gaseous state.

50. Prior to the priority date of the '398 Patent, the distinctions between gaseous and liquid LPG were well known in the art. For example, I have reviewed archives of the “Propane 101” website which pre-date the '398 Patent. True and correct copies of excerpts of the Propane 101 website as they existed in February, 2015 are filed with this declaration as Exhibit 2081, including the following web pages:

EX2081.A: <http://www.propane101.com>, dated February 9, 2015;

EX2081.B: <http://www.propane101.com/propaneliquidandvapor.htm>, dated February 4, 2015;

EX2081.C: <https://www.propane101.com/understandingpropanetanks.htm>, dated February 6, 2015;

EX2081.D: <http://propane101.com/propanecylinders.htm>, dated February 6, 2015;

EX2081.E: <http://www.propane101.com/industrialpropanecylinders.htm>, dated February 11, 2015; and

EX2081.F: <http://www.propane101.com/propanecylinderusage.htm>, dated February 14, 2015.

51. I have reviewed the information presented on these webpages, and concluded that it is both accurate, and consistent with my understanding of liquid petroleum gas as of June 12, 2015.

52. The “Propane Liquid and Propane Vapor” webpage states that:

Before propane is used, it exists in one of two forms, liquid or vapor. Both liquid propane and vapor are usable but cannot be used interchangeably. *In other words, a propane system designed to use vapor can’t utilize propane in its liquid form and vice-versa.* Additionally, the characteristics of propane liquid and propane vapor are so different that the primary properties we are concerned with are as different as night and day.

[EX2081.B.] Specifically, I agree that a propane system designed to use vapor cannot utilize propane in its liquid form and vice-versa. This is also true for component parts of a system that utilizes liquid propane in some parts of the system and propane vapor in other parts.

53. LPG “exists in a gaseous state at normal temperature and pressure but can be conveniently stored under pressure in a liquid state.” [EX1001, 1:44-47.] A POSITA would have understood that the propane storage disclosed by the ’398 Patent can be accomplished in large on-site tanks, or in portable cylinders. This is confirmed by reference to the “Propane 101” website referenced above. [EX2081.C; EX2081.D.]

54. Petitioner's expert, Dr. Morse, stated that "even though LPG is conveniently stored in a liquid state under high pressure, LPG exists as a gas at normal temperatures and pressures." [EX1003, ¶82.] According to Dr. Morse, "LPG supplied in this way will typically leave the storage tank as a liquid and gas mixture in equilibrium until there is a change in temperature and/or pressure. For example, when the LPG exiting the tank travels to a first regulator that reduces the pressure, the LPG will be vaporized to gaseous form as it passes through the regulator. Vaporizers/regulators that have the dual function of vaporizing fuel and regulating its pressure were well known in the art." [*Id.*]

55. Confusingly, Dr. Morse's assertion that LPG "will typically leave the storage tank as a liquid and gas mixture in equilibrium" is not consistent with his earlier declarations regarding related patents. For example, Dr. Morse submitted a declaration in connection with IPR2025-00805, regarding Champion's U.S. Patent No. 10,393,034, which is a child of the '398 Patent at issue here. There, Dr. Morse stated that LPG tanks supply "liquid propane to a vaporizer" and the "vaporizer converts the liquid LPG into gaseous fuel and supplies the gaseous fuel to the dual-fuel carburetor." [EX2101, ¶70.] Tellingly, Dr. Morse's analysis in earlier IPRs made no reference LPG tanks simultaneously supplying both liquid and gaseous LPG. I strongly disagree with Dr. Morse's current position. An LPG system

designed to draw liquid LPG from a source will draw *only* liquid LPG from the source.

56. While Dr. Morse correctly stated that LPG is typically stored as a liquid and enters the engine as a gas, his categorical assertion that “a fuel that is delivered to the carburetor in a gaseous state [is] a ‘gaseous fuel’” in all contexts is incorrect, as indicated by the very same references that Petitioner cites in its grounds. [*Id.* ¶84; *see also* Ex. 1012, 65 (separately identifying both a “Liquid Propane Line” and a “Gaseous Propane Line”).]

57. In my experience, the vast majority of fuel sources (including liquid gasoline, which both Petitioner and Patent Owner agree is a *liquid* fuel) are vaporized prior to combustion.

58. In fact, many LPG applications are optimized to run on either liquid or gaseous LPG. As such, categorically referring to any LPG source as a gaseous fuel source completely discounts numerous liquid LPG applications, and incorrectly characterizes the knowledge of a POSITA.

A. Gaseous LPG Systems

59. The fuel source containers of LPG are often called “cylinders.” LPG cylinders have a wide variety of possible configurations. For example, consumer-focused cylinders are designed to supply gaseous LPG and are used to fuel gas grills, fire pits, and generators. [EX2081.D.]

60. As another example, U.S. Patent Pub. No. 2011/0100335A1 (“Parlatore”), (cited by Petitioner in related proceedings) describes a system configured to operate using gaseous LPG. [EX2126, ¶[0014] (“In one exemplary embodiment and as shown in the exemplary diagram in FIG. 1, a gas, such [as] liquefied petroleum gas or propane, may be supplied to an engine as fuel. The gas may be stored in a bottle or tank, such as LPG tank 102. . . . An exemplary fuel system may use liquefied petroleum gas (LPG or propane) which may be stored in a vapor gaseous state in LPG tank 102. . . .”).]

61. Parlatore explicitly recognizes the benefits of propane vapor, stating that the LPG applications described therein “may be accomplished through the use of vapor fuel delivery rather than the delivery of liquid propane gas.” [*Id.*, ¶[0025].] Moreover, using propane vapor supplied directly from the source, rather than converting liquid propane to propane vapor, allows the system to avoid “issues pertaining to cooling and freezing, such as those known to affect the conversion of propane from liquid to gas.” [*Id.*, ¶[0025].]

B. Liquid LPG Systems

62. Conversely, it is my understanding that commercial or industrial cylinders are optimized to supply liquid LPG to motorized commercial equipment such as forklifts. Again, this is consistent with my experience and confirmed by reference to the “Propane 101” website referenced above. [EX2081.D-E.]

63. For example, “[p]ropane powered forklifts primarily use 33 pound [sic] cylinders as their fuel source and are equipped for liquid service. Because the cylinders are designed for liquid service, they have to be placed properly on the lift truck to operate correctly. Improper cylinder installation can result in loss of power and eventually complete loss of engine functionality.” [EX2081.E.]

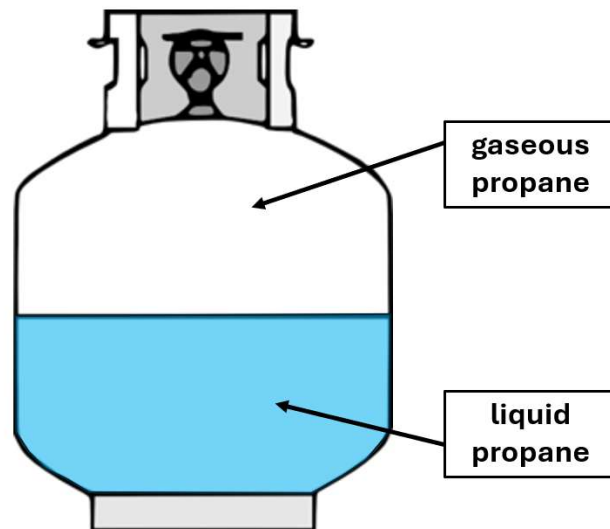
64. Petitioner’s Bernhardsson reference, which was cited in a related proceeding, provides another example of a system configured to operate using liquid LPG. [EX2100, 2:58-68 (“The system 4 for supplying a gaseous fuel, e.g. LPG (Liquefied Petroleum Gas) or natural gas, includes a container 40 in which the gas assumes liquid form under pressure. . . . The container 40 is connected to a vaporizer 43 via a solenoid valve 42 and a pipe 41 . . . and *gas supplied in liquid form to the vaporizer 43 is successively transformed into gas.*”) (emphasis added).] Notably, Bernhardsson *does not* teach that its system is operable on gaseous LPG, and using gaseous LPG in the system disclosed by Bernhardsson would render Bernhardsson’s vaporizer 43 superfluous.

65. Other references provide examples of LPG vaporizers for use with liquid LPG. For example, the Kubota Workshop manual describes a vaporizer which includes both primary and secondary chambers. [EX1012, 69.] The primary and secondary chambers—acting together—vaporize liquid LPG into a gaseous state before the fuel enters the carburetor. [*Id.*, 70-71.]

66. Perhaps most critically, Petitioner's Holzapfel reference discloses "an additional fuel supply system employing a normally gaseous fuel" but explicitly teaches that the system should be configured "so as to draw off the liquid and not gas." [EX1009, 2:8-15.]

C. LPG Storage and Distribution

67. Regardless of whether a LPG tank or cylinder is designed to supply liquid or gaseous LPG, the storage device contains LPG in both a liquid and gaseous state.² Liquid propane is more dense than gaseous propane, and therefore sinks to the bottom of the tank, as depicted below:



² This is also true with respect to gasoline tanks, which contain liquid gasoline and gasoline vapor.

Schematic Representation of an LPG Tank with Both Gaseous and Liquid Propane.

68. When the valve at the top of the LPG cylinder is opened, it causes the pressure within the cylinder to drop, which (1) causes the liquid LPG to boil and evaporate into a gas, and (2) releases the gaseous propane located near the valve.

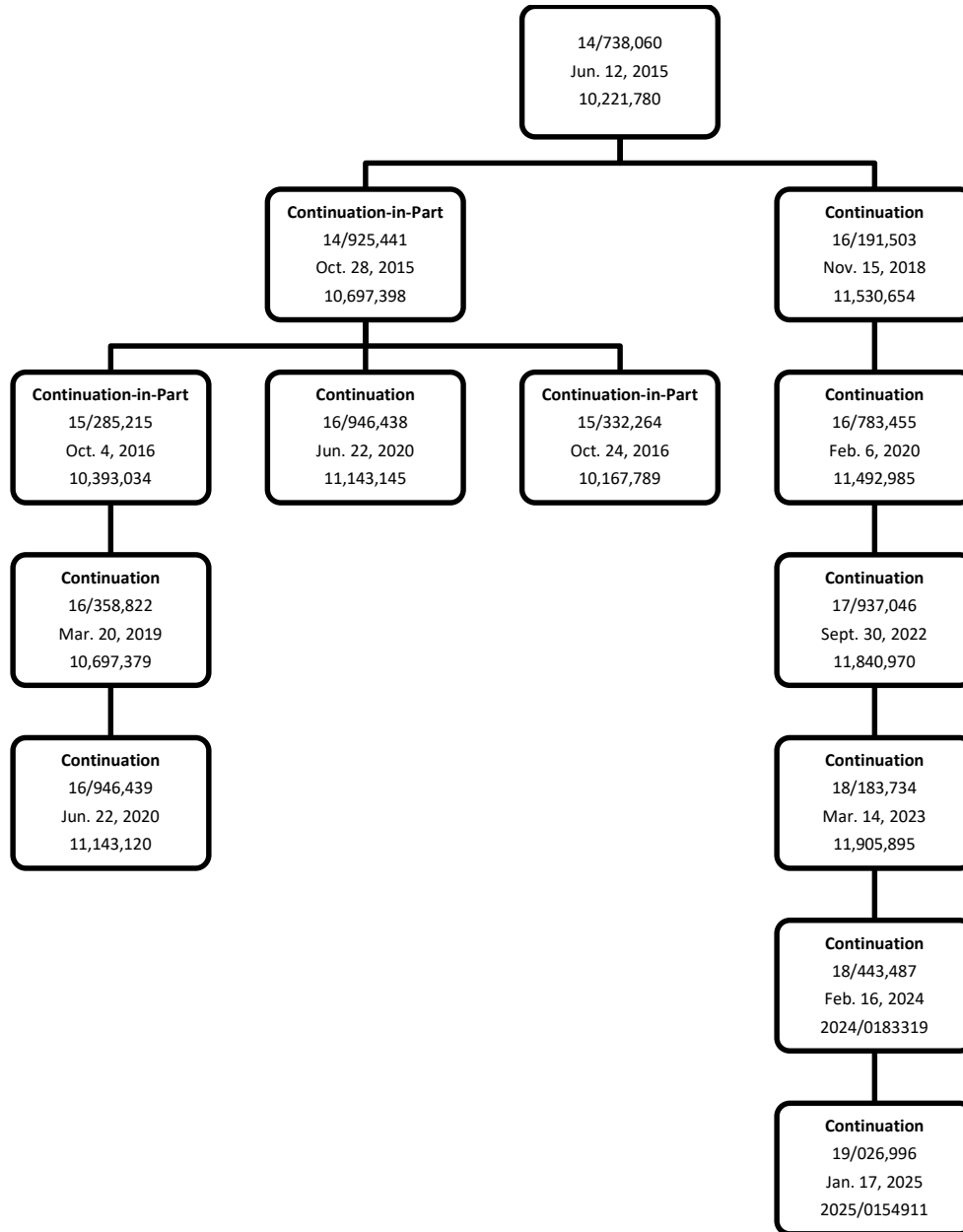
69. The different LPG use cases and storage configurations would have been known to a POSITA. For example, such differences are discussed on the Propane 101 Website: “The proper use of a propane cylinder involves the appliance(s) being serviced. Propane appliances and equipment that utilize cylinders . . . are not to be used as a replacement for an empty bulk propane tank. . . . Also, bottles that are used in vapor service such as a barbeque grill or fish fryer cannot be replaced by a forklift propane cylinder, as LP Gas forklift cylinders use liquid propane for their specific engine fuel applications. . . LP Gas cylinders are not interchangeable with ASME bulk propane tanks or with other types of cylinders that are approved for specific LP Gas applications.” [EX2081.F.]

70. Of key importance to the understanding of the ’398 Patent’s claims, “[p]ropane vapor service and propane liquid service are completely different from one another.” [EX2081.B.] The vast majority of propane applications—such as water heaters, furnaces, gas grills, and the generators at issue in the co-pending disputes between Patent Owner and Petitioner—utilize propane vapor. [EX2081.B.]

These applications are not configured to operate on liquid LPG. If liquid propane were injected into these systems it could result in fire or similar danger, which is why consumer propane cylinders should always be positioned upright with their valves at the top of the storage vessels.

VI. OVERVIEW OF THE '398 PATENT

71. The '398 Patent was filed as U.S. Patent Application No. 14/925,441 on October 28, 2015. EX1001, (21), (22). The '398 Patent is one of thirteen members of a patent family directed to multi-fuel engine technology, which are collectively referred to as the "2015 Family." The 2015 Family is depicted below:

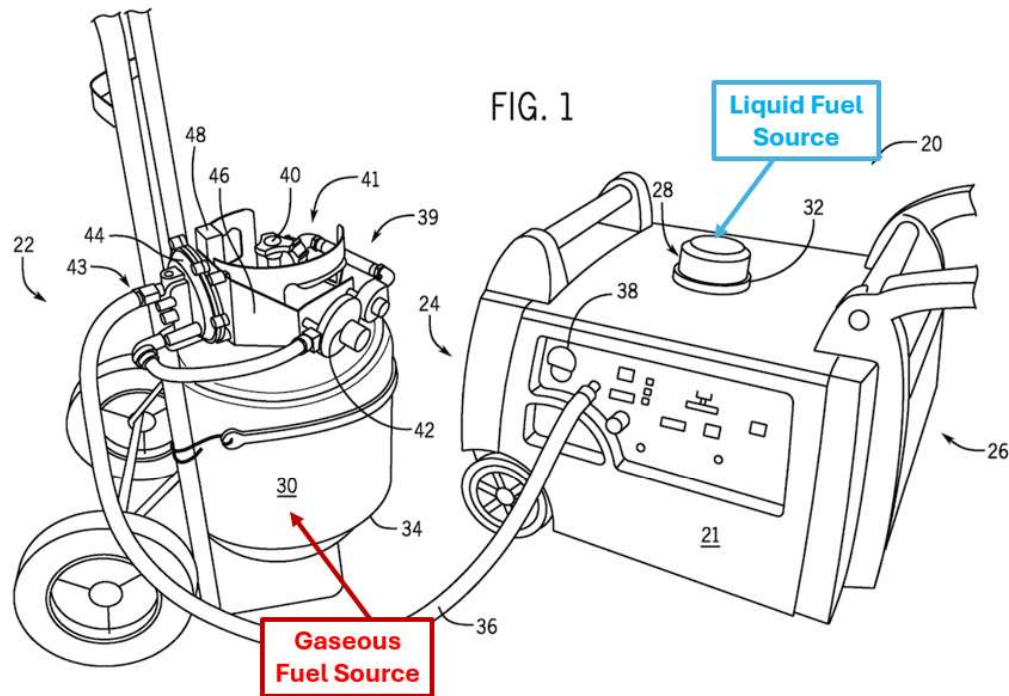


A. Summary

72. As the specification of the '398 Patent explains, the patent describes “A dual fuel engine includes an engine operable on a gaseous fuel and a liquid fuel and a switch to change operation of the engine between gaseous fuel and liquid fuel.” [EX1001, Abstract.] The technology requires a carburetor that can mix air and fuel

and connect to both a gaseous fuel source and a liquid fuel source. The invention is directed at using such dual-fuel engines in portable electric generators.

73. Figure 1 of the '398 Patent, reproduced below for convenience, shows an example embodiment of the technology. The patent teaches “mechanical fuel lockout switch 38 provides gasoline flow from gasoline tank 32 to the engine while preventing connection of an LPG supply line to fuel inlet 59 of the second fuel line.” [EX1001, 5:40-45.] The patent distinguishes the types of fuel used as either liquid or gaseous. For example, when describing “an exemplary embodiment of the invention, first fuel source 28 is a liquid fuel and second fuel source 30 is a gaseous fuel. The liquid fuel may be gasoline and the gaseous fuel may be liquid petroleum gas (LPG).” [EX1001, 4:7-10.]



[EX1001, Fig. 1.]

74. Note that the second fuel source 30 shown in Figure 1 is an LPG tank with the fuel outlet (service valve 40) located at the top of the tank. Such an embodiment would use a gaseous fuel flowing out from the second fuel source 30. The liquid in the LPG tank settles to the bottom of tank and cannot exit from the fuel source tank because the outlet is at the top of the tank. There are other types of applications that use LPG as a fuel source in liquid form. In those applications, the liquid LPG is drawn from the bottom of an LPG tank. This is not the configuration or use case taught by Figure 1 of the '398 Patent.

75. The '398 Patent explains that there are advantages to being able to use different types of fuel to generate electricity when, for example, “power outages in

the utility grid result from severe weather.” [EX1001, 1:31-33.] However, the patent warns that “a common problem with such configurations that couple two fuel sources to a single engine is that the engine can experience overly rich air-fuel ratio when both fuels are simultaneously engaged during cross-over switching between the fuel sources.” [EX1001, 1:57-62.] An associated problem is that “a float bowl in the carburetor that must first fill or empty prior to changeover causes delay in cross-over switching between the fuel sources.” [EX1001, 1:67-67.]

76. Given the benefits of a dual-fuel generator, as well as the associated drawbacks described in the Background of the Invention section, the '398 Patent sets forth technology that retains the benefits, while minimizing the drawbacks. The technology achieves such a balance by using both gaseous and liquid fuels. The use of the two fuel types is achieved with various switches, valves, solenoids, microcontrollers, and carburetors that can accept both gaseous and liquid fuel sources.

77. An exemplary configuration of the invention is displayed in Figure 4B of the patent, which has been reproduced below for convenience. The invention routes both gasoline and propane from their storage tanks, through valves, into the carburetor, and on to the engine.

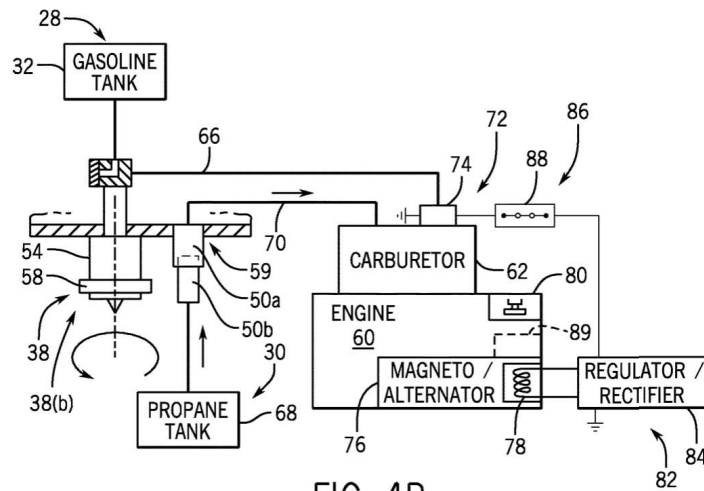
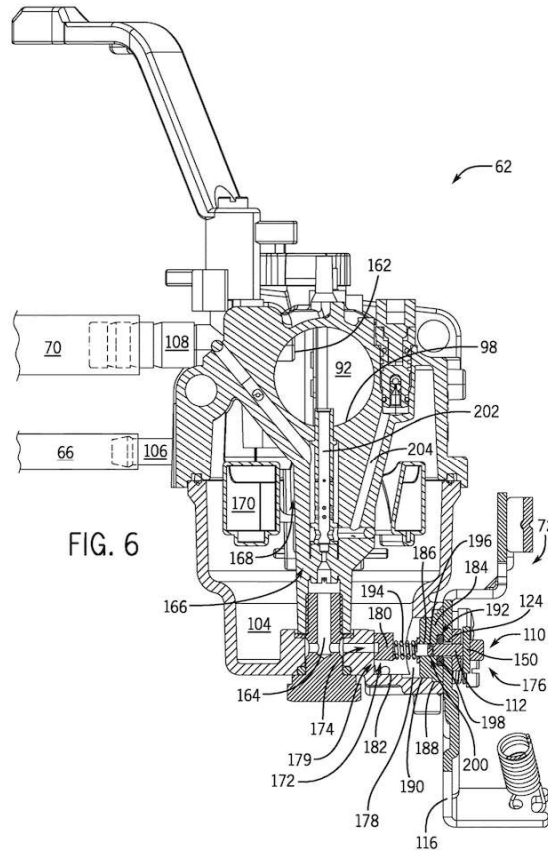


FIG. 4B

['398 Patent, Figure 4B.]

78. One embodiment of the dual-fuel carburetor 62 is shown in cross sectional form in Figure 6, which has been reproduced below for convenience. Gasoline flows into the carburetor through liquid fuel line 66, while propane flows into the carburetor through gaseous fuel line 70.



[’398 Patent, Fig. 6 Showing a Cross-Sectional View of a Carburetor Embodiment.]

B. Independent Claims of the ’398 Patent

79. Claim 1 of the ’398 Patent is an independent claim reciting:

’398 Patent, Claim 1	
Element	Claim language
[1.0]	A dual fuel engine comprising:
[1.1]	an engine operable on a gaseous fuel and a liquid fuel;
[1.2]	a switch to change operation of the engine between gaseous fuel and liquid fuel;
[1.3]	a carburetor attached to an intake of the engine to mix air and fuel and connect to a gaseous fuel source and a liquid fuel source;
[1.4]	a liquid fuel valve positioned along a liquid fuel line coupling the liquid fuel source to the carburetor;

'398 Patent, Claim 1	
Element	Claim language
[1.5]	a gaseous fuel valve positioned along a gaseous fuel line coupling the gaseous fuel source to the carburetor; and
[1.6]	a liquid fuel cut-off incorporated into the carburetor to interrupt liquid fuel upon actuation of the switch from liquid fuel to gaseous fuel.

80. Claim 57 of the '398 Patent requires the following limitations:

'398 Patent, Claim 57	
Element	Claim language
[57.0]	A method of assembling a dual fuel engine comprising:
[57.1]	providing an engine operable on a gaseous fuel and a liquid fuel;
[57.2]	attaching a carburetor to an intake of the engine, the carburetor comprising:
[57.3]	a throat to mix gaseous fuel with air and liquid fuel with air,
[57.4]	a float bowl, and
[57.5]	a fuel passage extending from the float bowl to the throat to provide liquid fuel;
[57.6]	coupling a switch to the engine to change operation of the engine between gaseous fuel and liquid fuel; and
[57.7]	attaching a liquid fuel cut-off to the carburetor to close the fuel passage upon actuation of the switch from liquid fuel to gaseous fuel.

C. Prosecution History of the '398 Patent

81. During prosecution of the '398 Patent, the examiner asserted that U.S. Patent Pub. No. 2007/0137591 ("Sugimoto") teaches "the engine operable on a gaseous fuel and a liquid fuel (paragraphs 0085 – 0086 describes a first fuel in liquid phase to gas, and a second gas fuel)." [EX1002, 180.]

82. In response, Patent Owner stated that:

Sugimoto actually discloses “[t]he external fuel bottle 71 supplies the second fuel gas in gas phase to the fuel gas pressure regulator 62” and “[t]he fuel pressure regulator 62 functions as a vaporizer for vaporizing the first fuel gas supplied thereto in liquid phase.” Sugimoto, ¶ [0078]. Since the first fuel gas is vaporized by the fuel pressure regulator 62, the first fuel gas and the second fuel gas are provided in a gaseous form to the carburetor 18b. *See Id.* at ¶ [0071]. As such, the Examiner has not shown that Sugimoto discloses an engine operable on a gaseous fuel and a liquid fuel.

[EX1002, 225.]

VII. OVERVIEW OF THE PRIOR ART

A. Kubota DF972-E2 Workshop Manual (“Workshop Manual”)

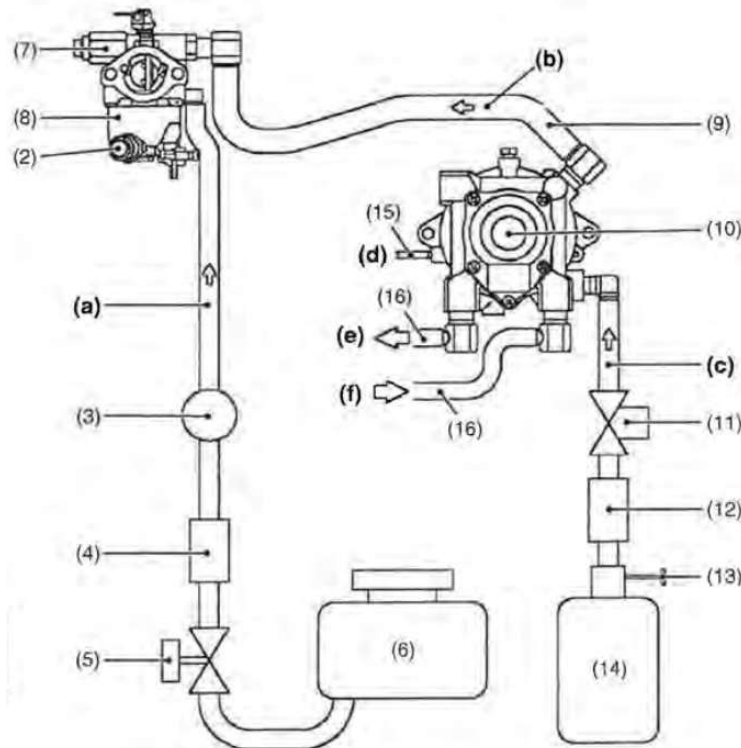
83. The Workshop Manual describes the Kubota DF972-E2 engine, which is an “off road engine” that can run on two different types of fuel. [EX1012, 10.] More specifically, the DF972-E2 engine is a “Vertical, water cooled, 4-cycle Dual Fuel (Gasoline/LPG) engine.” [EX1012, 8.]

84. The Workshop Manual explains that the engine is supplied by two different liquid fuel sources: gasoline and liquid LPG. The Workshop Manual teaches, “[f]or LPG fuel, the liquid fuel stored in the LPG tank (14) is sent to vaporizer (10) by pressure in the gaseous phase in the tank” and “[t]he liquid fuel is evaporated in [the] vaporizer.” [EX1012, 65.] The Workshop Manual explains that a “[v]aporizer is a device which converts the liquid fuel into the gaseous fuel” [*id.*,

69] and that, “[w]hen evaporating by primary chamber of vaporizer[,] liquid LPG needs the evaporation heat.” [*Id.*, 64.] “The coolant of the engine is made to circulate as a heat source to evaporate the LPG.” [*Id.*, 69.]

85. As described in detail below, liquid propane is transported to the vaporizer (10) via a liquid propane line (c). [*Id.*, 65.] The Workshop Manual summarizes the purpose of the vaporizer on page 64: “This vaporizer installs the water jacket, throws the coolant of engine, heats primary chamber, promotes evaporation, and prevents valves being frozen.” From these teachings, a POSITA would have understood that the Workshop Manual discloses that LPG tank (14) supplies *liquid* LPG, which is converted to a gaseous state only after passing through the vaporizer.

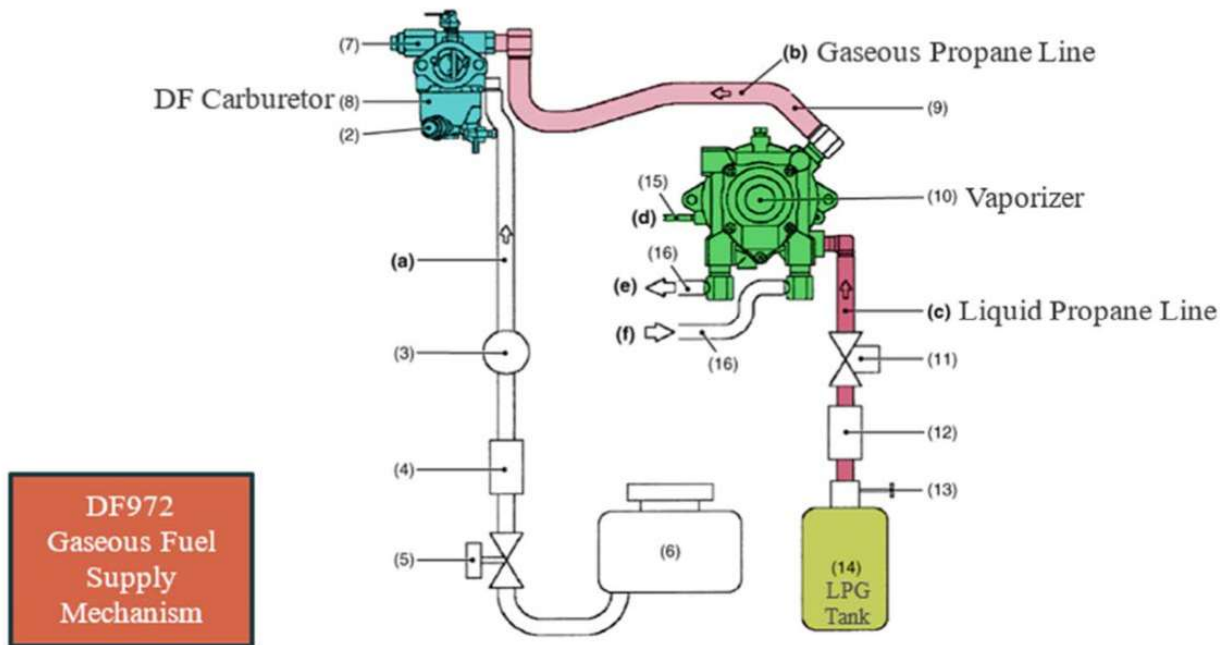
86. The Workshop Manual’s fuel system is illustrated with the following diagram:



(1) WG Carburetor	(9) Vapor Hose*	(a) Gasoline Line	[A] WG972-E2
(2) Gasoline Cut Off Solenoid	(10) Vaporizer	(b) Gaseous Propane Line	[B] DF972-E2
(3) Fuel Feed Pump	(11) LPG Shut Off Solenoid Valve*	(c) Liquid Propane Line	
(4) Fuel Filter	(12) LPG Filter*	(d) Vacuum Line	Component Marked * Is Not
(5) Gasoline Cock*	(13) LPG Manual Valve*	(e) Hot Coolant Out Line	Provided by KUBOTA
(6) Gasoline Tank*	(14) LPG Tank*	(f) Hot Coolant In Line	
(7) LPG Cut Off Solenoid	(15) Vacuum Hose*		
(8) DF Carburetor	(16) Coolant Hose*		

Fuel System Diagram and Index. [EX1012, 65.]

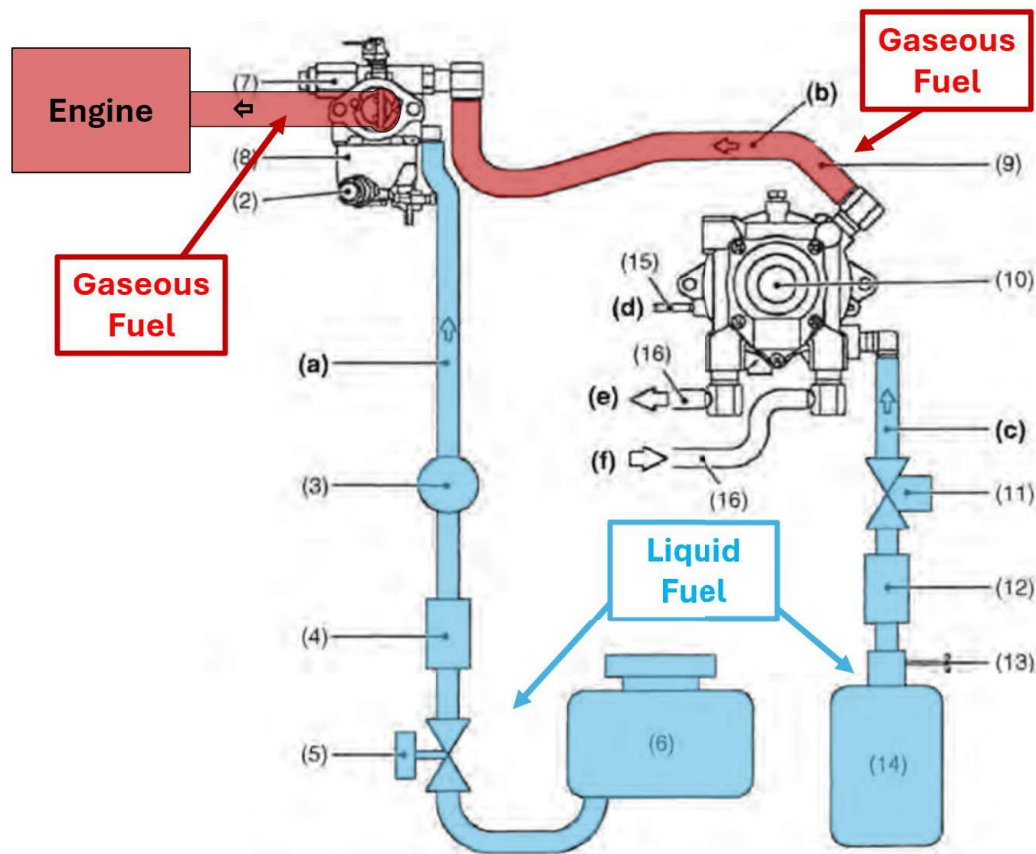
87. In an attempt to argue that the Workshop Manual teaches a gaseous fuel supply, the Petition annotates this diagram in the following manner:



Petition-Annotated Diagram of the Fuel System. [Pet., 14.]

88. What is important to note in the above diagram is that the fuel in the LPG tank flows out of the tank in liquid form, passes through LPG manual valve (13) in liquid form, continues to flow in liquid form through the LPG filter (12), as well as through the LPG shut off solenoid valve (11). Through this process, the liquid fuel flows through a fuel line identified as the “Liquid Propane Line” (c) before entering the Vaporizer (10).

89. To better understand how the Workshop Manual teaches the use of two liquid fuel sources, I have annotated the Fuel System diagram below with clear indications of when the fuels are in liquid form (blue) and when they are in a gaseous state (red).

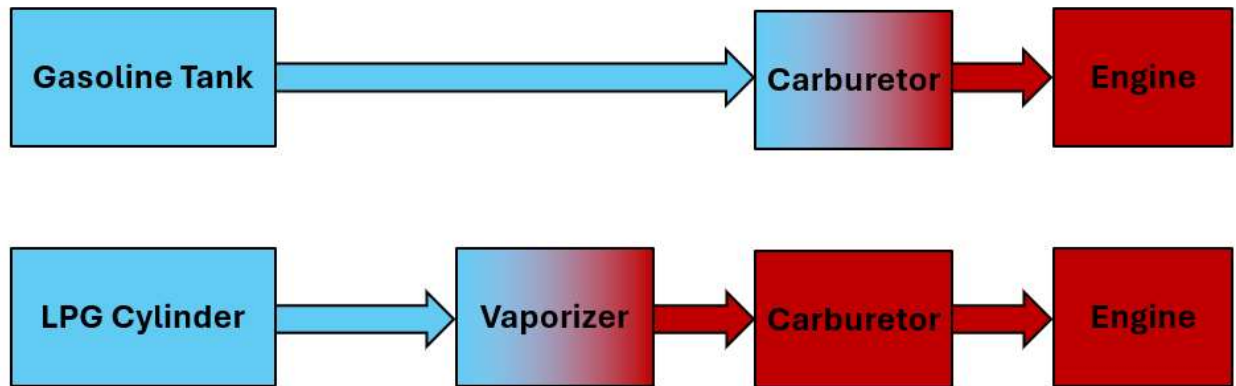


**Fuel System Diagram Annotated to Show Liquid and Gaseous Fuel States.
[Workshop Manual, pg. 65.]**

90. As shown above, the Workshop Manual discloses gasoline and LPG that are supplied from liquid fuel sources, travel through several components of the fuel system in liquid form, and are ultimately converted to a gaseous state for combustion.

91. The process of using two liquid fuels in the Workshop Manual can be represented by the process timeline below, depicting liquid fuel in blue and gaseous

fuel in red. A POSITA would have recognized that both the gasoline and LPG are liquid fuels that get converted to a gaseous state prior to combustion in the engine.



Fuel System Process.

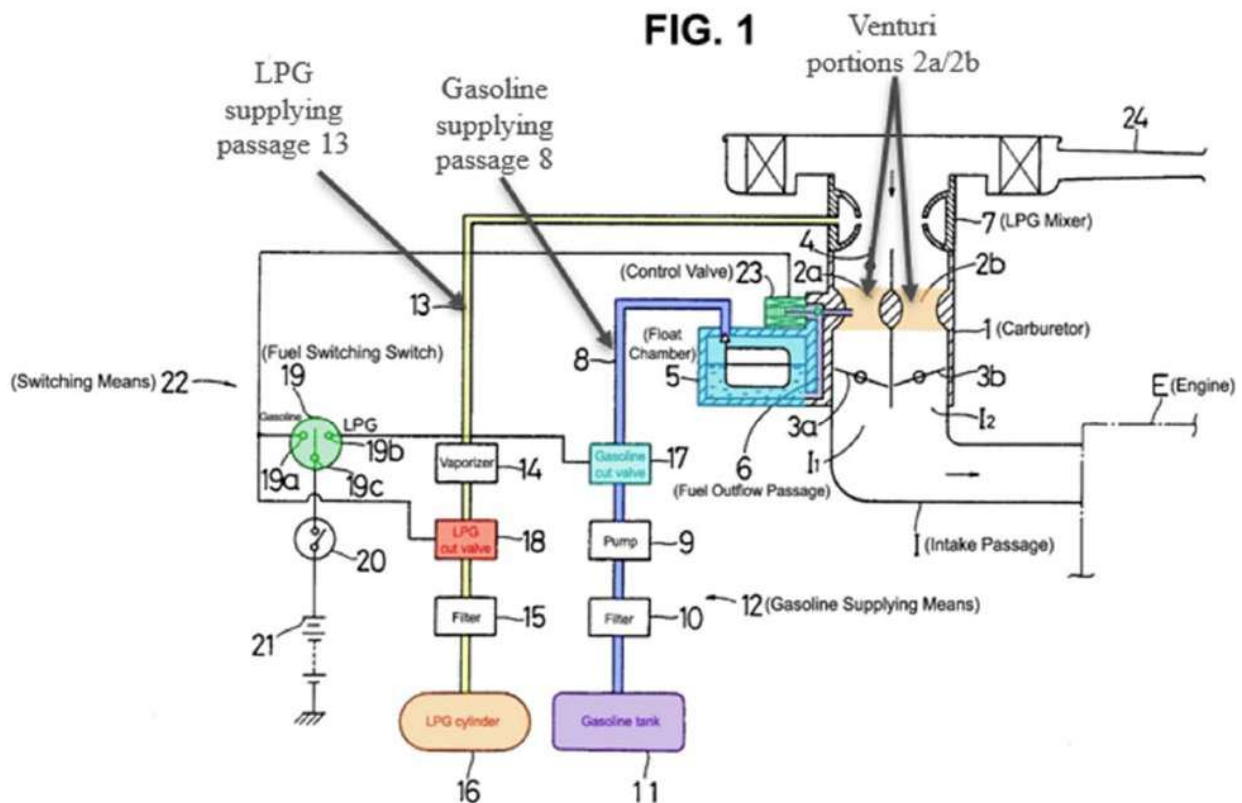
B. JPS61283734A (“Nakafushi”)

92. The Petition states that “Nakafushi discloses an engine configured to selectively use gasoline or LPG.” [Pet., 10 (citing EX1005, ¶[0001]).] Nakafushi discloses “LPG bomb 16” which a POSITA would have understood comprises an on-site LPG tank. [EX1005, ¶[0012].]³

³ Nakafushi refers to numeral 16 as both an “LPG cylinder” and an “LPG bomb.” EX1005, ¶[0012] (“LPG bomb 16 as an LPG supplying means by an LPG supplying passage 13 via a vaporizer 14 for vaporizing LPG”); ¶[0013] (“LPG supplying means (LPG bomb) 16 is operated to switch so as to supply LPG”); *see also* ¶¶[0016], [0021].

93. Much like the Workshop Manual, Nakafushi's LPG cylinder 16 is a source of liquid fuel that is subsequently vaporized by a vaporizer. Thus, at various points in the Nakafushi system, the LPG is either liquid or gaseous.

94. In order to argue that Nakafushi uses a gaseous fuel, the Petition annotates Nakafushi's fuel system diagram in Figure 1, but does not distinguish between the liquid and gaseous LPG, as shown below.

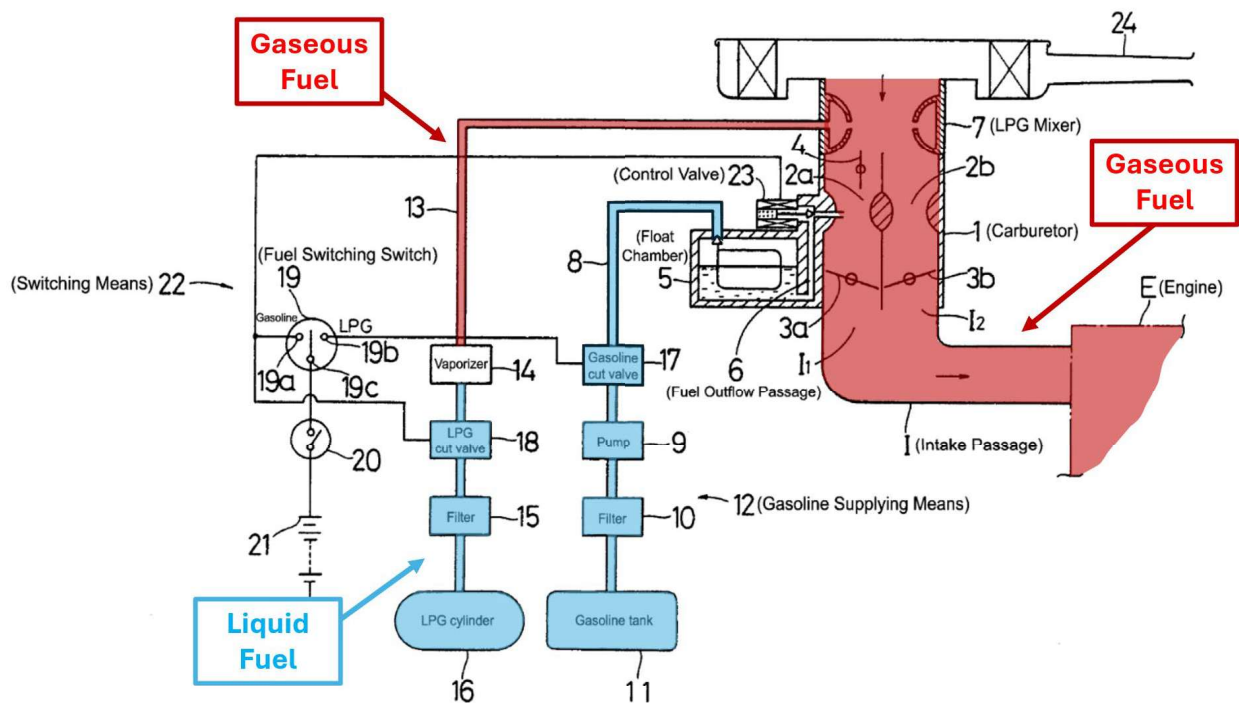


[Pet., 16 (citing EX1005, Fig. 1).]

95. In the diagram above, the Petitioner has shown the liquid LPG fuel in the same color as the gaseous LPG. In order to clearly show the system's use of

liquid fuel, I have annotated the liquid fuel sections in a common blue color in the figure below. Additionally, when the LPG is converted to its gaseous state by the vaporizer, I have indicated that phase change by showing the outflow in red.

FIG. 1

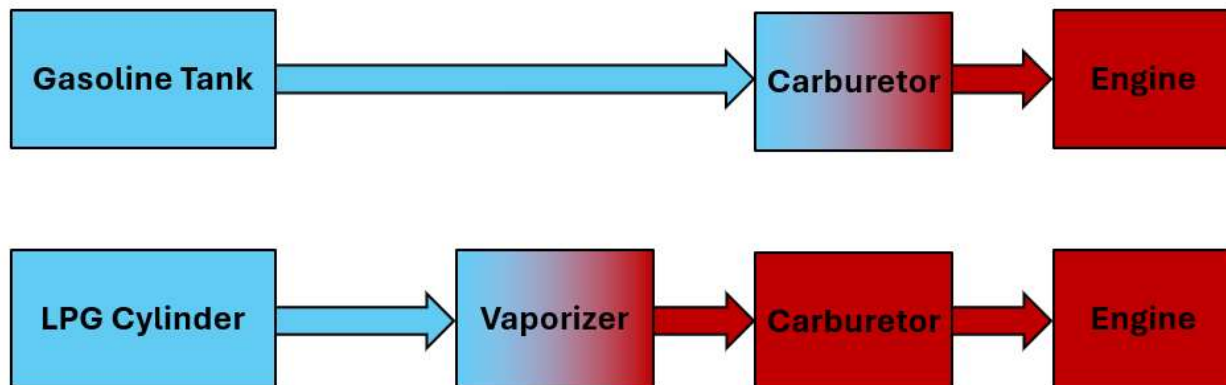


[EX1005, Fig. 1. Annotated to Show Liquid and Gaseous Fuel States.]

96. A POSITA would have understood that LPG bomb 16 supplies *liquid* LPG to filter 15, through LPG cut valve 18, and into vaporizer 14, which then converts the LPG into gaseous form. [EX1005, ¶[0012] (“LPG bomb 16 as an LPG supplying means by an LPG supplying passage 13 via a vaporizer 14 for vaporizing LPG”).] The function of the vaporizer is to convert the liquid LPG into a gaseous

state so it may be properly combusted by the engine. The vaporizer 14 is designed to receive the liquid LPG and heat the liquid to its boiling point.

97. The process of using two liquid fuels in Nakafushi can be represented by the process timeline below, depicting liquid fuel in blue and gaseous fuel in red. A POSITA would have recognized that both the gasoline and LPG are liquid fuels that get converted to a gaseous state prior to combustion in the engine.



Fuel System Process.

98. Nakafushi also discloses numerous additional components such as LPG mixer 7, gasoline cut valve 17, LPG cut valve 18, filters 10 and 15, pump 9, and fuel switching switch 19. These teachings demonstrate that Nakafushi discloses a combustion engine which is less compact, heavier, and more complex than a typical internal combustion engine used in portable electric generators. [EX1005, Fig. 1; ¶¶[0011]-[0013].]

C. U.S. Patent No 1,931,698 (“Holzapfel”)

99. Holzapfel was filed March 30, 1931, and discloses a fuel system for internal combustion engines that can operate on traditional gasoline, as well as a “low boiling point fuel.” [Holzapfel, 2:139-140.] Holzapfel is directed at applications where an “engine is employed for the purpose of driving a motor vehicle.” [Holzapfel, 1:23-24.] Holzapfel claims its invention is advantageous because “on a cold morning, or with a cold motor, it would be preferable to use the low boiling point fuel in tank 16 to start the motor.” [Holzapfel, 1:130-133.]

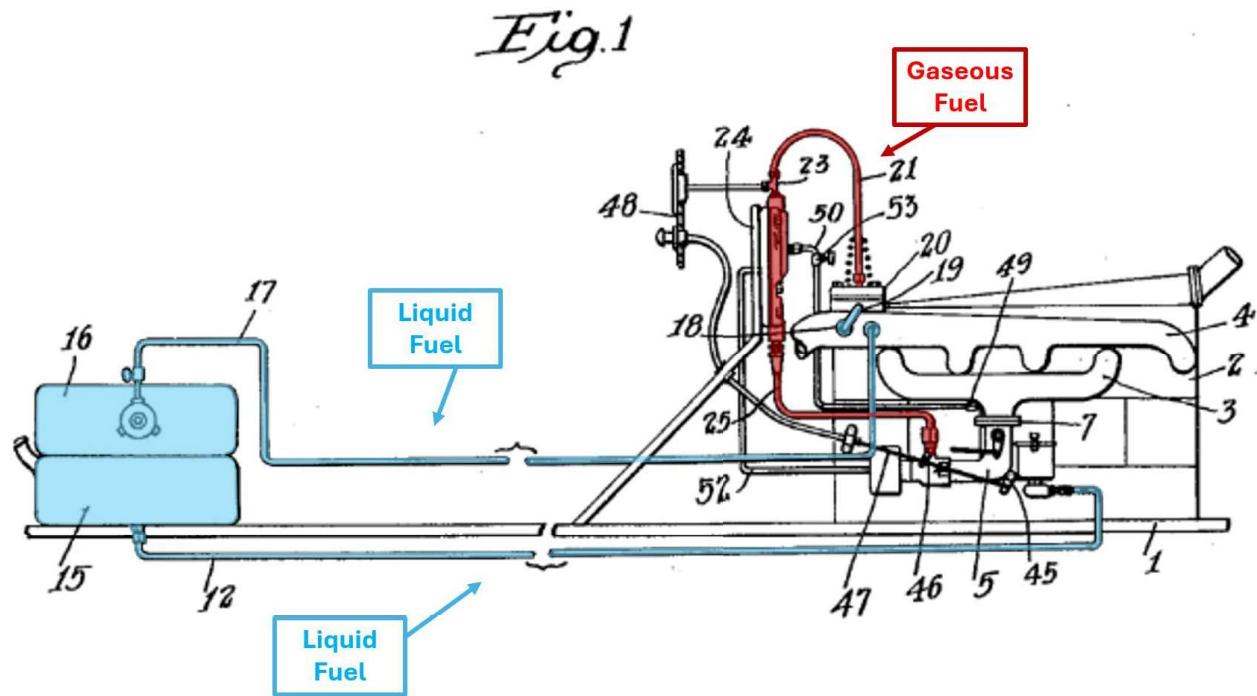
100. More specifically, Holzapfel “relates to fuel systems for internal combustion engines, and has particular reference to a fuel system embodying the supplying of liquid fuel and gaseous fuel to an engine in alternation at will.” [EX1009, 1:1-5.] With respect to the gaseous fuel system, Holzapfel explains:

I propose to add an additional fuel supply system employing a normally gaseous fuel, this system comprising a fuel supply tank 16 in which normally gaseous fuel is compressed and thereby maintained in liquified condition. From tank 16 there extends a suitable gaseous fuel supply tube 17 extending to the bottom of the tank 16, *so as to draw off the liquid and not gas.*

[EX1009, 2:8-15 (emphasis added).]

101. Holzapfel’s “low boiling point fuel” and gasoline fuel paths are depicted in the annotated figure, below, wherein the states of the two fuels are

colored blue when they are in the liquid state and red when they have been converted to a gaseous state. Note that both the gasoline tank 15 and the tank for the “normally gaseous fuel” tank 16 supply *liquid* fuel into the system.



[EX1009, Fig. 1 (annotated).]

VIII. PERSON OF ORDINARY SKILL IN THE ART

102. The Petitioner proposed that a person of ordinary skill in the art (“POSITA”) at the time of the alleged invention of the ’398 Patent “would have a degree in mechanical engineering, physics, materials science, or related fields, and three years of work experience in combustion engines.” [Pet., 9.] Petitioner also states that “[a]dditional higher graduate education could substitute for work

experience, and additional work experience/training could substitute for formal education.” [*Id.*]

103. I disagree with this proposed definition. As an initial matter, I note that Petitioner has provided virtually no justification for its proposal, which appears to rest on its expert’s summary conclusion provided in his declaration. As such, it is my understanding that it should be given little consideration. In contrast, I provide a detailed analysis and justification for my proposed definition below.

104. I understand a POSITA is determined by looking at, among other factors, (1) the educational level of the inventor, (2) the type of problems encountered in the art, (3) prior art solutions to those problems, (4) the rapidity with which innovations are made, (5) the sophistication of the technology, and (6) the educational level of active workers in the field. I understand these factors are not exhaustive, but are merely a guide to determining the level of ordinary skill in the art. For example, the claimed subject matter can be compared to subject matter that is typically taught in the relevant engineering curricula to provide guidance as to what would constitute appropriate educational requirements for a person of ordinary skill in the art.

105. In light of these considerations, as explained further below, a POSITA pertinent to the ’398 Patent would have a four-year degree in mechanical engineering or a closely related field and at least one year of experience designing, developing,

servicing, or operating fuel-powered machinery. Additional education could substitute for professional experience, and significant work experience—such as working with, servicing, or operating such machinery in the field—could substitute for formal education.

106. The '398 Patent describes technology at a level that someone with the above education and work experience would understand. A POSITA, as described above, would understand the different mechanical components and functionality of fuel-powered machinery that are required to practice the claims of the '398 Patent. They would have gained this understanding from either developing the components and control systems for such machines, or from servicing and operating such machinery in the field, which frequently requires knowledge of the machines to perform maintenance and repairs consistent with the requirements of operator manuals. Indeed, service manuals for such machinery assume that the reader is familiar with the mechanical components and control systems and how they work, at least at the level described in the '398 Patent.

107. As mentioned above, I often find it useful to compare the claimed subject matter to the subjects taught in engineering curricula. This comparison helps guide the selection of the formal educational requirements. My requirement of a four-year degree in mechanical engineering or a closely related field is based on my experience teaching mechanical engineering students for more than 25 years. The

material taught to mechanical engineering students covers the subject matter of the claims of the '398 Patent. For example, in the sophomore-level design class at Georgia Tech students learn how to use a processor and sensors to control the actions of an automated machine that includes pneumatic actuators controlled by electro-mechanical valves. The ultimate power source for the pneumatics is a pressured air tank whose fluid output goes through a regulator. The students utilize quick-connect hose couplings to connect the various components of their pneumatic systems.

108. During their senior year, mechanical engineering students complete a capstone design project wherein they usually design, construct, and demonstrate a prototype product. Such prototypes often utilize switches, valves, and various mechanical assemblies. Therefore, mechanical engineering students would be able to practice most of the claimed features, as well as understand how those features would be combined and operate.

109. The '398 Patent also includes components involving delivery of liquid and/or gas to the engines. The detailed components of such systems, like carburetors comprising float bowls, are not usually taught at the undergraduate level. Therefore, my proposed definition of a POSITA includes the requirement of one year of experience designing, developing, servicing, or operating fuel-powered machinery, or in the alternative, substantial work experience in the field.

110. I am very familiar with the technology described in the '398 Patent. As of the earliest priority date of the '398 Patent, and well before, I qualified as a POSITA under either parties' proposed definition. My opinions in this declaration are not impacted by the use of Petitioner's proposed definition or Patent Owner's proposed definition of a POSITA.

IX. CLAIM CONSTRUCTION

111. I have reviewed the claims, specification, and file history of the '398 Patent.

112. I have been informed that in an IPR proceeding, only terms that are in controversy need to be construed and only to the extent necessary to resolve the controversy. In all cases, I have applied the ordinary and customary meaning of claim terms, as understood by a POSITA, in my analysis provided herein.

X. CLAIMS 1-17, 19-22, AND 57-58 OF THE '398 PATENT ARE NOT INVALID

113. The Petition alleges nine (9) separate grounds in its invalidity challenges. In this section I address the grounds related to Claims 1-17, 19-22, and 57-58 of the '398 Patent.

A. Ground 1: The '398 Patent is Not Anticipated by the Workshop Manual

114. The Petition alleges that Claims 1, 3, 22, and 57 of the '398 Patent claims are anticipated by the Workshop Manual. However, this allegation fails for

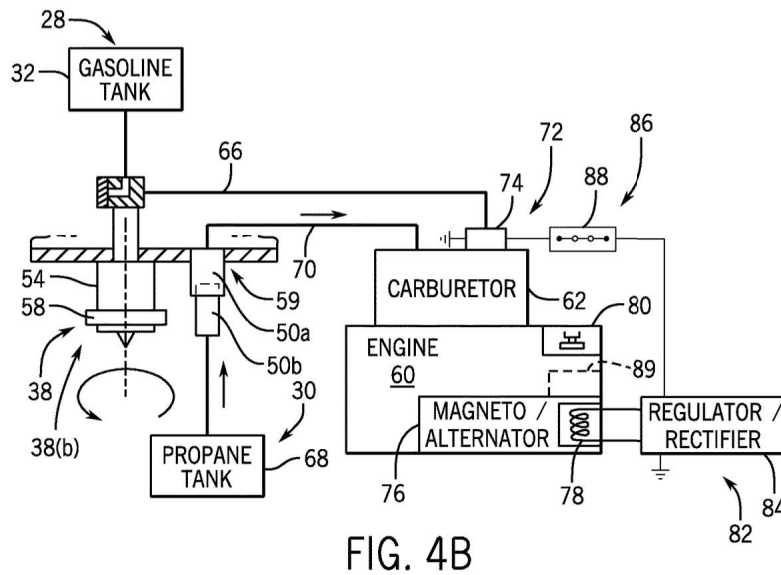
at least the reasons that the Workshop Manual fails to teach: i) a liquid fuel source and a gaseous fuel source, ii) a gaseous fuel valve positioned along a gaseous fuel line, and iii) attaching a liquid fuel cut-off to the carburetor. I address the failures of the Workshop Manual on a limitation-by-limitation basis below.

1. Claim 1

115. Claim 1 of the '398 Patent recites a “dual fuel engine” separately comprising (1) “an engine operable on a gaseous fuel and a liquid fuel,” (2) “a liquid fuel valve positioned along a liquid fuel line coupling the liquid fuel source to the carburetor,” (3) “a gaseous fuel valve positioned along a gaseous fuel line coupling the gaseous fuel source to the carburetor,” and (4) “a carburetor attached to an intake of the engine to mix air and fuel and connect to a gaseous fuel source and a liquid fuel source.” [EX1001, Cl. 1.]

116. Thus, a POSITA would have understood Claim 1 distinctly claimed the state of the fuel (i.e., gaseous or liquid) at three separate locations: the *source* of the fuel, the fuel *line*, and the *engine*.

117. Specifically, the claims separately recite a *gaseous* fuel source, a *gaseous* fuel line coupling the gaseous fuel source to the carburetor, and an engine operable on *gaseous* fuel. Figure 4B of the '398 Patent (reproduced below) depicts a gaseous fuel source (Propane Tank 68), a gaseous fuel line (Second Fuel Line 70) and an engine operable on gaseous fuel (Engine 60).



[EX1001, Fig. 4B]

118. Likewise, the claims separately recite a *liquid* fuel source, a *liquid* fuel line coupling the liquid fuel source to the carburetor, and an engine operable on *liquid* fuel. Figure 4B of the '398 Patent (reproduced below) depicts a liquid fuel source (Gasoline Tank 32), a liquid fuel line (First Fuel Line 66) and an engine operable on liquid fuel (Engine 60).

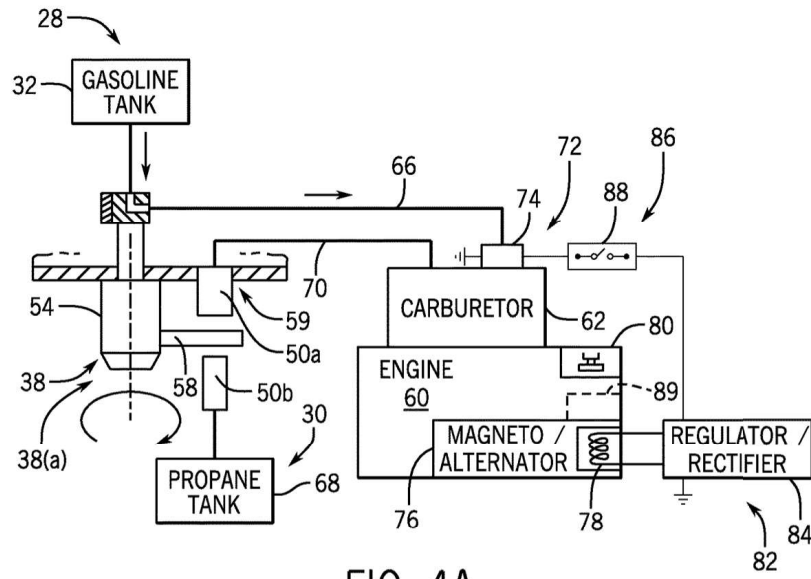


FIG. 4A

[EX1001, Fig. 4A]

119. One of Petitioner’s own exhibits teaches that one of the functions of a carburetor is the evaporation of gasoline. [EX1006, 7.] Specifically:

Liquid gasoline will not support rapid combustion without being changed to a mist or broken down or atomized into tiny drops. When liquid gasoline is introduced to the venturi, it is gasified by its collision with the rapidly moving air mass. The atomized fuel then flows to the intake manifold where the pressure is low, and any remaining liquid gasoline evaporates further. Vaporization is finally completed with the heat generated by the compression of the air-fuel mixture in the cylinder.

120. In light of this teaching (*i.e.*, that liquid fuel is atomized, and partially vaporized in the carburetor, further vaporized in the intake manifold, and completely vaporized in the cylinder), a POSITA would have understood that the “operable on”

requirement of Element [1.1] would have referred to the state of the fuel when it reaches the carburetor/engine. Therefore, a POSITA would have understood that an engine is “operable on” liquid fuel as claimed by the ’398 Patent liquid fuel even if the fuel is partially vaporized in the carburetor, intake manifold, or cylinder.

121. This is consistent with the prosecution history of the ’398 Patent.

122. During prosecution of the ’398 Patent, the examiner asserted that U.S. Patent Pub. No. 2007/0137591 (“Sugimoto”) teaches “the engine operable on a gaseous fuel and a liquid fuel (paragraphs 0085 – 0086 describes a first fuel in liquid phase to gas, and a second gas fuel).” [EX1002, 180.]

123. In response, Patent Owner stated that:

Sugimoto actually discloses “[t]he external fuel bottle 71 supplies the second fuel gas in gas phase to the fuel gas pressure regulator 62” and “[t]he fuel pressure regulator 62 functions as a vaporizer for vaporizing the first fuel gas supplied thereto in liquid phase.” Sugimoto, ¶ [0078]. Since the first fuel gas is vaporized by the fuel pressure regulator 62, the first fuel gas and the second fuel gas are provided in a gaseous form to the carburetor 18b. *See Id.* at ¶ [0071]. As such, the Examiner has not shown that Sugimoto discloses an engine operable on a gaseous fuel and a liquid fuel.

[EX1002, 225.]

124. However, not only does the '398 Patent claim the state of the fuel at the carburetor/engine—it also claims the state of the fuel (1) at the fuel “source” and (2) in an intervening “line.”

i. Element [1.3]: “a carburetor attached to an intake of the engine to mix air and fuel and connect to a gaseous fuel source and a liquid fuel source”

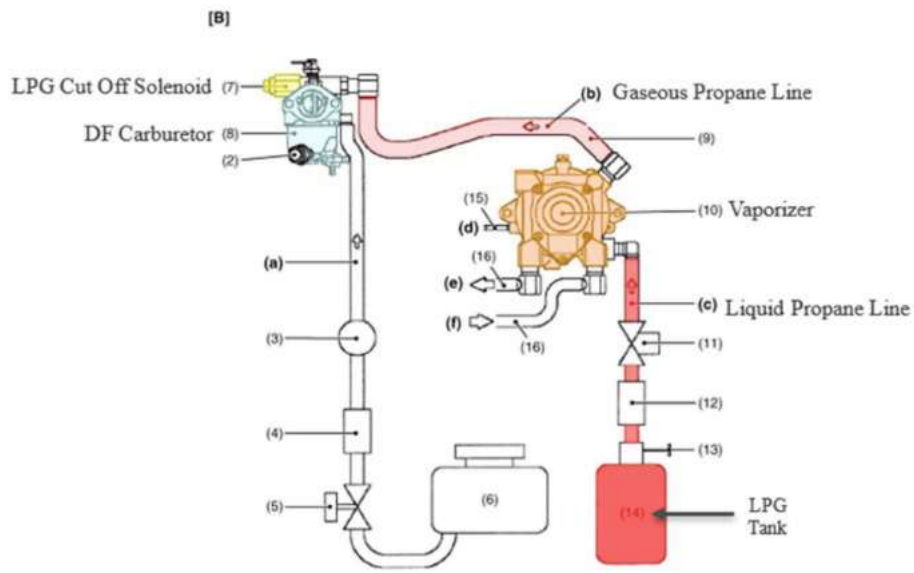
125. The Workshop Manual does not disclose “a carburetor attached to an intake of the engine to mix air and fuel and connect to a gaseous fuel source and a liquid fuel source.”

126. Specifically, the Workshop Manual does not disclose a “gaseous fuel source.”

127. As discussed above, the Workshop Manual describes a dual fuel engine that draws fuel from two different liquid sources: Gasoline Tank (6) and LPG Tank (14). [*See* § VII.A, above.]

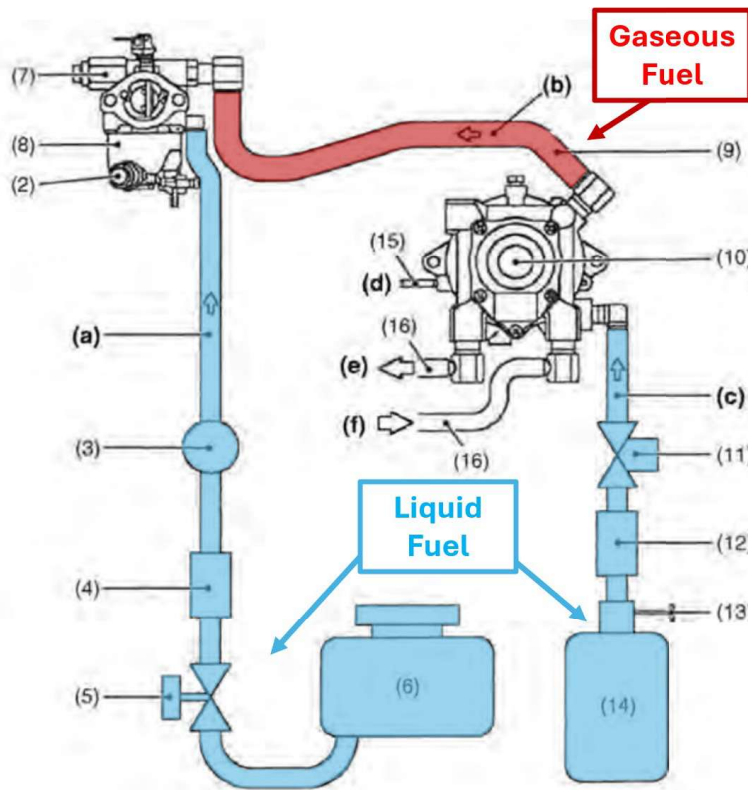
128. Petitioner explicitly maps the claimed liquid and gaseous fuels sources to Gasoline Tank (6) and LPG Tank (14). [Pet., 28 (“The Workshop manual discloses that the carburetor connects to a LPG tank (gaseous fuel source) and a gasoline tank (liquid fuel source).”).]

129. Petitioner’s annotations to the fuel system described in the Workshop Manual are reproduced below.



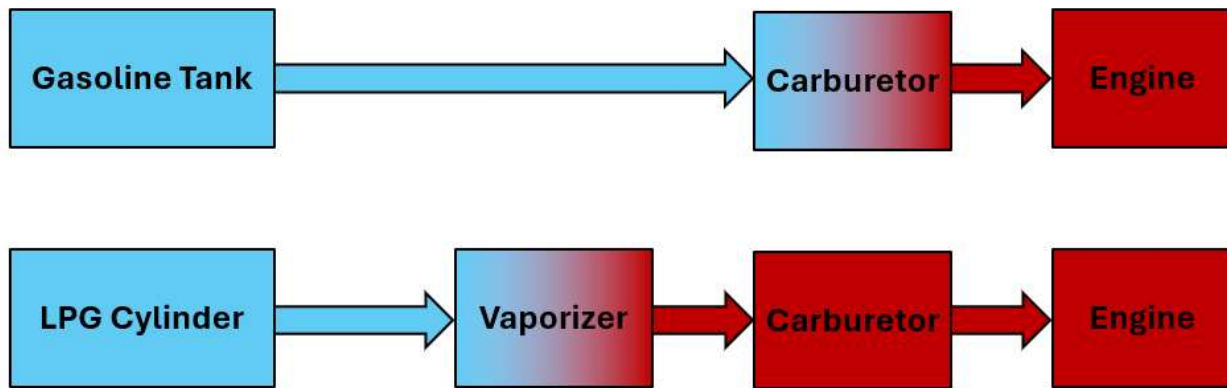
[Pet., 31 (annotations in original).]

130. However, the Workshop Manual explicitly teaches that LPG Tank (14) is a source of *liquid* fuel, not *gaseous* fuel. [EX1012, 65 (“For LPG fuel, *the liquid fuel stored in the LPG tank (14) is sent to vaporizer (10)*”) (emphasis added).] Contrary to Petitioner’s representations, LPG is liquid fuel when leaving the fuel source, and only becomes gaseous fuel after passing through the vaporizer, as depicted by the below annotated figure:



[EX1012, 65 (annotated).]

131. The relative state of the Gasoline and LPG can be appreciated more simply by considering the fuel system process timeline below, depicting liquid fuel in blue and gaseous fuel in red. The diagram shows the liquid gasoline being supplied to the carburetor, which then atomizes the gasoline and provides it to the engine. The liquid LPG is vaporized into a gaseous state by the vaporizer, and then passed through the carburetor to provide it to the engine.



Fuel System Process.

132. As explained in the prosecution history, the fact that the liquid fuel in the LPG tank is converted to its gaseous state prior to reaching the carburetor is pertinent for addressing Element [1.1] (“an engine operable on a gaseous fuel and a liquid fuel”). However, that fact would not have led a POSITA to have understood that the LPG tank was a gaseous fuel source. Rather, a POSITA would have viewed both the Gasoline Tank (6) and LPG Tank (14) as liquid fuel sources which supply liquid fuels that get converted into a gaseous state at subsequent points in the process.

133. As further evidence that the Workshop Manual does not disclose a gaseous fuel source, the presence of the vaporizer actually precludes LPG Tank (14) from being considered a “gaseous fuel source.” For example, if an LPG tank was used improperly such that LPG vapor exited the LPG tank and was sent to the vaporizer, then the vaporizer could not function properly to generate an appropriately-rich fluid flow into the carburetor. In such a case, the engine would

die. In fact, this is exactly what happens when the LPG tank runs out of liquid LPG. Therefore, the Workshop Manual does not disclose Element [1.3].

134. I note that the Petition attempts to distinguish the liquid propane in the LPG tank from the liquid gasoline by stating, “While tank (14) contains LPG in both liquid and vapor form, the Workshop Manual explains ‘[t]he liquid fuel is evaporated in vaporizer and is sent to the DF [dual fuel] carburetor (8) as a gaseous fuel.’” [Pet., 23-24.] However, the mere fact that the liquid fuel is vaporized before reaching the carburetor has no impact on its state *at the source*.

135. In fact, virtually the same could be said about the gasoline fuel: Gasoline tank (6) contains gasoline in both liquid and vapor form, but the gasoline is atomized and vaporized prior to combustion. Therefore, the fact that liquid fuels are stored in tanks that are not completely full at all times, (and therefore necessarily contain some amount of fuel vapor), is irrelevant to the question of whether or not a POSITA would have considered the fuel source to be a gaseous fuel source.

136. A POSITA would have considered a fuel source to be a gaseous fuel source only if it was the *source* of *gaseous* fuel. Conversely, LPG Tank (14) is a source of *liquid* fuel, and is therefore not a gaseous fuel source.

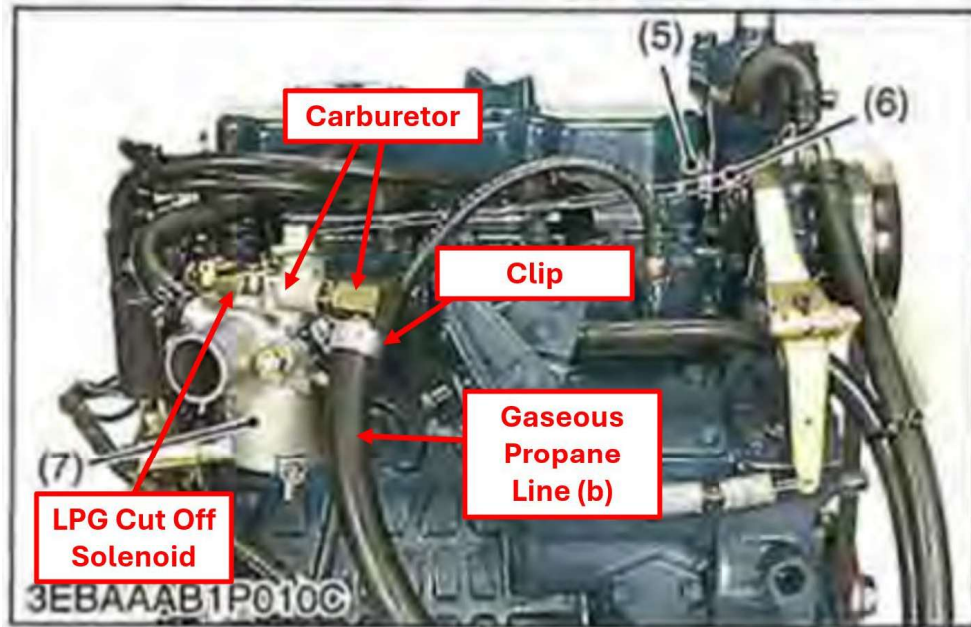
ii. Element [1.5]: “a gaseous fuel valve positioned along a gaseous fuel line coupling the gaseous fuel source to the carburetor”

137. The Workshop Manual does not disclose “a gaseous fuel valve positioned along a gaseous fuel line coupling the gaseous fuel source to the carburetor.”

138. Petitioner identifies “Gaseous Propane Line (b)” as the alleged “gaseous fuel line.” [Pet., 30-31.]

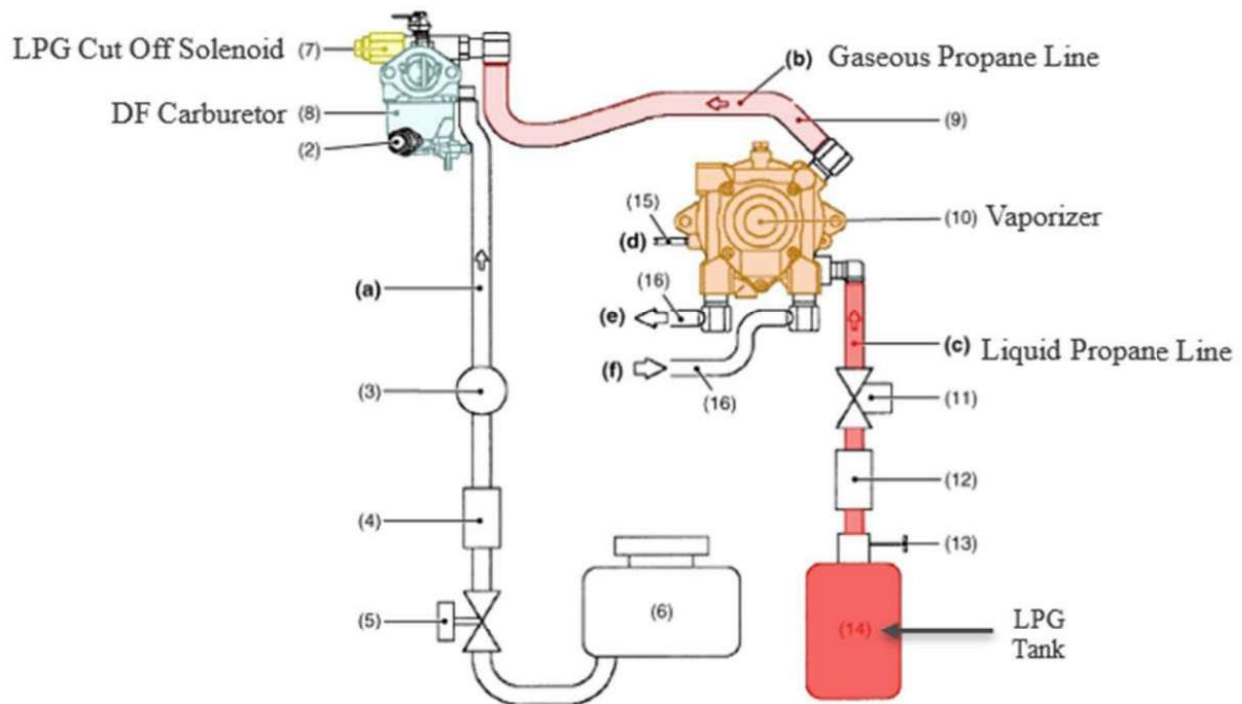
139. Petitioner likewise identifies the Workshop Manual’s “LPG Cut Off Solenoid” (alternatively identified by numeral “(7)” on p. 65 and “(3)” on p. 68) as the alleged “gaseous fuel valve positioned along a gaseous fuel line.” [Pet., 30-31.]

140. Gaseous Propane Line (b) consists of a black fuel line, and is depicted attaching to the carburetor (metallic) upstream of the LPG Cut Off Solenoid in the annotated figure, below. [EX1012, 115.]



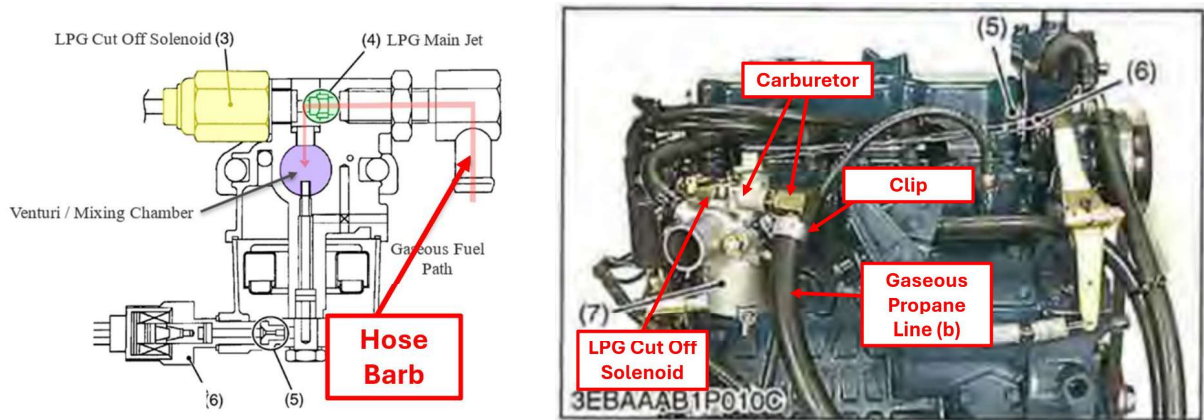
[EX1012 (Workshop Manual) at p. 115 (annotated).]

141. Petitioner’s annotations identifying the alleged “gaseous fuel line” and “gaseous fuel valve” provide further clarity regarding the relationship between Gaseous Propane Line (b) and the LPG Cut Off Solenoid, and are reproduced below:



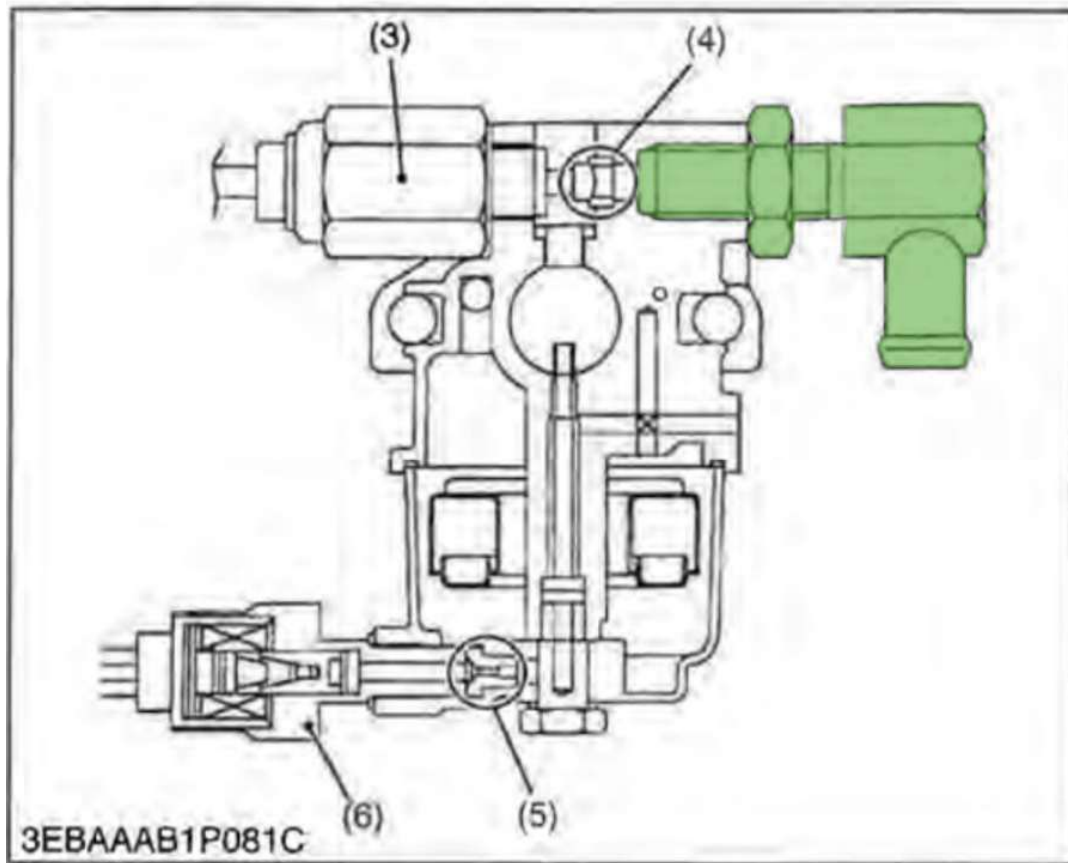
[Pet., 31 (annotations in original).]

142. Specifically, Petitioner’s annotations make clear that LPG Cut Off Solenoid (7) is not located *along* Gaseous Propane Line (b). Rather, Gaseous Propane Line (b) is attached to the hose barb depicted at the top right of the below diagram (below, left), and secured with a clip (below, right). Petitioner’s expert (Dr. Morse) testified that this was a common way to secure a fuel line. [EX2127 (Morse Depo. Tr.) at 109:11-110:8 (“It’s common to have a hose barb on the tank and then an elastomeric fuel line that attaches to the barb, and typically with a clip to secure it.”).] A “clip” is depicted in silver below, and is immediately adjacent Gaseous Propane Line (b) (black).



[Pet., 31 (annotations in original) (left); EX1012 (Workshop Manual) at p. 115 (annotated) (right).]

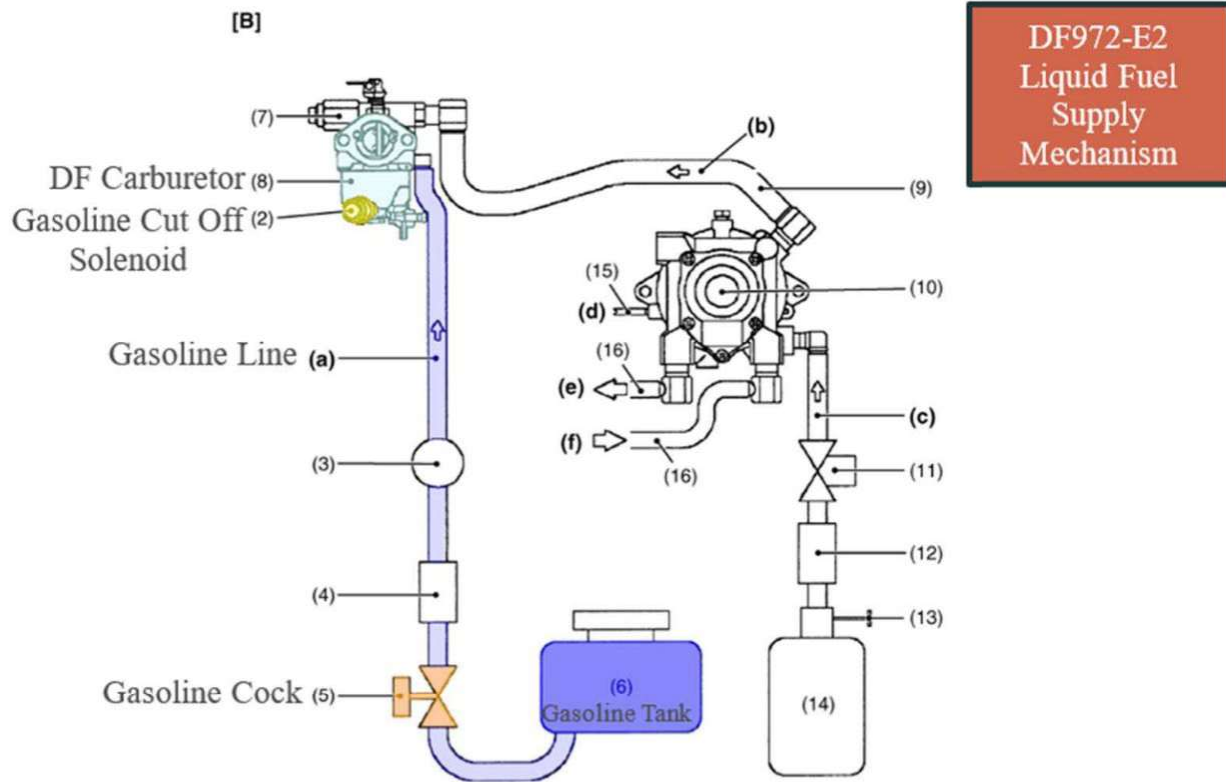
143. As shown, Petitioner identifies the LPG Cut Off Solenoid as being located on the “gaseous fuel path,” which (while true) is irrelevant when analyzing specific claim limitations requiring the valve be located along the gaseous fuel *line*. Based on Petitioner’s annotated figure, LPG Cut Off Solenoid (3) is located *after* Gaseous Propane Line (b), with several intervening components that gaseous fuel passes through located between LPG Cut Off Solenoid (3) and Gaseous Propane Line (b). Those intervening components are highlighted in green, in the annotated figure below.



[EX1012, 68 (annotated).]

144. As further evidence, Petitioner’s analysis of Element [1.4] (requiring “a liquid fuel valve positioned along a liquid fuel line”) is instructive.

145. There, Petitioner identified the Workshop Manual’s “Gasoline Cock (5)” as the claimed “liquid fuel valve” and “Gasoline Line (a)” as the claimed “liquid fuel line.” [Pet., 29.] Petitioner’s annotations are reproduced below:



[Pet., 30 (annotations in original).]

146. Unlike LPG Cut Off Solenoid (7) (identified with respect to Element [1.5]), Gasoline Cock (5) is clearly positioned *along* the alleged liquid fuel line. For example, the alleged fuel line continues both upstream and downstream of the alleged fuel valve.

147. A similar configuration is also found with respect to the Workshop Manual's "LPG Shut Off Solenoid Valve (11)" which is positioned *along* "Liquid Propane Line (c)." [EX1012, 65.] As shown above, on the right side of Petitioner's annotated diagram, the liquid propane line again continues both upstream and downstream of the alleged fuel valve.

148. Conversely, LPG Cut Off Solenoid (7) identified with respect to this element is located entirely downstream of Gaseous Propane Line (b), with other intervening components positioned between Gaseous Propane Line (b) and LPG Cut Off Solenoid (7).

149. For at least the reasons set forth above, the Workshop Manual does not disclose Element 1.5 (“a gaseous fuel valve positioned along a gaseous fuel line coupling the gaseous fuel source to the carburetor.”).

2. Claims 3, 22

150. Claims 3 and 22 depend from Claim 1, and are therefore not invalid for the same reasons.

3. Claim 57

i. Element [57.7]: “attaching a liquid fuel cut-off to the carburetor to close the fuel passage upon actuation of the switch from liquid fuel to gaseous fuel”

151. The Workshop Manual does not disclose “attaching a liquid fuel cut-off to the carburetor to close the fuel passage upon actuation of the switch from liquid fuel to gaseous fuel.”

152. The Petition’s purported analysis with respect to Element [57.7] merely incorporates by reference §VII.A.1.g (referring to Element [1.6] (“a liquid fuel cut-off incorporated into the carburetor to interrupt liquid fuel upon actuation of the switch from liquid fuel to gaseous fuel”)). [Pet., 41.]

153. Elsewhere, Petitioner argues that “[i]t is inherent that the components of the DF972 engine were assembled to form the engine, as their integration into a functional system necessitates assembly steps.” [Pet., 35.]

154. However, Petitioner explicitly argues that the Workshop Manual’s “Gasoline Cut Off Solenoid is incorporated into the carburetor.” [Pet., 33.] Neither the Petition, Dr. Morse’s declaration, nor the Workshop Manual itself include any explicit disclosure of “attaching” the Gasoline Cut Off Solenoid to the carburetor.

B. Ground 2: The ’398 Patent is Not Obvious Over the Workshop Manual in View of Matsushima, Yamamoto, and Olmr

155. Claims 2, 4-14, and 19-21 depend from Claim 1. Ground 2 does not provide any additional analysis with respect to Claim 1. As such, these claims are not invalid for the same reasons as Claim 1.

156. Similarly, Claim 58 depends from Claim 57. Ground 2 does not provide any additional analysis with respect to Claim 57. As such, Claim 58 is not invalid for the same reasons as Claim 57.

157. Additional analysis with respect to specific dependent claims is addressed below.

1. Claim 2: “The dual fuel engine of claim 1, wherein the engine is a pull start, batteryless engine.”

158. The Workshop Manual (alone or in view of Matsushima) does not disclose or otherwise render obvious “The dual fuel engine of claim 1, wherein the engine is a pull start, batteryless engine.”

159. Petitioner concedes that the Workshop Manual discloses a DF972 engine with a battery start (as opposed to a pull start) and argues that a POSITA “would have found it obvious to incorporate Matsushima’s recoil-starter 40 with the DF972 engine.” [Pet., 41.] Specifically, Petitioner argues for replacing the battery start with a pull start. [Pet., 41 (arguing that a POSITA would have found it obvious to “incorporate a pull-start to start the DF972 engine *in place of* the battery.”).]

160. However, the Petition lacks sufficient motivation to replace the battery start with a pull start.

161. Specifically, Petitioner makes two statements regarding the alleged motivation for replacing the Workshop Manual’s pull start with Matsushima’s recoil starter. First, Petitioner argues that “[i]ncorporating a pull-start into the Workshop Manual’s dual-fuel engine would improve reliability in cold or remote applications and reduce costs.” [Pet., 41.]

162. However, Petitioner’s arguments are conclusory, and there is no evidentiary support in either the Petition or Dr. Morse’s declaration that replacing

the Workshop Manual's battery start system with a pull start would improve its reliability in cold or remote applications, or otherwise reduce costs. Moreover, given that the Workshop Manual relies on powered solenoid valves for many applications, it is unclear how removing the battery (which is used to power those valves) would reduce costs, much less result in a functional device.

163. Second, Petitioner argues that “Matsushima provides a blueprint for implementing a recoil starter on an engine of similar displacement and layout.” [Pet., 41.]

164. However, Petitioner does not provide any support for its implication that Matsushima and the Workshop Manual disclose “engine[s] of similar displacement and layout.” [Pet., 41.] Matsushima teaches that its “invention relates to a fuel injection system for an internal combustion engine for supplying fuel to an intake system thereof, and more particularly to an electronically-controlled fuel injection system of this kind which is adapted for use in *small-sized engines equipped with no battery*.” [EX1029, 1:6-11 (emphasis added).] U.S. Patent No. 3,465,740 (cited by Matsushima as an appropriate “known type” of recoil starter) provides further guidance, referring “particularly to rewind type pull-rope starters for small internal combustions engines such as those commonly employed to power lawn mowers, garden tractors, snow blowers and the like.” [EX1029, 4:63-68; *see also* EX2128 (U.S. Patent No. 3,465,740), 1:36-40.]

165. The Workshop Manual discloses a 962cc engine. [EX1012, 8.] Petitioner's expert (Dr. Morse) testified that a 962cc engine such as the engine disclosed by the Workshop Manual "would be a large engine" "[i]f you use it on a lawn mower." [EX2127 (Morse Depo. Tr.) at 130:9-131:15.] A POSITA would have understood that a 962cc engine would have been substantially more difficult to start with a pull-starter than the smaller engines contemplated by Matsushima.

166. For example, a POSITA would have understood that the typical engine for a lawn mower, garden tractor, snow blower, or similar device in 1990 (Matsushima's priority date) would have been smaller than the Workshop Manual by a large factor. [See e.g., EX2130 (U.S. Patent No. 4,707,017) at 5:7-18 (referring to motorcycle engines over 170 cubic centimeters as "relatively large").]

167. As an additional example, the Workshop Manual discloses a water-cooled engine. [EX1012, 8.] Therefore, the pull start would have needed to turn the water pump in addition to the engine itself, significantly increasing the difficulty of pull-starting the DF972 engine.

168. Petitioner's conclusory analysis of the purported motivation to combine the Workshop Manual and Matsushima is particularly deficient in light of Dr. Morse's deposition testimony. There, Dr. Morse repeatedly emphasized that the particular characteristics of an engine are incredibly relevant when analyzing the operation of said engine. [EX2127 (Morse Depo. Tr.) at 50:17-51:8 (agreeing that

“the decision of how to configure the transfer piping and all the associated equipment is dictated by the specific application”); 67:2-9 (“[t]he specific problems that could arise [from drawing liquid propane instead of gaseous propane] would depend on the specific engine being evaluate and the specific configuration”); 121:6-15 (increased fuel pressure may or “may not be an advantage in all cases, depending on how you’ve configured everything”); 122:15-123:3 (“the particular mass flow rate of fuel is dictated by the specific configuration of the engine” and “the fluid properties of the fuel and the configuration of the tank where the fuel is stored and the configuration of the fuel line from the tank to the engine”); 176:4-13 (“certainly the working fluid is something that is taken into account when designing a piping system”)].

169. In light of Dr. Morse’s repeated emphasis on specific engine characteristics and applications, his conclusory assertion of a motivation to combine based on “similar displacement and layout” is particularly deficient, especially where he provided no evidence that the engines in question actually had a “similar displacement.”

170. Finally, Petitioner’s analysis of a reasonable expectation of success is deficient, at least because it does not account for the difficulties in adding a pull start to a large, water-cooled engine. For example, Petitioner has not introduced any evidence to establish that an operator would physically be able to start a 962cc water-

cooled engine using a pull start. My opinion, based on at least i) my education and experience as a POSITA, ii) my understanding of the forces required to force an engine revolution and initiate a compression/ignition cycle while manually activating a dry water pump, and iii) my many years of pull-starting lawn mowers, chainsaws, and the like, is contrary to this suggestion. It would be, at minimum, very difficult to pull start the large, water-cooled engine presented in the Workshop Manual.

171. Additionally, pull start engines often require priming the engine with fuel and choking the air flow. However, Petitioner's proposed combination removes both the battery and electric start system from the Workshop Manual's engines, and the Workshop Manual *does not* disclose a manual choke or any mechanism to manually prime the engine. As such, a POSITA would not have understood the Workshop Manual's engine to be operable with a pull start. For these reasons, Petitioner's proposed motivation to combine and reasonable expectation of success analysis is not sufficient to render Claim 2 obvious.

2. Claim 4: "The dual fuel engine of claim 1, wherein the engine is a pull-start engine having an electrical power generator to supply electrical power"

172. The Workshop Manual (alone or in view of Matsushima) does not disclose or otherwise render obvious "The dual fuel engine of claim 1, wherein the

engine is a pull-start engine having an electrical power generator to supply electrical power.”

173. Once again, Petitioner argues that a POSITA would have found it “obvious to combine Matsushima’s recoil-starter assembly with the [Workshop Manual’s] DF972 engine.” [Pet., 43.] However, Petitioner does not identify a motivation to combine Matsushima’s recoil-starter assembly with the Workshop Manual’s DF972 engine. Instead, Petitioner incorporates its analysis with respect to “§VII.B.1” (referring to Claim 2).

174. However, as discussed above, Petitioner’s analysis with respect to Claim 2 refers to *replacing* the Workshop Manual’s battery start (and battery) with Matsushima’s recoil-starter assembly. [See Claim 2 (“wherein the engine is a pull start, batteryless engine”); Pet., 41 (arguing that a POSITA would have found it obvious to “incorporate a pull-start to start the DF972 engine *in place of* the battery.”).] Therefore, the Petition does not include any analysis of a motivation to *combine* Matsushima’s recoil-starter assembly with the Workshop Manual’s DF972 engine (rather than install the recoil-starter assembly instead of the Workshop Manual’s battery). Likewise, the Petition does not include any analysis of a reasonable expectation of success regarding the same.

175. Moreover, Petitioner’s incorporated motivation to combine analysis is deficient for the same reasons as discussed with respect to Claim 2 (*i.e.*, it relies on

conclusory statements, lacks evidentiary support, and is contradicted by the record evidence). [See §X.B.1, above.]

176. Finally, there is no expectation of success for the proposed combination. In fact, it is my opinion, based on my experience with pull-start engines, that at POSITA would have expected failure when attempting the proposed combination.

3. Claims 5-14

177. Claims 5-14 depend from Claim 4, and are therefore not invalid for the same reasons.

178. Additional analysis with respect to specific dependent claims is addressed below.

4. Claim 8: “The dual fuel engine of claim 6, wherein the solenoid valve is normally open to provide liquid fuel to the engine when the solenoid valve is unpowered”

179. The Workshop Manual (alone or in view of Matsushima and/or Olmr) does not disclose or otherwise render obvious “The dual fuel engine of claim 6, wherein the solenoid valve is normally open to provide liquid fuel to the engine when the solenoid valve is unpowered.”

180. The “solenoid valve” referred to in Claim 8 is the “liquid fuel cut-off.”
[EX1001, Cl. 6.]

181. Petitioner concedes that the “liquid fuel cut-off” allegedly disclosed by the Workshop Manual is normally closed. [Pet., 44 (“The Gasoline Cut Off Solenoid is normally closed”).] Therefore, the Workshop Manual alone does not disclose this limitation.

182. Instead, Petitioner argues that it “would have been obvious to a POSA to use a normally-open solenoid, instead” of the Workshop Manual’s Gasoline Cut Off Solenoid. [Pet., 44; *see also* Pet., 46 (arguing a POSITA “would have been motivated to use Olmr’s normally-open solenoid rather than a normally-closed solenoid based on the express teachings of Olmr.”).]

183. According to Petitioner, a normally-open solenoid is preferred because (1) “many small engines do not utilize a battery or other source of power for starting,” and (2) “should the valve control circuit fail, the spool valve plunger 45 will fail in the normally open position allowing continued operation of the engine.” [Pet., 46 (citing EX1007, 3:43-53).] As discussed above, Petitioner’s motivation to combine analysis is deficient at least because it failed to consider specific characteristic(s) of the engines in question, which Petitioner’s expert repeatedly emphasized is important. [*See* §X.B.1, above.]

184. Moreover, as explained in additional detail below, Petitioner’s proposed motivations are not applicable to the DF972 engine disclosed by the Workshop Manual. Specifically, Petitioner has not established that the DF972

engine is a “small” engine, as contemplated by Olmr, and thus, has failed to establish that Olmr’s stated motivation is applicable to the DF972 engine. In fact, Olmr teaches that it is applicable for “[s]mall internal combustion engines, such as those used to power lawn and garden equipment.” [EX1007, 1:10-11.] As discussed above, a POSTIA would have understood these types of engines to be much smaller than those disclosed in the Workshop Manual. [See §X.B.1, above.] Conversely (and as explained above), the Workshop Manual discloses a much larger and more complex engine that includes a water cooling system and a vaporizer. [See §X.B.1, above.]

185. Similarly, the DF972 engine disclosed by the Workshop Manual *does* “utilize a battery or other source of power for starting,” thus explicitly rendering Olmr’s stated motivation inapplicable. [EX1012, 8, 76-80 (referring to the Workshop Manual’s battery and electrical system).]

186. Moreover, Olmr does not relate to a dual fuel engine. As Petitioner previously acknowledged, the Workshop Manual discloses a fuel select switch (8) which determines whether current flows to the gasoline cut off solenoid (6) or the LPG cut off solenoid (3):

With the fuel select switch (8) in the "GASOLINE" position "D" and the main switch in the "ON" position, the battery current flows to the gasoline cut off solenoid (6). Therefore gasoline fuel in the float chamber flows to the mixing chamber.

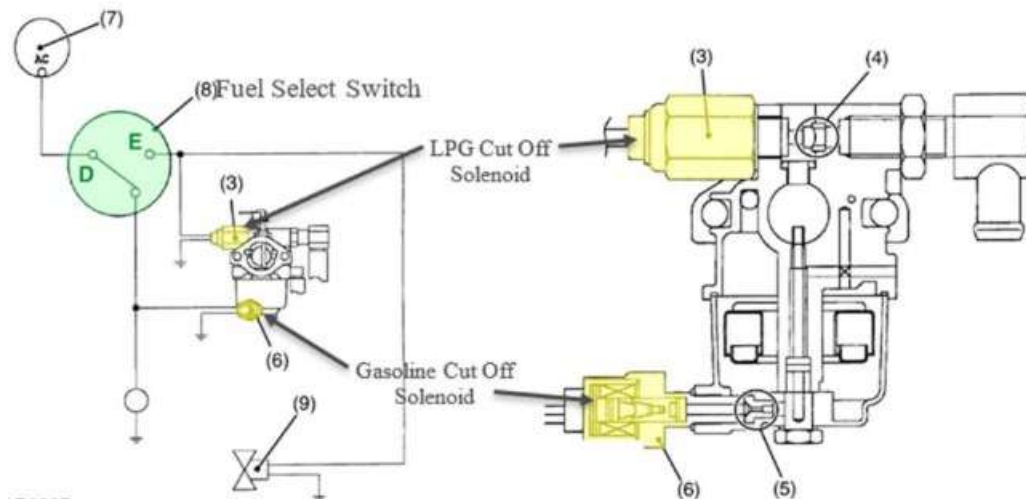
When the fuel select switch (8) is turned to the "LPG" position "E", the battery current stops to the gasoline cut off solenoid (6) and flows to the LPG cut off solenoid (3) and LPG shut off solenoid valve (9).

...

When the main switch (7) turned to the "OFF" position, the battery current stops to the both of solenoids.

[EX1012, 68; *see also* Pet., 24-25.]

187. Petitioner's annotations of the pertinent Workshop Manual figures (which detail which valve(s) are impacted by which position(s) of Fuel Select Switch (8)), are reproduced below:



[Pet., 25 (citing EX1012, 68).]

188. Given the overall structure and layout of the Workshop Manual's switching system, replacing the Gasoline Cut Off Solenoid with a normally-open

solenoid (as allegedly suggested by Olmr) would render the resulting device inoperable.

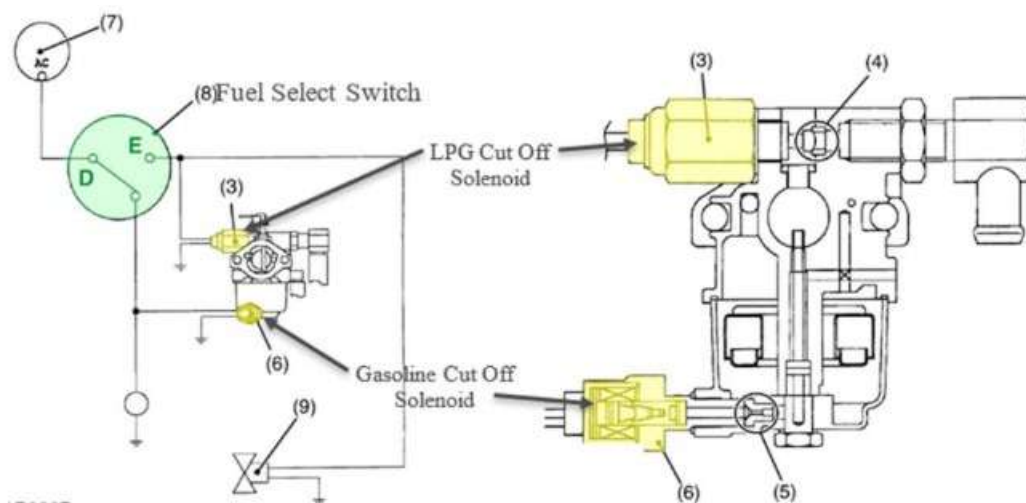
189. The Workshop Manual teaches that “[w]hen the main switch (7) turned to the ‘OFF’ position, the battery current stops to the both of solenoids.” [EX1012, 68.] Under Petitioner’s proposed combination, turning the main switch to “off” would result in *stopping* current to the (now) normally-open Gaseous Cut Off Solenoid, resulting in the solenoid opening and allowing gasoline to flow into the carburetor. This is precisely the opposite of the desired result (i.e., no fuel reaches the carburetor when the switch is “off”).

190. Petitioner does not explicitly address this deficiency. Presumably, Petitioner will argue that its conclusory assertion that the proposed combination “would have involved a simple substitution and a rewiring of the DF972’s switch” is sufficient to resolve this deficiency. However, Petitioner does not explain at any point what the proposed “rewiring” entails. In fact, generically asserting that a POSITA would have been able to “rewire” the prior art to match the configuration disclosed by the challenged patent—without any explicit disclosure of the “rewired” configuration—is the very definition of hindsight.

191. Regardless, the Workshop Manual’s inoperable “Off” switch is not the only issue caused by Petitioner’s proposed combination. The Workshop Manual’s “Fuel Select Switch” identified by Petitioner as allegedly anticipating Element 1.2

(Pet., 24-25) operates by directing current *either* to the LPG Cut Off Solenoid *or* the Gasoline Cut Off Solenoid, both of which are normally closed in the configuration disclosed by the Workshop Manual. [EX1012, 68.] Petitioner's proposed combination suggests replacing the Workshop Manual's Gasoline Cut Off Solenoid with a normally open solenoid. [Pet., 44.] However, this also renders the DF972 Engine inoperable.

192. Fuel Select Switch (8) functions by providing current either to Gasoline Cut Off Solenoid (6) or LPG Cut Off Solenoid (3) (but not both simultaneously). Due to the normally-closed configuration disclosed by the Workshop Manual, the *powered* solenoid is the only open solenoid, and turning off main switch (7) removes power from both solenoids and prevents any fuel flow into the carburetor. Petitioner's annotations of this configuration are reproduced below:



[Pet., 25 (citing EX1012, 68).]

193. Under Petitioner’s proposed modification (ostensibly based on the teachings of Olmr) the Gaseous Cut Off Solenoid would be normally open, and the LPG Cut Off Solenoid would be normally closed. Thus, when the Fuel Select Switch (8) is in Position “D” (“Gasoline”) as shown above, on the left, current is provided to the normally open Gasoline Cut Off Solenoid (meaning the solenoid is closed). However, current is not provided to the normally closed LPG Cut Off Solenoid (meaning the solenoid is also closed).

194. Conversely, when the Fuel Select Switch (8) is in Position “E” (“LPG”), current is provided to the normally closed LPG Cut Off Solenoid (meaning the solenoid is open). However, current is not provided to the normally open Gasoline Cut Off Solenoid (meaning the solenoid is also open).

195. The impact of Fuel Select Switch (8) on the alleged Gaseous Cut Off Solenoid and LPG Cut Off Solenoid under Petitioner’s proposed modification in view of Olmr is represented in the table below:

	Powered Solenoid	Gasoline Cut Off Solenoid Position	LPG Cut Off Solenoid Position
Switch Position “D” (“GASOLINE”)	Gasoline Cut Off Solenoid	Closed	Closed
Switch Position “E” (“LPG”)	LPG Cut Off Solenoid	Open	Open

196. Simply put, under Petitioner’s proposed configuration, the Workshop Manual’s engine either receives both fuels simultaneously when in Switch Position

“D” (resulting in problematic engine “flooding”) [(EX1001, 8:29-40)], or receives no fuel at all when in Switch Position “E”. Neither outcome is desirable. Once again, Petitioner does not provide any explanation regarding how this problem would have been resolved.

197. Finally, Petitioner also makes the conclusory statement that “[a]lthough the DF972 engine has a battery, a POSA would have been nonetheless motivated to use this configuration to allow engine starting if the engine is modified to operate without a battery or if the battery is dead.” [Pet., 46 (emphasis added).] Petitioner’s conclusory motivation is improperly grounded in hindsight, and is therefore deficient.

198. Specifically, Petitioner’s proposed motivation is improperly grounded in a hypothetical (“if the engine is modified to operate without a battery”) which is not true. As discussed above, Petitioner proposed replacing the Workshop Manual’s battery with respect to Claim 2, but argued for “combin[ing] Matsushima’s recoil-starter assembly with the [Workshop Manual’s] DF972 engine” when discussing Claim 4. [Pet., 43.] Claim 8 depends from Claim 4 (not from Claim 2).

5. Claim 9

199. Claim 9 depends from Claim 8, and is therefore not invalid for the same reasons.

- 6. Claim 20: “The dual fuel engine of claim 1 further comprising: a spring pushing the liquid fuel cut-off to interrupt liquid fuel; and an actuating magnet coupled to the carburetor to selectively pull the liquid fuel cut-off against the spring away from a position interrupting liquid fuel”**

200. The Workshop Manual (alone or in view of Matsushima and/or Olmr) does not disclose or otherwise render obvious “The dual fuel engine of claim 1 further comprising: a spring pushing the liquid fuel cut-off to interrupt liquid fuel; and an actuating magnet coupled to the carburetor to selectively pull the liquid fuel cut-off against the spring away from a position interrupting liquid fuel.”

201. Specifically, Petitioner concedes the Workshop Manual does not disclose a spring. [Pet., 51 (“the Workshop Manual does not depict a spring in the Gasoline Cut Off Solenoid”).] Nevertheless, Petitioner contends that a POSITA “would understand the Gasoline Cut Off Solenoid has a spring” because “solenoid valves (like the Gasoline Cut Off Solenoid) typically consist of a spring-plunger design.” [Pet., 50-51.]

202. However, Petitioner does not provide any support for its statement that solenoid valves “typically” consist of a spring-plunger design, such that a POSITA would have understood the depicted solenoid to disclose the claimed structure. In fact, numerous other configurations of solenoid valves exist, and Petitioner’s expert (Dr. Morse) concedes that “you don’t need to have a spring-plunger design to have a solenoid valve.” [EX2127 (Morse Depo. Tr.) at 181:15-182:5.]

203. For example, U.S. Patent No. 8,631,972 (“Kessler”) teaches that “Bistable solenoid or valves are known from the prior art. In order to change between valve positions (open/closed), a bistable valve requires a pulse and then remains in this position until a counter-pulse is transmitted to the valve.” [EX2131, 13:64-14:50.] Kessler also discloses that Figure 19 (reproduced below) “is a schematic representation of a cross-sectional view through an actuator 18 as a bistable solenoid” which does not include springs. [*Id.*, 29:3-13.]

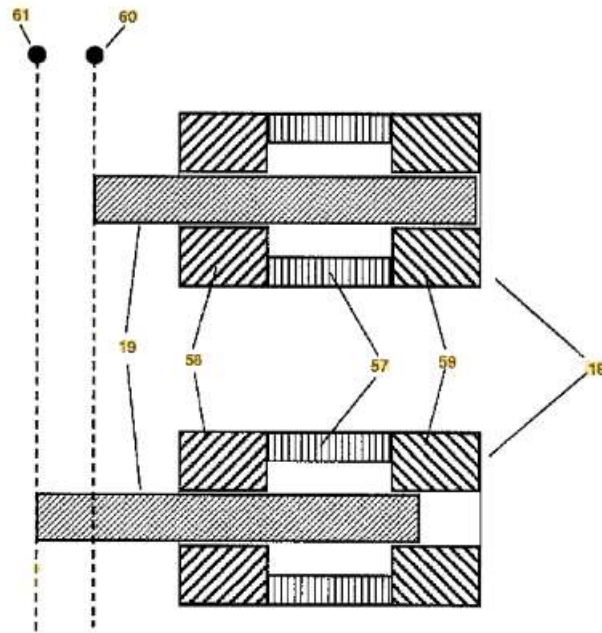


Figure 19

[EX2131 (Kessler), Fig. 19]

204. Petitioner has not established that the mere disclosure of a “solenoid” is sufficient to anticipate claim elements directed to a precise configuration of solenoid.

205. Alternatively, Petitioner argues it would have been obvious to replace the Gasoline Cut Off Solenoid with either (1) a solenoid structured like “the starter solenoid for the DF972 engine” or (2) “Olmr’s cutoff solenoid.” [Pet., 51.]

206. However, Petitioner does not identify any motivation to replace the Gasoline Cut Off Solenoid with either of the proposed replacements. For example, Petitioner does not identify any deficiencies in the Gasoline Cut Off Solenoid, or any benefits in either of the proposed replacements. Instead, Petitioner’s analysis is entirely conclusory and unsupported.

7. Claim 21

207. Claim 21 depends from Claim 20, and is therefore not invalid for the same reasons.

C. Ground 3: The ’398 Patent is Not Anticipated by Nakafushi

208. The Petition alleges that Claims 1, 3, 22, and 57 of the ’398 Patent claims are rendered invalid as anticipated by Nakafushi. However, this allegation fails at least because Nakafushi does not teach: i) the use of a liquid fuel source and a gaseous fuel source, ii) a gaseous fuel valve positioned along a gaseous fuel line, and iii) attaching a liquid fuel cut-off to the carburetor. I address the failures of Nakafushi on a limitation-by-limitation basis below.

1. Claim 1

209. As discussed above, a POSITA would have understood Claim 1 distinctly claimed the state of the fuel (i.e., gaseous or liquid) at three separate locations: the *source* of the fuel, the fuel *line*, and the *engine*. [See §X.A.1, above.]

i. Element [1.3]: “a carburetor attached to an intake of the engine to mix air and fuel and connect to a gaseous fuel source and a liquid fuel source”

210. Nakafushi does not disclose “a carburetor attached to an intake of the engine to mix air and fuel and connect to a gaseous fuel source and a liquid fuel source.”

211. Specifically, Nakafushi does not disclose a “gaseous fuel source.”

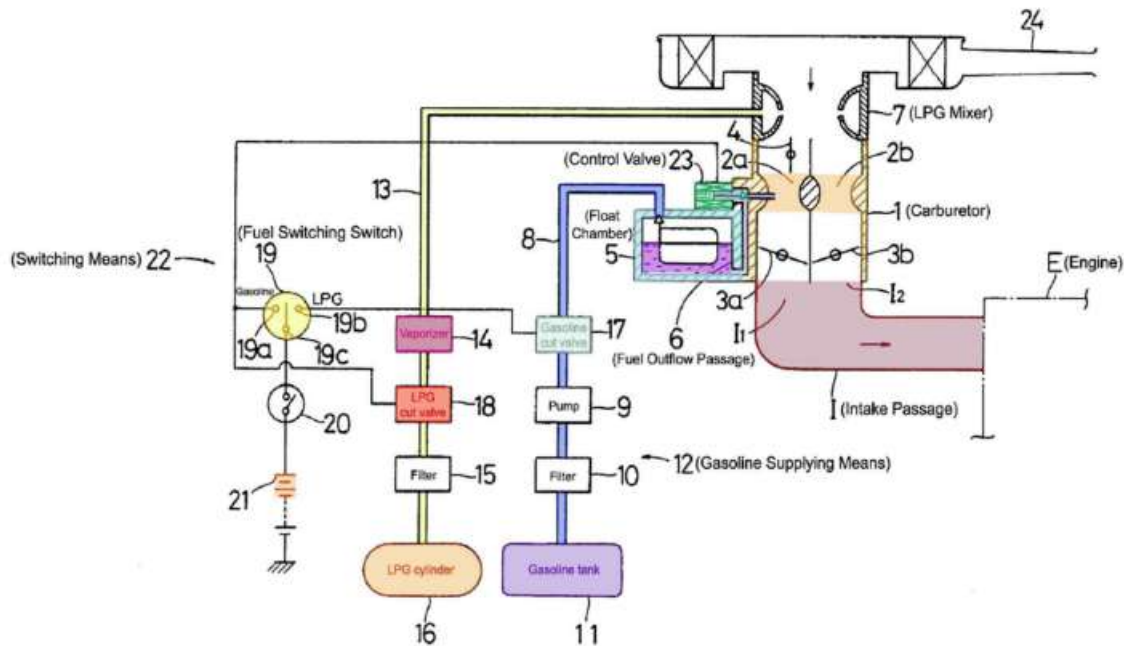
212. As discussed above, Nakafushi describes a dual fuel engine that draws fuel from two different sources of liquid fuel: Gasoline Tank 11 and LPG Cylinder 16. [See §VII.B, above.]

213. Petitioner explicitly maps the claimed liquid and gaseous fuels sources to Gasoline Tank 11 and LPG Cylinder 16. [Pet., 66 (“Nakafushi discloses a carburetor 1 attached to the intake of the engine E, and the carburetor connects the LPG cylinder and gasoline tank to the intake.”).]

214. Petitioner’s annotations to the fuel system described in the Nakafushi reference are reproduced below. Specifically, Petitioner’s annotations are

misleading because Petitioner uses the same color to represent both gaseous and liquid fuel states.

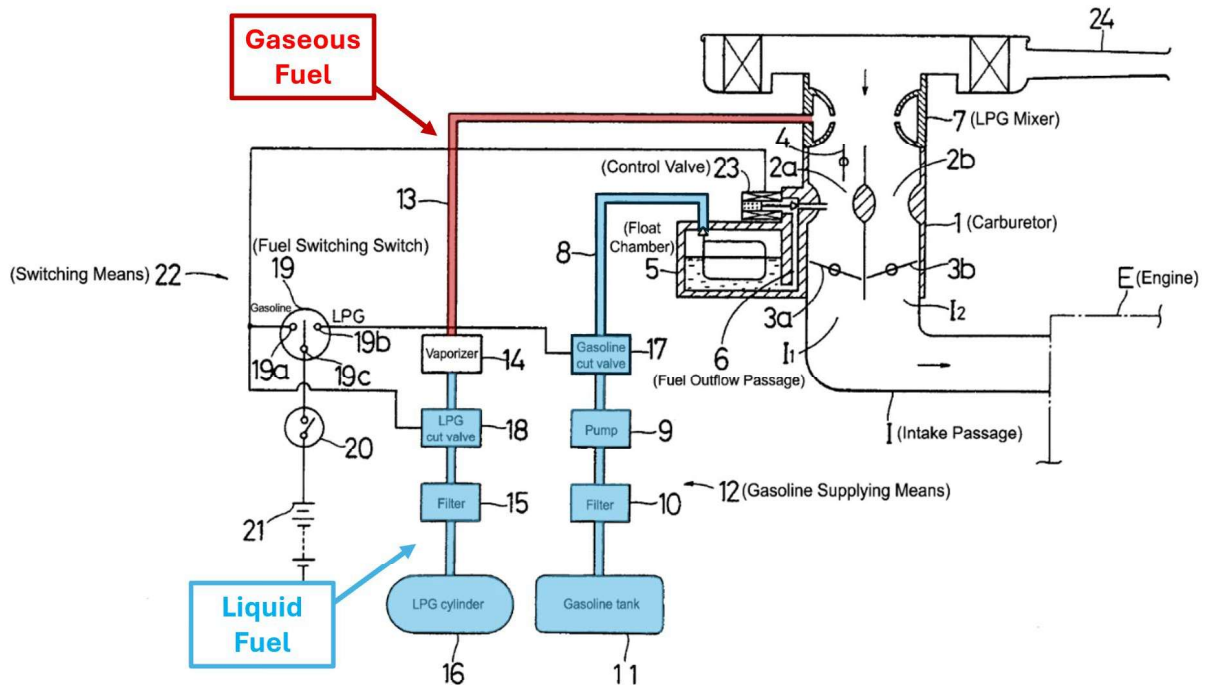
FIG. 1



[Pet., 66 (annotations in original).]

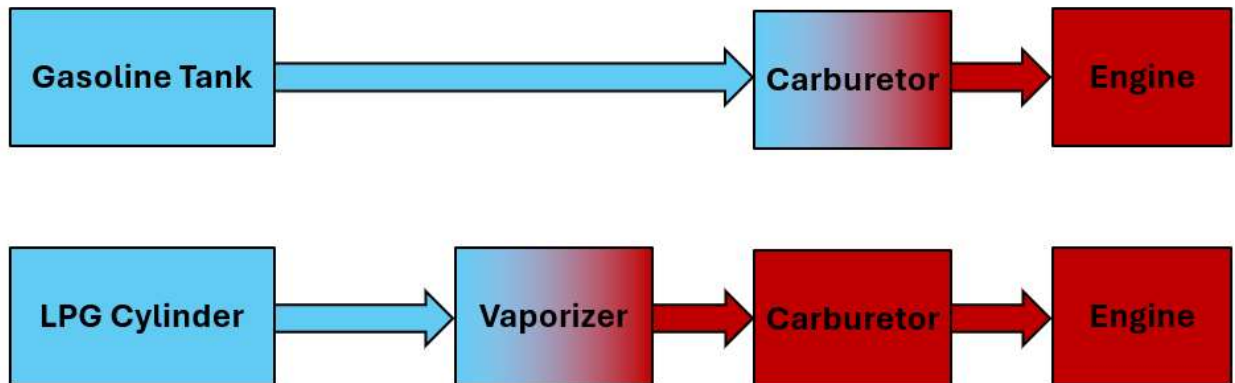
215. Contrary to Petitioner's representations, LPG is liquid fuel when leaving the fuel source, and only becomes gaseous fuel after reaching the vaporizer, as depicted by the below annotated figure:

FIG. 1



[EX1005, Fig. 1 (annotated)]

216. The relative state of the Gasoline and LPG at various points in the system can be appreciated more simply by considering the fuel system process timeline below, depicting liquid fuel in blue and gaseous fuel in red.



Fuel System Process.

217. The diagram shows the liquid gasoline being supplied to the carburetor, which then vaporizes the gasoline and provides it to the engine. Meanwhile, the liquid LPG is vaporized into a gaseous state by the vaporizer, and then passed through the carburetor to provide it to the engine.

218. As explained in the prosecution history, the mere fact that the liquid fuel in the LPG tank is converted to its gaseous state prior to reaching the carburetor would not have led a POSITA to believe that the LPG tank was a gaseous fuel source. Rather, a POSITA would have viewed both Gasoline Tank 11 and LPG Cylinder 16 as liquid fuel sources which supply liquid fuels that get converted into a gaseous state at subsequent points in the process.

219. As further evidence that Nakafushi does not disclose a gaseous fuel source, the presence of the vaporizer actually precludes LPG Cylinder 16 from being considered a “gaseous fuel source.” For example, if an LPG cylinder was used improperly such that LPG vapor exited the LPG tank and was sent to the vaporizer, then the vaporizer could not function properly to generate an appropriately-rich fluid flow into the carburetor. In such a case, the engine would die. In fact, this is exactly what happens when the LPG cylinder runs out of liquid LPG. Therefore, Nakafushi does not disclose Element [1.3].

220. A POSITA would have considered a fuel source to be a gaseous fuel source only if it provided gaseous fuel. Conversely, LPG Cylinder 16 provides *liquid* fuel, and is therefore not a gaseous fuel source.

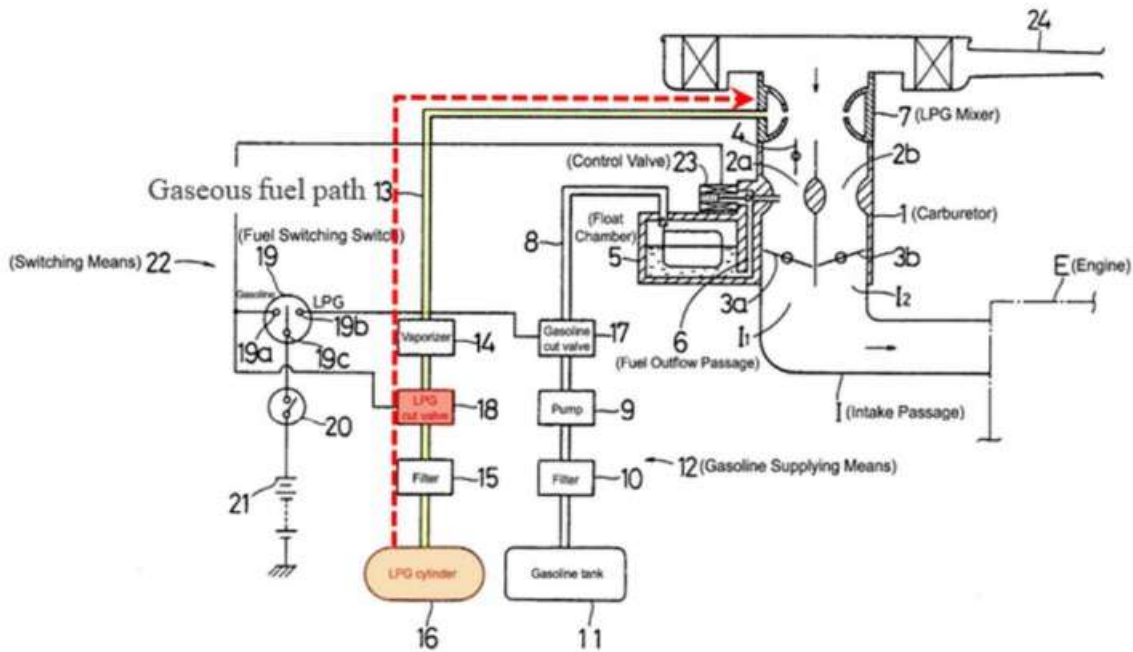
ii. Element [1.5]: “a gaseous fuel valve positioned along a gaseous fuel line coupling the gaseous fuel source to the carburetor”

221. Nakafushi does not disclose “a gaseous fuel valve positioned along a gaseous fuel line coupling the gaseous fuel source to the carburetor.”

222. Petitioner identifies “LPG supplying passage 13” as the alleged “gaseous fuel line.” [Pet., 68-69.] Petitioner likewise identifies Nakafushi’s “LPG cut valve 18” as the alleged “gaseous fuel valve positioned along a gaseous fuel line.” [Pet., 68-69.]

223. Petitioner’s annotations identifying the alleged “gaseous fuel line” and “gaseous fuel valve” are reproduced below:

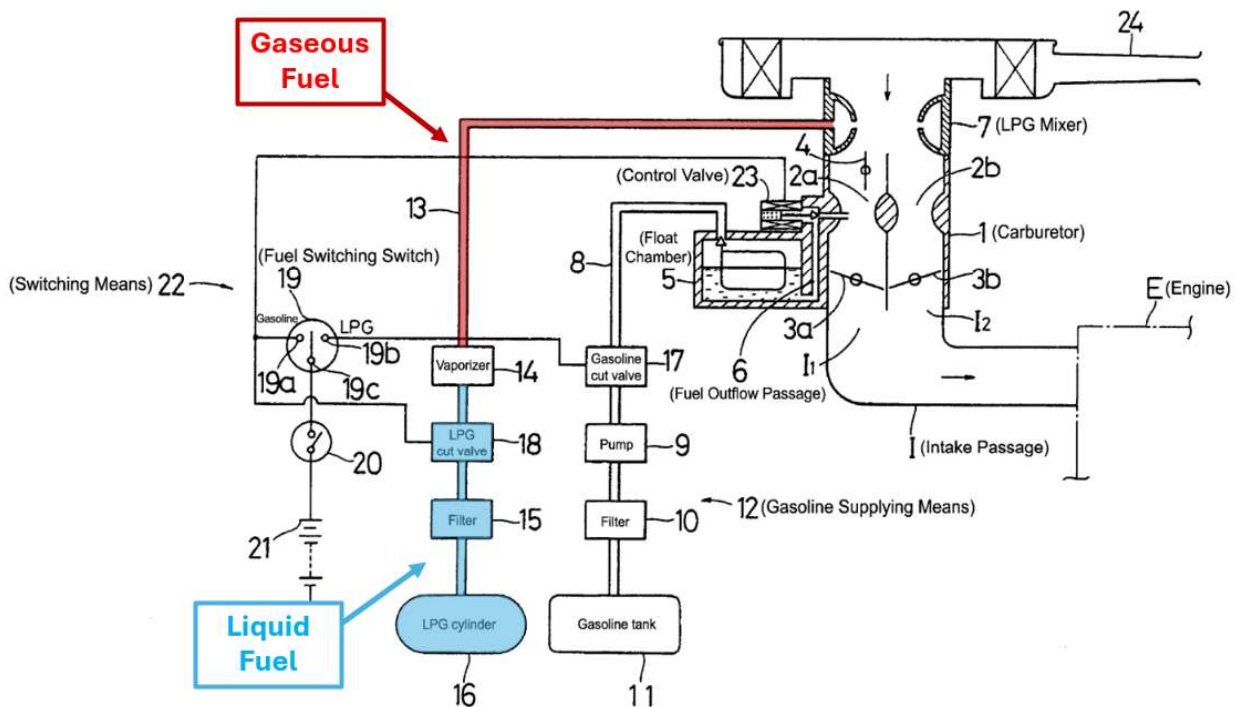
FIG. 1



[Pet., 69 (annotations in original).]

224. Petitioner asserts that “LPG cut valve 18 is positioned on the LPG supplying passage 13.” [Pet., 69.] However, contrary to Petitioner’s representations, LPG cut valve 18 is not located *along* a gaseous fuel line coupling the gaseous fuel source to the carburetor. As depicted in the annotated figure, below, LPG cut valve 18 is located between LPG cylinder 16 and vaporizer 14, and is therefore located along a *liquid* fuel line (blue) and not a gaseous fuel line (red).

FIG. 1



[EX1005, Fig. 1 (annotated).]

225. For at least the reasons set forth above, Nakafushi does not disclose Element 1.5 (“a gaseous fuel valve positioned along a gaseous fuel line coupling the gaseous fuel source to the carburetor.”).

2. Claims 3, 22

226. Claims 3 and 22 depend from Claim 1, and are therefore not invalid for the same reasons.

3. Claim 57

i. Element [57.7]: “attaching a liquid fuel cut-off to the carburetor to close the fuel passage upon actuation of the switch from liquid fuel to gaseous fuel”

227. Nakafushi does not disclose “attaching a liquid fuel cut-off to the carburetor to close the fuel passage upon actuation of the switch from liquid fuel to gaseous fuel.”

228. The Petition’s purported analysis with respect to Element [57.7] merely incorporates by reference §VII.C.1.g (referring to Element [1.6] (“a liquid fuel cut-off incorporated into the carburetor to interrupt liquid fuel upon actuation of the switch from liquid fuel to gaseous fuel”)). [Pet., 77.]

229. Elsewhere, Petitioner argues that “[i]t is inherent in Nakafushi that these components were assembled to form the dual-fuel engine, as their described integration into a functional system necessitates assembly steps.” [Pet., 72.]

230. However, Petitioner explicitly argues that Nakafushi’s control valve 23 is “incorporated into the carburetor.” [Pet., 70.] Neither the Petition, Dr. Morse’s declaration, nor Nakafushi itself include any explicit disclosure of “attaching” control valve 23 to the carburetor.

D. Ground 4: The '398 Patent is Not Obvious Over Nakafushi in View of Matsushima, Yamamoto, and Olmr

231. Claims 2, 4-14, and 19-21 depend from Claim 1. Ground 4 does not provide any additional analysis with respect to Claim 1. As such, these claims are not invalid for the same reasons as Claim 1.

232. Likewise, Claim 58 depends from Claim 57. Ground 4 does not provide any additional analysis with respect to Claim 57. As such, Claim 58 is not invalid for the same reasons as Claim 57.

233. Additional analysis with respect to specific dependent claims is addressed below.

1. Claim 2: “The dual fuel engine of claim 1, wherein the engine is a pull start, batteryless engine.”

234. Nakafushi (alone or in view of Matsushima) does not disclose or otherwise render obvious “The dual fuel engine of claim 1, wherein the engine is a pull start, batteryless engine.”

235. Petitioner argues that a POSITA would have found it obvious “to incorporate a pull-start and an electrical power generator to supply electrical power *in place of* Nakafushi’s battery.” [Pet., 77 (emphasis added).]

236. However, the Petition does not articulate a motivation to replace the battery start with a pull start or a reasonable expectation of success of the same. Instead, Petitioner suggests “the same reasons discussed above with respect to

incorporating Matsushima's pull-start assembly for use with the [Workshop Manual's] DF972 engine." [Pet., 77 (citing §VII.B.1).]

237. However, Petitioner's prior analysis relates to the combination of Matsushima and the Workshop Manual, *not* the combination of Matsushima and Nakafushi, and Petitioner has not established that the same analysis is applicable to Nakafushi.

238. In fact, the evidence identified by the Petitioner supports the conclusion that Petitioner's analysis *is not* equally applicable to the Matsushima/Nakafushi combination. First, Petitioner previously argued that "[i]ncorporating a pull-start into the Workshop Manual's dual-fuel engine would improve reliability in cold or remote applications and reduce costs." [Pet., 41.] However, Petitioner concedes that Nakafushi does not disclose a use case for its engine *at all*, and as such, there is no evidence that a POSITA would have looked to modify its engine for cold/remote applications. [EX2127 (Morse Depo. Tr.) at 74:9-16 (acknowledging that "the Nakafushi reference [does not] identif[y] a specific application for the engine it discloses").]

239. Likewise, Petitioner's position is that Nakafushi discloses a combination schematic diagram/flowchart for engine design, but does not disclose a specific engine structure. [EX2127 (Morse Depo. Tr.) at 74:17-75:2 ("I don't think Nakafushi is limited to any specific engine displacement.").] As such, given that

Nakafushi does not disclose a specific structure, it is unclear how relying on Matsushima could disclose a less costly structure.

240. Second, Petitioner previously argued that “Matsushima provides a blueprint for implementing a recoil starter on an engine of similar displacement and layout [to the Workshop Manual].” [Pet., 41.] But again, Petitioner concedes that Nakafushi does not disclose an engine of a specific displacement. [EX2127 (Morse Depo. Tr.) at 74:17-75:2 (“I don’t think Nakafushi is limited to any specific engine displacement”).] As such, it is unclear how analysis ostensibly comparing Matsushima and the Workshop Manual is applicable to Nakafushi.

241. Finally, Petitioner’s proposed motivation to combine is also deficient for the same reasons set forth with respect to the Workshop Manual. [See §X.B.1, above.]

242. Petitioner’s reasonable expectation of success analysis is also deficient. Specifically, a POSITA would not have had an expectation of success in modifying Nakafushi in the manner suggested because the design of Nakafushi’s fuel control valves 17 and 18, fuel switching switch 19, and switching means 22 are connected to a battery 21. Those connections would be unpowered without a battery and would not function the same before startup.

2. Claim 4: “The dual fuel engine of claim 1, wherein the engine is a pull-start engine having an electrical power generator to supply electrical power”

243. Nakafushi (alone or in view of Matsushima) does not disclose or otherwise render obvious “The dual fuel engine of claim 1, wherein the engine is a pull-start engine having an electrical power generator to supply electrical power.”

244. Once again, Petitioner argues that a POSITA would have found it “obvious to incorporate Matsushima’s recoil-starter assembly and electrical power generator with Nakafushi’s engine.” [Pet., 77.] However, Petitioner does not identify a motivation to combine Matsushima’s recoil-starter assembly and electrical power generator with Nakafushi’s engine. Instead, Petitioner incorporates its analysis with respect to a “§VII.D.1” (referring to Claim 2). This is insufficient for several reasons.

245. First, as discussed above, Petitioner’s Claim 2 analysis merely incorporated the motivation to combine and reasonable expectation of success analysis with respect to the Workshop Manual (a different reference). But, Petitioner did not establish that the Workshop Manual and Nakafushi are sufficiently similar, such that the same motivation and expectation of success should apply. [See §X.D.1, above.]

246. Second, Petitioner’s Workshop Manual analysis (which is then incorporated into Claim 2, and then again into Claim 4) does not reference incorporating Matsushima’s electrical power generator into the Workshop Manual

(presumably because Petitioner asserts that the Workshop Manual already has an electrical power generator). [Pet., 43 (alleging that “[t]he Workshop Manual discloses an electrical power generator, powered by operation of the DF972 engine”).] As such, Petitioner has not even attempted to identify a motivation to combine Matsushima’s alleged electrical power generator with Nakafushi’s engine (nor a reasonable expectation of success in accomplishing the same).

247. Finally, Petitioner’s proposed motivation to combine and reasonable expectation of success analysis is also deficient for the same reasons set forth with respect to Claim 2 and the Workshop Manual. [See §§X.D.1; X.B.1-2.]

3. Claims 5-14

248. Claims 5-14 depend from Claim 4, and are therefore not invalid for the same reasons.

249. Additional analysis with respect to specific dependent claims is addressed below.

4. Claim 8: “The dual fuel engine of claim 6, wherein the solenoid valve is normally open to provide liquid fuel to the engine when the solenoid valve is unpowered”

250. Nakafushi (alone or in view of Matsushima and/or Olmr) does not disclose or otherwise render obvious “The dual fuel engine of claim 6, wherein the solenoid valve is normally open to provide liquid fuel to the engine when the solenoid valve is unpowered.”

251. Petitioner maps the “solenoid valve” referred to in Claim 8 to Nakafushi’s “control valve 23” and concedes that “[t]he control valve 23 of Nakafushi is normally closed.” [Pet., 81.] Therefore, Nakafushi alone does not disclose this limitation.

252. Instead, Petitioner argues that it “would have been obvious to a POSA to configure it as a normally-open solenoid for the same reasons discussed above with respect to the [Workshop Manual’s] DF972 engine.” [Pet., 81-82 (citing §VII.B.6).]

253. However, Petitioner has not established that any alleged motivation to combine the Workshop Manual and Olmr is equally applicable to Nakafushi and Olmr.

254. For example, Petitioner does not address the differences between the power systems disclosed by the Workshop Manual and Nakafushi. [*Compare* EX2127 (Morse Depo. Tr.) at 104:7-13 (testifying that Nakafushi’s “gasoline cut valve 17 and the LPG cut valve 18 are both normally open”) *with id.* at 143:5-15 (testifying that the Workshop Manual’s “valve 6” and “valve 3” are normally closed”); *see also id.* at 102:12-103:3 (referring to Nakafushi’s power system as “a little trickier than I first thought”).] Notably, Petitioner does not explain how Nakafushi’s “normally open” LPG cut valve 18 results in an operable engine, given

that a normally open valve would allow propane to pass through the system even when not powered.

255. Regardless, Petitioner's proposed motivation to combine is also deficient for the same reasons set forth with respect to the Workshop Manual. [See §X.B.4, above.]

5. Claim 9

256. Claim 9 depends from Claim 8, and is therefore not invalid for the same reasons.

6. Claim 20: "The dual fuel engine of claim 1 further comprising: a spring pushing the liquid fuel cut-off to interrupt liquid fuel; and an actuating magnet coupled to the carburetor to selectively pull the liquid fuel cut-off against the spring away from a position interrupting liquid fuel"

257. Nakafushi (alone or in view of Matsushima and/or Olmr) does not disclose or otherwise render obvious "The dual fuel engine of claim 1 further comprising: a spring pushing the liquid fuel cut-off to interrupt liquid fuel; and an actuating magnet coupled to the carburetor to selectively pull the liquid fuel cut-off against the spring away from a position interrupting liquid fuel."

258. First, Petitioner relies on Olmr's solenoid, but does not identify a motivation to replace Nakafushi's control valve 23 with Olmr's solenoid, nor a reasonable expectation of success with respect to the same. [Pet., 85.]

259. Presumably, Petitioner will attempt to rely on the alleged motivation discussed with respect to Claim 5. [Pet., 79-80.] However, Claim 20 does not depend from Claim 5, and Petitioner did not incorporate its analysis.

260. Regardless, Petitioner's Claim 5 does not actually identify a motivation to replace Nakafushi's cut valve 23 with Olmr's solenoid. For example, Petitioner does not identify any deficiencies in cut valve 23, or any benefits in the proposed replacement. Instead, Petitioner's analysis is entirely conclusory and unsupported.

7. Claim 21

261. Claim 21 depends from Claim 20, and is therefore not invalid for the same reasons.

E. Ground 5: The '398 Patent is Not Anticipated by Holzapfel

262. The Petition alleges that Claims 1 and 15-16 of the '398 Patent are invalid as anticipated by Holzapfel. However, this allegation fails at least because Holzapfel does not teach: i) the use of a liquid fuel source and a gaseous fuel source, and ii) a liquid fuel valve positioned along a liquid fuel line. I address the failures of Holzapfel on a limitation-by-limitation basis below.

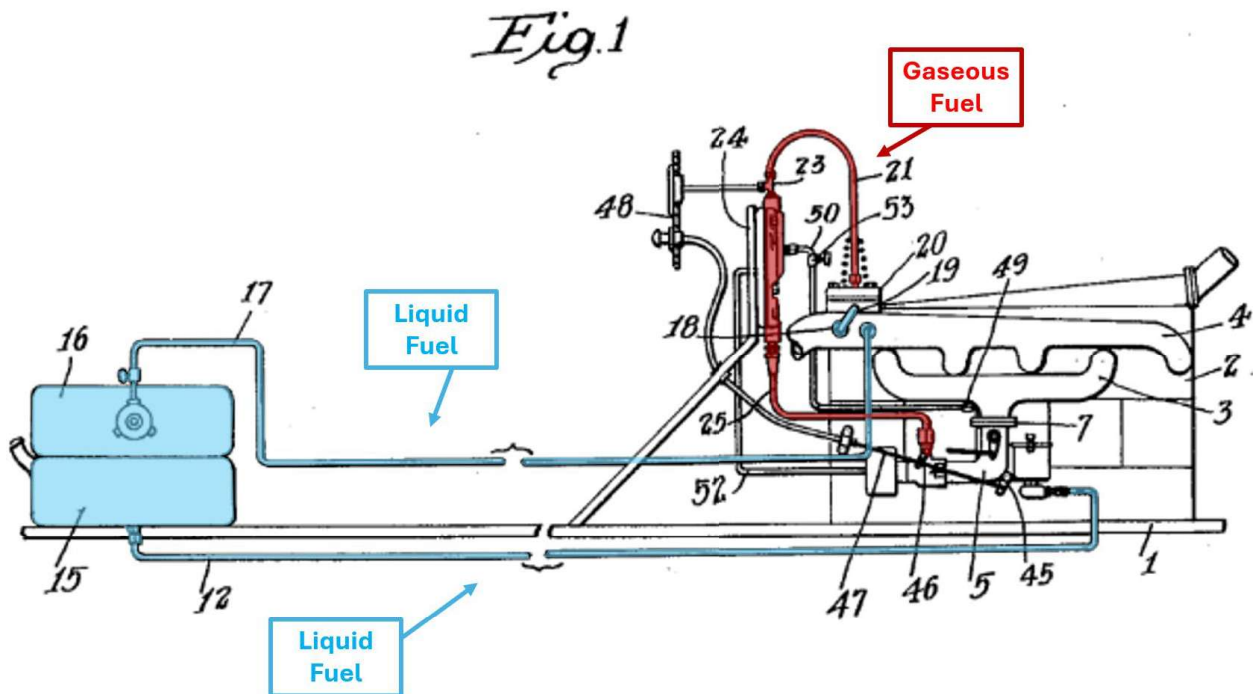
1. Claim 1

263. As discussed above, POSITA would have understood Claim 1 distinctly claimed the state of the fuel (i.e., gaseous or liquid) at three separate locations: the *source* of the fuel, the fuel *line*, and the *engine*. [See §X.A.1, above.]

i. **Element [1.3]: “a carburetor attached to an intake of the engine to mix air and fuel and connect to a gaseous fuel source and a liquid fuel source”**

264. Holzapfel does not disclose “a carburetor attached to an intake of the engine to mix air and fuel and connect to a gaseous fuel source and a liquid fuel source.”

265. Specifically, Holzapfel does not disclose a “gaseous fuel source.” As discussed above, Holzapfel describes a dual fuel engine that draws liquid fuel from two different sources: main liquid supply tank 15 and fuel supply tank 16. [See §VII.C, above.]. Both of these tanks supply liquid fuel, as illustrated below in an annotated version of Holzapfel Figure 1, wherein fuel in the liquid state has been highlighted in blue and fuel in a gaseous state has been highlighted in red.



Holzapfel Fuel System Shown in Fig. 1 (Annotated to Show Liquid and Gaseous States of the Two Fuels).]

266. Petitioner explicitly maps the claimed liquid and gaseous fuels sources to main liquid supply tank 15 and fuel supply tank 16. [Pet., 95 (“Holzapfel discloses carburetor 5 that is attached to intake manifold 3, and that connects gaseous supply tank 16 and liquid supply tank 15.”).] However, Holzapfel explicitly teaches that “From tank 16 there extends a suitable gaseous fuel supply tube 17 extending to the bottom of the tank 16, so as to draw off the liquid *and not gas*.” [EX1009, 2:12-16 (emphasis added).] Furthermore, Holzapfel teaches that this fuel remains in the liquid state until it “changes to a gas on the release of pressure.” [Holzapfel, 2:125.] A POSITA would have known that pressure was not released on this fuel until it entered the heat exchanger 20 and the pressure reducing valve 24.

267. Holzapfel explicitly teaches that fuel supply tank 16 does not supply gaseous fuel. A POSITA would have considered a fuel source to be a gaseous fuel source only if it provided gaseous fuel. Conversely, fuel supply tank 16 provides *liquid* fuel, and is therefore not a gaseous fuel source. [See §X.A.1, above.]

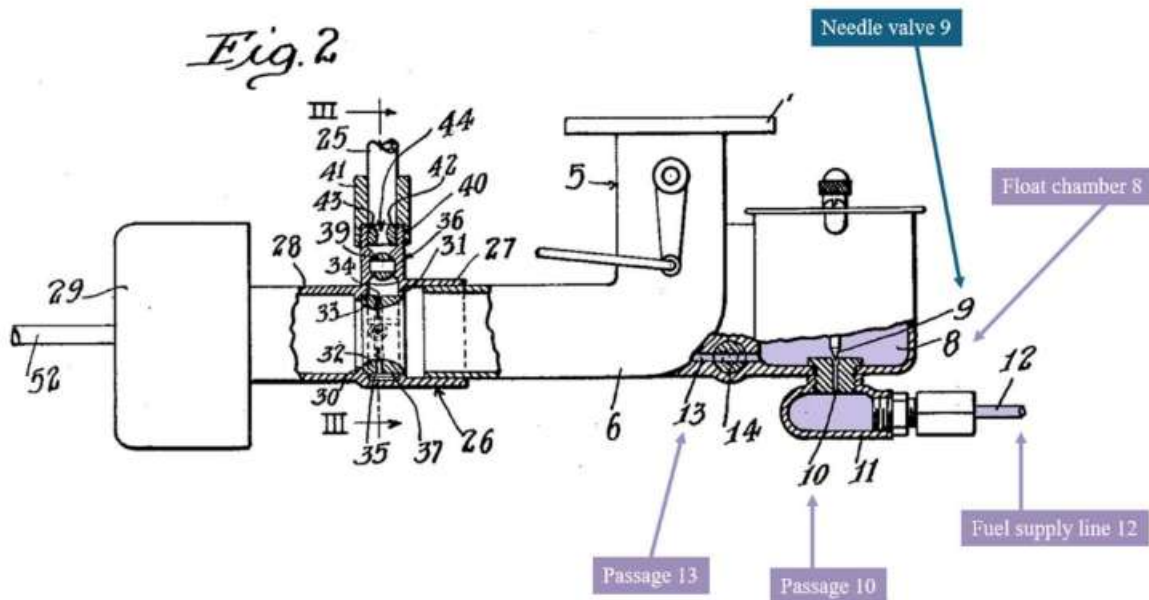
ii. Element [1.4]: “a liquid fuel valve positioned along a liquid fuel line coupling the liquid fuel source to the carburetor”

268. Holzapfel does not disclose “a liquid fuel valve positioned along a liquid fuel line coupling the liquid fuel source to the carburetor.”

269. Petitioner identifies “Fuel supply line 12” as the alleged “liquid fuel line.” [Pet., 97-98.]

270. Petitioner likewise identifies Holzapfel’s “needle valve 9” as the alleged “liquid fuel valve positioned along a liquid fuel line.” [Pet., 97-98.]

271. Petitioner’s annotations identifying the alleged “liquid fuel line” and “liquid fuel valve” are reproduced below:



[Pet., 98 (annotations in original).]

272. Petitioner’s annotations make clear that needle valve 9 is not located *along* Fuel supply line 12. Specifically, Holzapfel discloses an intervening inlet connection 11 and passage 10 between fuel supply line 12 and needle valve 9.

273. For at least the reasons set forth above, Holzapfel does not disclose Element [1.4].

2. Claims 15-16

274. Claims 15-16 depend from Claim 1, and are therefore not invalid for the same reasons.

XI. CLOSING

275. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1101 of Title 18 of the United States Code.

May 26, 2026


Dr. William E. Singhose

References

- [1] W. Singhose, K. Bohlke, and W. Seering, "Fuel-Efficient Pulse Command Profiles for Flexible Spacecraft," *AIAA J. of Guidance, Control, and Dynamics*, vol. 19, no. 4, pp. 954-960, 1996.
- [2] W. Singhose, S. Derezinski, and N. Singer, "Extra-Insensitive Input Shapers for Controlling Flexible Spacecraft," *AIAA J. of Guidance, Control, and Dynamics*, vol. 19, no. 2, pp. 385-91, 1996.
- [3] L. Y. Pao and W. E. Singhose, "Verifying Robust Time-Optimal Commands for Multi-Mode Flexible Spacecraft," *AIAA J. of Guidance, Control, and Dynamics*, vol. 20, no. 4, pp. 831-833, 1997.
- [4] W. Singhose, A. Banerjee, and W. Seering, "Slewing Flexible Spacecraft with Deflection-Limiting Input Shaping," *AIAA J. of Guidance, Control, and Dynamics*, vol. 20, no. 2, pp. 291-298, 1997.
- [5] B. W. Mills, W. E. Singhose, and W. P. Seering, "Closed-Form Generation of Specified-Fuel Commands for Flexible Systems," in *American Control Conference*, Philadelphia, PA, 1998, vol. 5: IEEE, Piscataway, NJ, pp. 2632-6.
- [6] W. Singhose, T. Singh, and W. Seering, "On-Off Control with Specified Fuel Usage," *ASME J. Dynamic Systems, Measurement, and Control*, vol. 121, no. 2, pp. 206- 212, 1999.
- [7] Y.-G. Sung and W. Singhose, "Closed-Form Specified-Fuel Commands for Two Flexible Modes," *AIAA J. of Guidance, Control, and Dynamics*, vol. 30, no. 6, pp. 1590-6, 2007.
- [8] W. Singhose and K. Grosser, "Limiting Excitation of Unmodeled High Modes with Negative Input Shapers," in *IEEE Conference on Controls Applications*, Kohala, Hawaii, 1999.
- [9] K. Grosser and W. Singhose, "Command Generation for Reducing Perceived Lag in Flexible Telerobotic Arms," *JSME International Journal*, vol. 43, no. 3, pp. 755-761, 2000.
- [10] S. Klooster, K. Kozak, J. Vaughan, P. Sanders, and W. Singhose, "Fluid Power Control of a Hyper-Active Seat for Low-Frequency Vibration Suppression," in *IFAC Symposium on Advances in Automotive Control*, Salerno, Italy, 2004.
- [11] W. Singhose, E. Biediger, H. Okada, and S. Matunaga, "Control of Flexible Satellites Using Analytic On-Off Thruster Commands," in *AIAA Guidance, Navigation, & Control Conf.*, Austin, TX, 2003: AIAA-2003-5333.

- [12] W. Singhose, E. Biediger, H. Okada, and S. Matunaga, "Experimental Verification of Real-Time Control for Flexible Systems with On-Off Actuators," *ASME J. of Dynamic Systems, Measurement, and Controls*, vol. 128, no. 2, pp. 287-96, 2006.
- [13] W. Singhose, E. Biediger, H. Okada, and S. Matunaga, "Closed-Form Specified-Fuel Commands for On-Off Thrusters," *AIAA J. of Guidance, Control, and Dynamics*, vol. 29, no. 3, pp. 606-11, 2006.
- [14] G. Peláez, W. Singhose, and A. Vizan, "Shaping Tool Head Pneumatic Actuator Commands to Reduce Cut Car Letters Machine Vibration," in *WSEAS Int. Conf. on Signal Processing, Robotics and Automation*, 2002, pp. 54-59.