

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MWE INVESTMENTS, LLC,
HARBOR FREIGHT TOOLS USA, INC., and
GENERAC POWER SYSTEMS, INC.,
Petitioners

v.

CHAMPION POWER EQUIPMENT, INC.,
Patent Owner.

U.S. Patent No. 11,143,145

Title: BATTERYLESS DUAL FUEL ENGINE WITH LIQUID FUEL CUT-OFF

Inter Partes Review No. IPR2025-01457

DECLARATION OF MAHDI SHAHBAKHTI

TABLE OF CONTENTS

I.	BACKGROUND INFORMATION	9
A.	Qualifications and Experience	9
B.	Compensation	17
C.	Materials Considered.....	18
II.	STATEMENT OF LEGAL PRINCIPLES.....	19
A.	Person of Ordinary Skill in the Art	20
B.	Prior Art.....	21
C.	Claim Construction.....	21
D.	Anticipation (§102)	23
E.	Obviousness (§103).....	24
III.	SUMMARY OF THE ‘145 PATENT	29
A.	State of the Art:	32
IV.	OVERVIEW OF THE ASSERTED PRIOR ART	35
A.	Overview of Kubota DF-972-E2 Workshop Manual (“Workshop Manual”).....	35
B.	JPS61283734A (“Nakafushi”)	39
C.	U.S. Patent No. 1,931,698 (“Holzapfel”).....	42
D.	U.S. Patent No. 5,161,496 (“Matsushima”)	43
E.	U.S. Patent No. 5,301,644 (“Olmr”)	45
F.	U.S. Patent No. 6,213,083 (“Winberg”).....	45
G.	U.S. Patent No. 3,718,000 (“Walker”).....	47
V.	THE CHALLENGED CLAIMS	49
VI.	CLAIM TERMS	50
VII.	THE CHALLENGED CLAIMS ARE UNPATENTABLE BASED ON THE PRIOR ART	50

A.	Ground 1: Claims 1-5 and 10 are Rendered Obvious by the Workshop Manual.....	50
B.	Ground 2: Claims 6-9 are Rendered Obvious by the Combination of Workshop Manual, Matsushima, and Olmr.	73
C.	Ground 3: Claims 1-10 are Rendered Obvious by the Combination of Nakafushi, Matsushima, and Olmr.....	79
D.	Ground 4: Claims 1-5 and 8-10 are Rendered Obvious by the Combination of Holzapfel, Matsushima, and Olmr.....	103
E.	Ground 5: Claims 11-16 are Rendered Obvious by the Combination of Workshop Manual, Matsushima, and Winberg.	125
F.	Ground 6: Claims 11-16 are Rendered Obvious by the Combination of Nakafushi, Matsushima, and Winberg.	139
G.	Ground 7: Claims 11, 13, and 14 are Obvious by Holzapfel.....	151
H.	Ground 8: Claims 12, 15, and 16 are Rendered Obvious by the Combination of Holzapfel, Matsushima, and Winberg.	156
VIII.	CONCLUSION.....	161

LIST OF EXHIBITS

Exhibit	Description
1001	U.S. Patent No. 11,143,145 (“145 Patent”)
1002	File History of U.S. Patent No. 11, 143,155 (“145 File History”)
1003	Curriculum Vitae of Mahdi Shahbakhti
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”)
1008	U.S. Patent No 1,931,698 (“Holzapfel”)
1009	Kubota DF-972-E2 Workshop Manual (“Workshop Manual”)
1010	Declaration from Mr. James Strepek re Kubota Manuals
1011	Declaration from Mr. Scott Schlabach re Kubota Manuals
1012	U.S. Patent No. 5,161,496 (“Matsushima”)
1013	U.S. Patent No. 6,213,083 (“Winberg”)
1014	Champion’s Infringement Contentions with Respect to Petitioner Generac’s Model PM4500DF and GP7500E DF Generators
1015	U.S. Patent No. 3,718,000 (“Walker”)
1016	DuroMax XP4400EH Operator’s Manual (“DuroMax”)
1017	Declaration of David Raskin (dated May 7, 2025)

CLAIM LIST

Claim 1	Claim Language
[1.0]	A dual fuel generator comprising:
[1.1]	an engine operable on a gaseous fuel and a liquid fuel;
[1.2]	an electrical power generator driven by the engine and comprising a charging coil;
[1.3]	a switch to change operation of the engine between gaseous fuel and liquid fuel;
[1.4]	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;
[1.5]	a liquid fuel cut-off solenoid to interrupt liquid fuel flow to the engine upon actuation of the switch from liquid fuel to gaseous fuel; and
[1.6]	a voltage regulator coupled to the charging coil to receive power therefrom and that operates to provide a regulated voltage to the liquid fuel cut-off solenoid.
Claim 2	Claim Language
[2]	The dual fuel generator of claim 1 further comprising: a liquid fuel valve along a liquid fuel line coupling the liquid fuel source to the carburetor; and a gaseous fuel valve along a gaseous fuel line coupling the gaseous fuel source to the carburetor.
Claim 3	Claim Language
[3]	The dual fuel generator of claim 2, wherein each of the liquid fuel valve and the gaseous fuel valve comprises a mechanical valve.
Claim 4	Claim Language
[4]	The dual fuel generator of claim 2, wherein the liquid fuel cut-off solenoid is attached to the carburetor.
Claim 5	Claim Language
[5]	The dual fuel generator of claim 1, wherein the gaseous fuel is LPG and the liquid fuel is gasoline.
Claim 6	Claim Language

[6]	The dual fuel generator of claim 1, wherein the switch is an electro-mechanical switch connecting one fuel source to the carburetor and connected to the electrical power generator, and wherein the liquid fuel cut-off solenoid is connected to open and close a fuel path to the engine in response to reception of electrical power from the switch.
Claim 7	Claim Language
[7]	The dual fuel generator of claim 6, wherein the switch selectively powers the solenoid valve by controlling electrical connection between the solenoid valve and the electrical power generator.
Claim 8	Claim Language
[8]	The dual fuel generator of claim 1, wherein the liquid fuel cut-off solenoid is normally open to provide liquid fuel to the engine when the liquid fuel cut-off solenoid is unpowered.
Claim 9	Claim Language
[9]	The dual fuel generator of claim 8, wherein the dual fuel generator is a batteryless dual fuel generator and the engine is a pull-start engine, the batteryless dual fuel generator further comprising a pull-starter that drives the electrical power generator to power and close the liquid fuel cut-off solenoid while starting the engine on gaseous fuel.
Claim 10	Claim Language
[10]	The dual fuel generator of claim 1, wherein the electrical power generator comprises a magneto or an alternator.
Claim 11	Claim Language
[11.0]	A dual fuel generator comprising:
[11.1]	an engine operable on a gaseous fuel and a liquid fuel;
[11.2]	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; and
[11.3]	a manually actuated fuel shutoff coupled to the carburetor, the manually actuated fuel shutoff comprising: a first end in the carburetor that actuates to

	selectively allow or block a flow of fuel through the carburetor; and a second end external to the carburetor to actuate the first end.
Claim 12	Claim Language
[12]	The dual fuel generator of claim 11, wherein the engine is a pull start, batteryless engine.
Claim 13	Claim Language
[13]	The dual fuel generator of claim 11, wherein the gaseous fuel is LPG and the liquid fuel is gasoline.
Claim 14	Claim Language
[14]	The dual fuel generator of claim 11, wherein the manually actuated fuel shutoff comprises a rotating mechanical valve.
Claim 15	Claim Language
[15.0]	The dual fuel generator of claim 14 wherein the carburetor comprises:
[15.1]	a float bowl; a throat; and a fuel passage to provide fuel from the float bowl to the throat;
[15.2]	wherein the manually actuated fuel shutoff comprises a shaft extending into the carburetor through an aperture in the float bowl, the shaft being coupled to a valve tip in the float bowl that rotates to open and close the fuel passage.
Claim 16	Claim Language
[16]	The dual fuel generator of claim 15 wherein the valve tip rotates parallel to an inlet of the fuel passage between a first position permitting fuel flow into the inlet and a second position blocking fuel flow into the inlet.

DECLARATION OF DR. MADHI SHAHBAKHTI

I declare that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true. These statements were made with the knowledge that willful false statements and the like so made are punishable under Section 1001 of Title 18 of the Unites States Code.

Date: Oct. 7, 2025

By: M. Shahbakhti
Dr. Mahdi Shahbakhti

I, Dr. Mahdi Shahbakhti declare as follows:

I. BACKGROUND INFORMATION

A. Qualifications and Experience

[0001]. I am a Professor of Mechanical Engineering at the University of Alberta and an Adjunct Professor of Mechanical Engineering at Michigan Technological University. At the University of Alberta, I serve as the Director of the Energy Mechatronics Laboratory. The Energy Mechatronics Laboratory conducts research in a multidisciplinary area of engineering that includes mechanical and electrical systems, design of thermo-fluid systems, and control engineering.

[0002]. I am also a professional engineer (PEng) registered in Alberta (license # 284744). Over the past years, I have led various projects in the area of internal combustion engines and mechanical engineering. I currently lead several design, fabrication, and testing projects in the field of mechanical engineering including, among other things, internal combustion engines and powertrain systems running with conventional and alternative fuels.

[0003]. Before joining Michigan Technological University in 2012, I spent two years as a post-doctoral scholar at the Mechanical Engineering Department at the University of California, Berkeley. My post-doctorate work

focused on model-based design and adaptive control of internal combustion engines and consisted of working closely with the Toyota Motor Company.

[0004]. I earned a Ph.D. in Mechanical Engineering from the University of Alberta in 2009 and a Master of Science degree from KNT University of Technology in 2003. Both my Ph.D. and MSc. dissertations were in the area of internal combustion engines.

[0005]. I have also worked on various aspects of internal combustion engines including design, modeling, benchmarking, experimental studies, calibration, and electronic control unit (ECU) design and implementation since 2000. These include dual fuel, bi-fuel, and single-fuel engines. I have studied engines running with a variety of fuels including but not limited to gasoline, diesel, ethanol, n-heptane, iso-octane, gaseous fuels (natural gas, butane, hydrogen, ...), and biofuels.

[0006]. I along with my research group have tested various dual fuel and bi-fuel engines for different applications. These include small (< 0.5 liter) to large scale engines (e.g., 15 liter). Our work has included carburetor, throttle body injection (TBI), port fuel injection (PFI), direct injection (DI) systems, and mixer systems for gaseous fuels in engines. In addition, my work has also covered various engine types including spark ignition, compression ignition, lean burn, low

temperature combustion (HCCI, PPCI, RCCI) engines, and their exhaust aftertreatment systems.

[0007]. I have direct industry experience related to the internal combustion engines. From 2001 to 2004, I worked as a researcher in the automotive industry. During this time, I was involved in the research and development of internal combustion engines and powertrain management systems for gasoline and natural gas bi-fuel vehicles. In the past 13 years, I, along with my research group, have performed a number of research projects sponsored by various companies such as Cummins, Westport, Ford Motor Company, Toyota Motor Corporation, General Motors Corporation, Hyundai, IAV GmbH, Hitachi, and Denso.

[0008]. I have taught undergraduate and graduate courses in mechanical engineering departments in the U.S. and Canada since 2004, taking the role as a primary instructor for more than 26 academic semesters, and a teaching assistant for eight academic semesters. I have regularly taught a graduate course and undergraduate technical elective course on “Internal Combustion Engines and Alternative Fuels”, MECE 541, at the University of Alberta since 2008. Some of the others courses I have taught include Thermodynamics, Fluid Dynamics, Energy Thermal Fluids, Feedback Control Design of Dynamic Systems, Model Predictive Control, Machine Learning Control, etc.

[0009]. I have supervised 148 graduate and undergraduate students for mechanical engineering research projects or dissertations. These include 37 Ph.D., 77 M.S. and 34 B.S. students in the mechanical engineering departments in four academic institutions from 2010 to 2025. Such mentorships have been in the areas of modeling, design, experimental studies, and control of mechanical engineering systems.

[0010]. I am currently the Technical Editor for the International Journal of American Society of Mechanical Engineers (ASME)/ Institute of Electrical and Electronics Engineers (IEEE) Transactions on Mechatronics. In addition, I served six years as the Associate Editor for ASME Journal of Dynamic Systems, Measurement, and Controls (2017–2023), Associate Editor (2014–2020) for the International Journal of Powertrains (Inderscience Publishers) and a guest editor for a special issue on “Optimal Design and Operation of Energy Systems” in the International Journal of Optimal Control Applications and Methods (2020–2022). In these roles, I have regularly evaluated research work in the field of mechanical and electrical engineering systems.

[0011]. I have also served on the United States’ National Science Foundation (NSF) and U.S. Department of Energy (DOE) review panels in the areas of mechanical engineering systems, controls, and energy systems. I have been a reviewer for: (i) international grant proposals from funding agencies from

the United States, Canada, Croatia, France, Germany, Poland, and the Netherlands,

(ii) the U.S. Academy of Engineering research program, (iii) 24 international engineering journals, and (iv) Springer International Publishing for books in the areas of mechanical engineering systems and mechatronics.

[0012]. I have been a member of the Society of Automotive Engineers (SAE) (membership #6109271569) for about 20 years. I have organized a number of technical sessions in the area of internal combustion engines at SAE World Congress in Detroit during 2016 and 2022. In addition, I have been a member of SAE Technical Committee on New Engines, Components, Actuators and Sensors since 2016.

[0013]. I have been a member of the American Society of Mechanical Engineers (ASME) for the past thirteen years (membership #125958). I am a very active member of ASME's Dynamic Systems & Control Division and have served as the chair of the Energy Systems technical committee (2018–2020), chair of the Automotive Transportation Systems technical committee (2020–2022), and chaired 45 sessions and co-organized more than 70 technical sessions in the areas of modeling, design, optimization, and control of mechanical engineering systems. I am currently part of the ASME executive committee for the Dynamic Systems & Control Division.

[0014]. I have been awarded over \$6.1 million in grants/support as a Principal Investigator (PI) and over \$9.0 million as a co-PI from international, federal, provincial, and industry sources for conducting research in the areas of design, modeling, optimization, and control of mechanical engineering systems. For example, I along with two of my colleagues recently received 1,140,000 CAD in funding from the Canada National Sciences and Engineering Research Council (NSERC) and Diesel Tech Industries for the period 2025–2028 to design and control dual fuel engines running with hydrogen and diesel fuels.

[0015]. As the director of Energy Mechatronics Laboratory (EML) at the University of Alberta, I currently supervise/co-supervise 26 members for research and development (R&D) engineering works. These include 3 research associates, 5 post-doctoral scholars, 11 PhD students, 3 MSc graduate students, and 2 lab engineers and 2 undergraduate students. The majority of the EML projects are with industry partners specializing in mechanical engineering systems. Our works center on modeling, design, fabrication, testing of mechanical-electrical-chemical engineering systems. Over the past 12 years (UAlberta, MichiganTech), I have led R&D projects with more than 20 companies most of them global companies (e.g., Cummins, Westport, Ford, GM, ...) for different engineering technologies. The majority of EML graduates/trainees (>70) are currently working in mechanical/electrical engineering companies in the U.S. and Canada.

[0016]. I have been recognized by different awards. Some of the recognitions/awards for my work related to internal combustion engines include:

- Transport Canada 2023 Technology Achievement Award Finalist, 2023.
- Best Presentation Award, SAE Int. Powertrain, Fuels & Lubricants Conference, Baltimore, MD, USA, 2016.
- Best Presentation in the Session, American Control Conference (ACC), 2012 (Montreal), 2015 (Chicago).
- Society of Automotive Engineers (SAE) International Ralph R. Teetor Educational Award, 2016 (An international award recognizing top engineering educators for outstanding contributions).
- Best Paper Award, ASME Automotive and Transportation Systems Technical Committee – ASME Dynamic Systems Control Conference, Columbus, OH, USA, 2015.
- Best Paper Award, ASME Automotive and Transportation Systems Technical Committee – ASME Dynamic Systems Control Conference, Fort Lauderdale, FL, USA, 2012.
- Canada NSERC (Natural Science and Engineering Research Council) Postdoctoral Fellowship, 2010 – 2012.

- Zita and John Rosen Teaching Excellence Award for Principal Instructor, University of Alberta, 2009 (An award for teaching Internal Combustion Engine (MECE 541) course. Only one award, across the university, is granted annually to give special recognition to a graduate student principal instructor who is an especially skilled and dedicated teacher).
- David Morris Graduate Scholarship in Automotive Engineering, University of Alberta, 2008.
- Winning Team (first prize) of a Total of 66 Research Teams from 26 Canadian Universities, Canada Automotive21 High Qualified Personnel Competition, Windsor, Canada, June 11-13, 2007.
- Chevron Graduate Scholarship in Natural Gas Engineering, University of Alberta, 2005.
- Best Paper Award in 3rd International Conference on Internal Combustion Engines, Tehran, Iran, 2004.
- Summa Cum Laude (ranked first among graduates) in MSc Mech Eng – Powertrain (2003), K. N. Toosi University of Technology, Tehran, Iran.

[0017]. My publications can be found at https://sites.ualberta.ca/~mahdi/Shahbakhti_Publications.html. These include more than 250 peer-reviewed publications in the field of mechanical engineering. Many of these publications are in the area of internal combustion engines. According to Google Scholar, these research publications have been recognized and cited over 6,500 times from more than 90 different countries.

[0018]. I have been retained as an expert in eight Inter Partes Review (“IPR”) proceedings and two International Trade Commission (“ITS”) proceedings in the past seven years to provide expert opinion in connection with different areas of mechanical engineering systems and mechatronics/control systems including: internal combustion engines, vehicles, powertrains, heating ventilation air conditioning (HVAC) systems, buildings, and vacuum systems.

[0019]. My full curriculum vitae (CV) is attached as Ex. 1003 to this report.

B. Compensation

[0020]. I have been retained by counsel for MWE Investments, LLC (“Petitioner”) to provide my expert opinion in connection with mechanical and control systems for internal combustion engines, fuel regulators, fuel valves, and controllers.

[0021]. I am being compensated through WIT Legal, LCC in

connection with this matter. WIT Legal, LCC is being compensated for my time in connection with this matter at a rate of \$550 per hour. My compensation is in no way based on the outcome of this investigation or on the opinions that I provide. I have no interest, financial or otherwise, in the outcome of this matter. I have no financial interest in, or affiliation with, any of the parties in this matter.

C. Materials Considered

[0022]. The analysis that I provide in this Declaration is based on my education, research, and experience, as well as the documents I have considered. In forming my opinions, I have read and considered Patent No. 11,143,145 (hereafter referred to as the “’145 Patent”) and its prosecution history. I have cited to the following documents in my analysis below:

Exhibit	Description
1001	U.S. Patent No. 11,143,155 (“’145 Patent”)
1002	File History of U.S. Patent No. 11, 143,155 (“’145 File History”)
1003	<i>Intentionally left blank</i>
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”)

1008	U.S. Patent No 1,931,698 (“Holzapfel”)
1009	Kubota DF-972-E2 Workshop Manual (“Workshop Manual”)
1010	Declaration from Mr. James Strepek re Kubota Manuals
1011	Declaration from Mr. Scott Schlabach re Kubota Manuals
1012	U.S. Patent No. 5,161,496 (“Matsushima”)
1013	U.S. Patent No. 6,213,083 (“Winberg”)
1014	Champion’s Infringement Contentions with Respect to Petitioner Generac’s Model PM4500DF and GP7500E DF Generators
1015	U.S. Patent No. 3,718,000 (“Walker”)
1016	DuroMax XP4400EH Operator’s Manual (“DuroMax”)
1017	Declaration of David Raskin (dated May 7, 2025)

[0023]. All the opinions contained in this declaration are based on the documents that I reviewed and my knowledge and professional judgment. My opinions have also been guided by my understanding of how a person of ordinary skill in the art would have understood the claims of the ’145 patent.

[0024]. I reserve the right to supplement and amend any of my opinions in this declaration based on documents, testimony, and other information that becomes available to me after the date of this declaration.

II. STATEMENT OF LEGAL PRINCIPLES

[0025]. I am not a lawyer. My understanding of the legal standards to apply in reaching the conclusions in this declaration are based on discussions with

counsel for Petitioner, my experience applying similar standards in other patent-related matters, and my reading of the documents submitted in this proceeding. In preparing this declaration, I have tried to faithfully apply these legal standards to the challenged claims.

A. Person of Ordinary Skill in the Art

[0026]. I understand that a person of ordinary skill in the art (hereinafter “POSA”) would “be aware of all the pertinent prior art” at the time of the alleged invention (*Custom Accessories, Inc. v. Jeffrey-Allan Indus.*, 807 F.2d 955, 963 (Fed. Cir. 1986)), including specialized knowledge applicable to various aspects of the claimed invention. *See, e.g., AVX Corp. v. Greatbatch, Ltd.*, IPR2014-00697, Paper 60 at 3 (P.T.A.B. Jan. 11, 2016). A POSA is also a person of ordinary creativity, not an automaton, and thus is able to make inferences from the art. *KSR Int’l Co. v. Teleflex*, 550 U.S. 398, 420-21 (2007).

[0027]. I have also been advised that to determine the appropriate level of a person having ordinary skill in the art, the following factors may be considered: (1) the types of problems encountered by those working in the field and prior art solutions thereto; (2) the sophistication of the technology in question, and the rapidity with which innovations occur in the field; (3) the educational level of active workers in the field; and (4) the educational level of the inventor.

[0028]. For purposes of this IPR, a POSA would have a college degree in mechanical engineering, physics, or related fields, and three years of work experience in combustion engines. Additional higher graduate education could substitute for work experience, and additional work experience/training could substitute for formal education.

B. Prior Art

[0029]. I have been advised and understand that the information used to evaluate whether an invention was new is generally referred to as “prior art.” I understand that prior art includes patents and printed publications that existed before the earliest priority date or the earliest filing date of the patent (which I have been informed is also called the “effective filing date”). I have been informed and understand that a patent or published patent application is prior art if it was filed before the earliest filing date of the claimed invention and that a printed publication is prior art if it was publicly available before the earliest filing date.

[0030]. I have also been informed that material publicly disclosed before the earliest priority date or the earliest filing date of the patent also qualifies as “prior art.” Examples of material publicly disclosed include videos, books, presentations, speeches, etc.

C. Claim Construction

[0031]. I understand that a purpose of claim construction is to determine what a person of ordinary skill in the art would have understood the claim terms to mean. Claim terms are generally given their ordinary and customary meaning, which is the meaning that the term would have to a person of ordinary skill in the art in question as of the effective filing date.

[0032]. I understand that the person of ordinary skill in the art is deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification. I understand that the patent specification, under the legal principles, has been described as the single best guide to the meaning of a claim term, and is thus highly relevant to the interpretation of claim terms. And I understand for terms that do not have a customary meaning within the art, the specification usually supplies the best context of understanding the meaning of those terms.

[0033]. I further understand that other claims of the patent in question, both asserted and unasserted, can be valuable sources of information as to the meaning of a claim term. Because the claim terms are normally used consistently throughout the patent, the usage of a term in one claim can often illuminate the meaning of the same term in other claims. Differences among claims can also be a useful guide in understanding the meaning of particular claim terms.

[0034]. I understand that the prosecution history can further inform the meaning of the claim language by demonstrating how the inventors understood the invention and whether the inventors limited the invention in the course of prosecution, making the claim scope narrower than it otherwise would be. Extrinsic evidence, such as dictionaries, may also be consulted in construing the claim terms.

[0035]. I understand that, in Inter Partes Review (IPR) proceedings, a claim of a patent shall be construed using the same claim construction standard that would be used to construe the claim in a civil action filed in a U.S. district court (which I understand is called the “Phillips” claim construction standard), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.

[0036]. Accordingly, I have been instructed by counsel to apply the “Phillips” claim construction standard for purposes of interpreting the claims in this proceeding, to the extent they require a construction.

D. Anticipation (§102)

[0037]. I understand that under 35 U.S.C. §102, a patent claim is unpatentable for anticipation if the claimed subject matter was patented or described in a printed publication before the effective filing date of the claimed

invention. I have been informed that this is referred to as unpatentability by anticipation. I have also been informed that a patent claim is anticipated under § 102 if a single prior art reference discloses all limitations of the claimed invention.

E. Obviousness (§103)

[0038]. I understand that a patent claim is obvious if, as of the effective filing date, it would have been obvious to a person having ordinary skill in the field of the technology (the “art”) to which the claimed subject matter belongs.

[0039]. I understand that the following factors should be considered in analyzing obviousness: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims; and (3) the level of ordinary skill in the pertinent art. I also understand that certain other facts known as “secondary considerations” such as commercial success, unexplained results, long felt but unsolved need, industry acclaim, simultaneous invention, copying by others, skepticism by experts in the field, and failure of others may be utilized as indicia of non-obviousness. I understand, however, that secondary considerations should be connected, or have a “nexus,” with the invention claimed in the patent at issue.

[0040]. I understand that a reference qualifies as prior art for obviousness purposes when it is analogous to the claimed invention. The test for determining what art is analogous is: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not

within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved.

[0041]. I understand that a person of ordinary skill in the art is assumed to have knowledge of all prior art. I understand that one skilled in the art can combine various prior art references based on teachings of those prior art references, general knowledge present in the art, or common sense. I understand that a motivation to combine references may be implicit in the prior art, and there is no requirement that there be an actual or explicit teaching to combine two references. Thus, one may take into account the inferences and creative steps that a person of ordinary skill in the art would employ to combine the known elements in the prior art in the manner claimed by the patent at issue. I understand that one should avoid "hindsight bias" and ex post reasoning in performing an obviousness analysis. But this does not mean that a person of ordinary skill in the art for purposes of the obviousness inquiry does not have recourse to common sense.

[0042]. I understand that when determining whether a patent claim is obvious in light of the prior art, neither the particular motivation for the patent nor the stated purpose of the patentee is controlling. The primary inquiry has to do with the objective reach of the claims, and that if those claims extend to something that is obvious, then the entire patent claim is invalid.

[0043]. I understand one way that a patent can be found obvious is if there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims. I understand that a motivation to combine various prior art references to solve a particular problem may come from a variety of sources, including market demand or scientific literature. I understand that a need or problem known in the field at the time of the invention can also provide a reason to combine prior art references and render a patent claim invalid for obviousness. I understand that familiar items may have obvious uses beyond their primary purpose, and that a person of ordinary skill in the art will be able to fit the teachings of multiple prior art references together like the pieces of a puzzle. I understand that a person of ordinary skill is also a person of at least ordinary creativity. I understand when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this finite number of predictable solutions leads to the anticipated success, I understand that the invention is likely the product of ordinary skill and common sense, and not of any sort of innovation.

[0044]. I understand that the fact that a combination was obvious to try might also show that it was obvious, and hence invalid, under the patent laws. I understand that if a patent claims a combination of familiar elements according to

known methods, the combination is likely to be obvious when it does no more than yield predictable results. Thus, if a person of ordinary skill in the art can implement a predictable variation, an invention is likely obvious. I understand that combining embodiments disclosed near each other in a prior art reference would not ordinarily require a leap of inventiveness.

[0045]. I understand that obviousness may be shown by demonstrating that it would have been obvious to modify what is taught in a single piece of prior art to create the patented invention. Obviousness may also be shown by demonstrating that it would have been obvious to combine the teachings of more than one item of prior art. I understand that a claimed invention may be obvious if some teaching, suggestion, or motivation exists that would have led a person of ordinary skill in the art to combine the invalidating references. I also understand that this suggestion or motivation may come from the knowledge of a person having ordinary skill in the art, or from sources such as explicit statements in the prior art. I understand that when there is a design need or market pressure, and there are a finite number of predictable solutions, a person of ordinary skill may be motivated to apply common sense and his skill to combine the known options in order to solve the problem.

[0046]. I understand the following are examples of approaches and rationales that may be considered in determining whether a piece of prior art could

have been combined with other prior art or with other information within the

knowledge of a person having ordinary skill in the art:

- Some teaching, motivation, or suggestion in the prior art that would have led a person of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention;
- Known work in one field of endeavor may prompt variations of it for use in the same field or a different field based on design incentives or other market forces if the variations would have been predictable to a person of ordinary skill in the art;
- Combining prior art elements according to known methods to yield predictable results;
- Applying a known technique to a known device, method, or product ready for improvement to yield predictable results;
- Applying a technique or approach that would have been “obvious to try” (choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);
- Simple substitution of one known element for another to obtain predictable results; or

- Use of a known technique to improve similar products, devices, or methods in the same way.

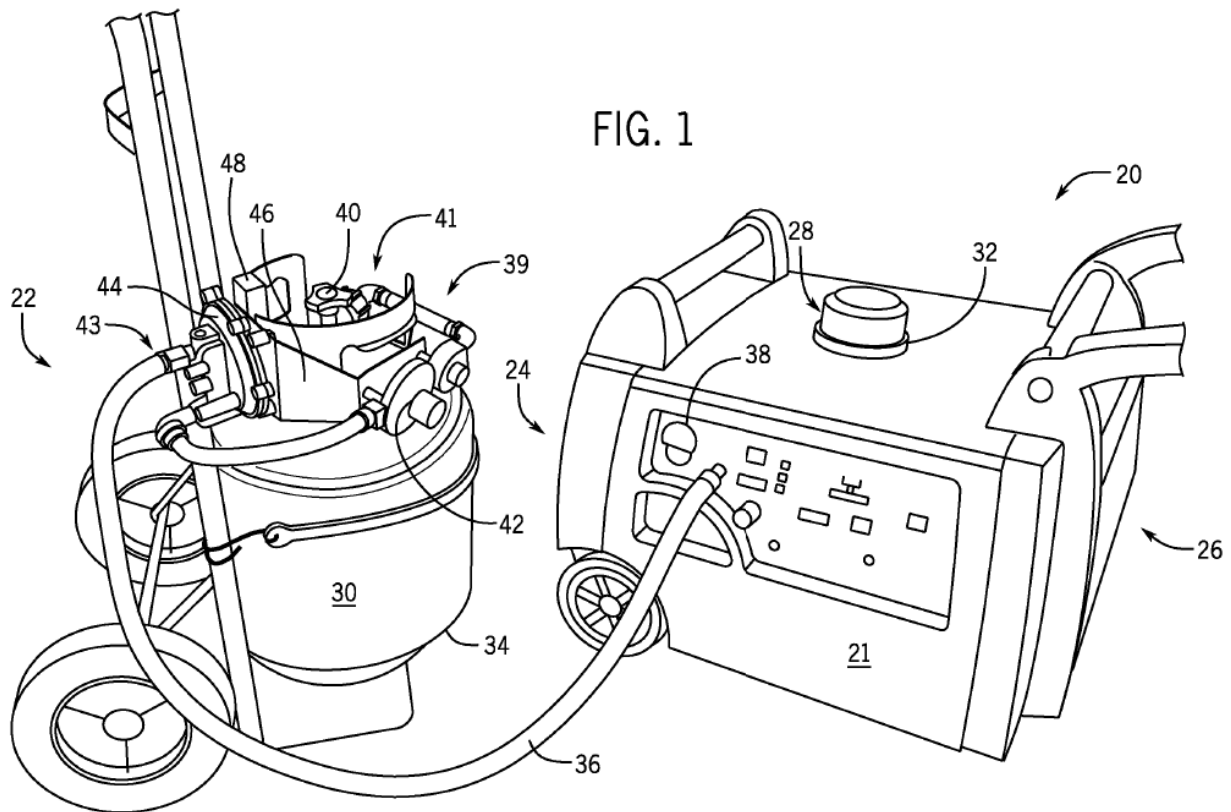
[0047]. I understand that, when determining whether a claimed combination is obvious, the correct analysis is not whether one of ordinary skill in the art, writing on a blank slate, would have chosen the particular combination of elements described in the claim. Instead, I understand the correct analysis considers whether one of ordinary skill, facing the wide range of needs created by developments in the field of endeavor, would have seen a benefit to selecting the combination claimed.

[0048]. I understand that the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference. The test for obviousness, in other words, is not whether the references could be physically combined but whether the claimed inventions are rendered obvious by the teachings of the prior art as a whole.

III. SUMMARY OF THE ‘145 PATENT

[0049]. The ‘145 Patent is a continuation of Application No. 14/925,441, filed October 28, 2015, now Patent No. 10,697,398, which was a continuation-in-part of Application No. 14/738,060, filed June 12, 2015, now Patent No. 10,221,780 (the “’780 Patent”).

[0050]. The '145 Patent is directed to dual fuel engines/generators operable on liquid or gaseous fuels. Ex.1001, 1:17-20. The '145 Patent acknowledges that dual fuel generators typically run on liquid fuel (such as gasoline) and an alternative gaseous fuel (such as liquified petroleum gas (LPG) also known as propane). *Id.*, 1:39-55. FIG. 1 of the '145 Patent shows a perspective view of a generator 20 with such an engine:



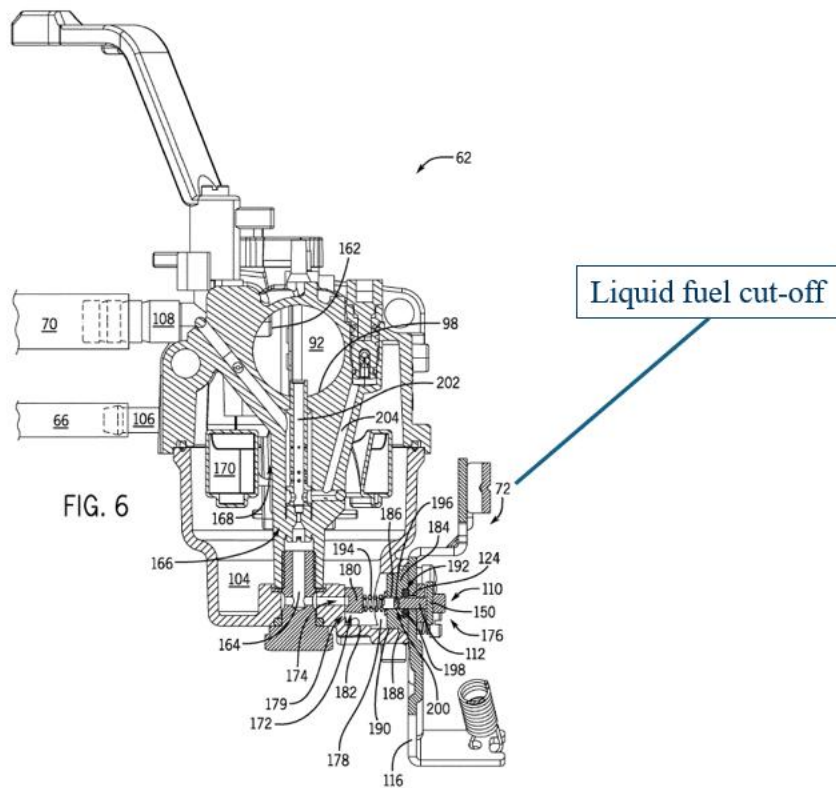
Ex.1001, Fig. 1 (Annotated).

[0051]. As shown in FIG. 1, generator 20 includes gasoline tank 32 to hold a liquid fuel (gasoline), and generator 20 also is connected by way of LPG

supply hose 36 to pressurized fuel container 34, which holds LPG. Ex.1001, 4:3-44; FIG. 1.

[0052]. The '145 Patent states that switching fuel sources in conventional multi-fuel engines can cause overly rich air-fuel ratios and unstable operating conditions when both liquid and gaseous fuels are fed to the engine. *Id.*, 1:56-2:3. The '145 Patent purports to solve this problem by implementing a switch that powers cutoff solenoids for controlling liquid and gaseous fuel flow. *Id.*, 2:11-19.

[0053]. The '145 Patent also couples a liquid fuel cut-off to the carburetor to prevent excess gasoline from passing to the engine, as depicted in FIG. 6:



Ex.1001, FIG. 6.

[0054]. The '145 Patent discloses the liquid fuel cut-off can be manually operated or electrically operated such as by a solenoid. *Id.*, 8:33-44.

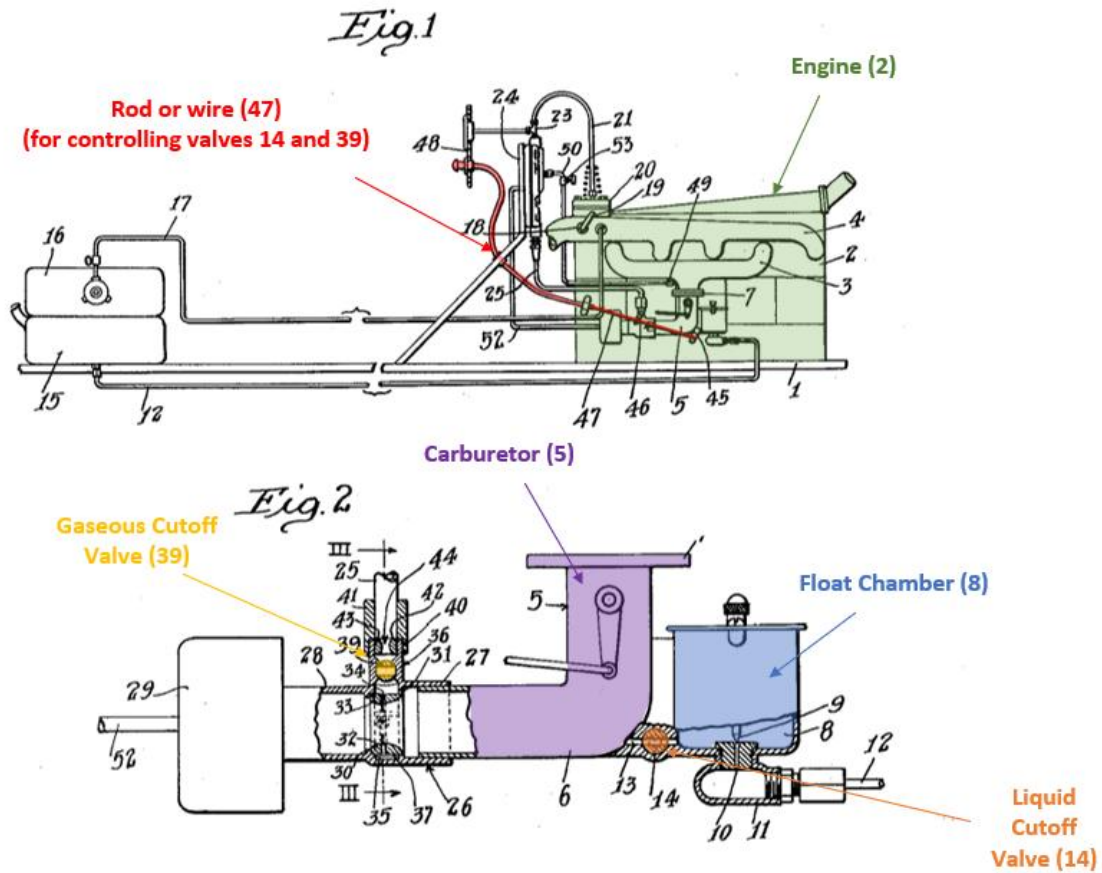
[0055]. The '145 Patent discloses that the engine may be a pull-start engine with a recoil starter. *Id.*, 8:65-9:9. In this embodiment, during engine startup, the recoil starter cranks the engine, causing a magneto to supply electrical power to the solenoid of the liquid fuel cut-off. *Id.*

A. State of the Art:

1. Dual Fuel Combustion Engines

[0056]. Dual fuel engines that can alternate between running on liquid or gaseous fuel have been known in the art for nearly 100 years. For example, Holzapfel, U.S. Patent No 1,931,698, was filed in 1931 and discloses “a fuel system embodying the supplying of liquid fuel and gaseous fuel to an engine in alternation at will.” Ex. 1019, 1:1–5; *Infra*, §IV.C. Holzapfel further teaches that the disclosed engine “provide[s] a fuel system...in which the liquid fuel supply may be cut off and the gaseous fuel supply turned on, or vice versa so that when the liquid fuel is employed the gaseous fuel is disconnected and while the gaseous fuel is employed the liquid fuel is disconnected.” *Id.*, 1:35–42; *Infra*, §IV.C.

[0057]. Holzapfel also discloses that a “rod or wire 47” is connected to gaseous and liquid cutoff valves to control both valves, as seen in Holzapfel’s Figs. 1-2 below:



Ex. 1019, Figs. 1–2 (Annotated).

2. Carburetors

[0058]. A carburetor is a device that supplies an air-fuel mixture to a spark-ignition engine. The diagram below shows a carburetor's basic elements.

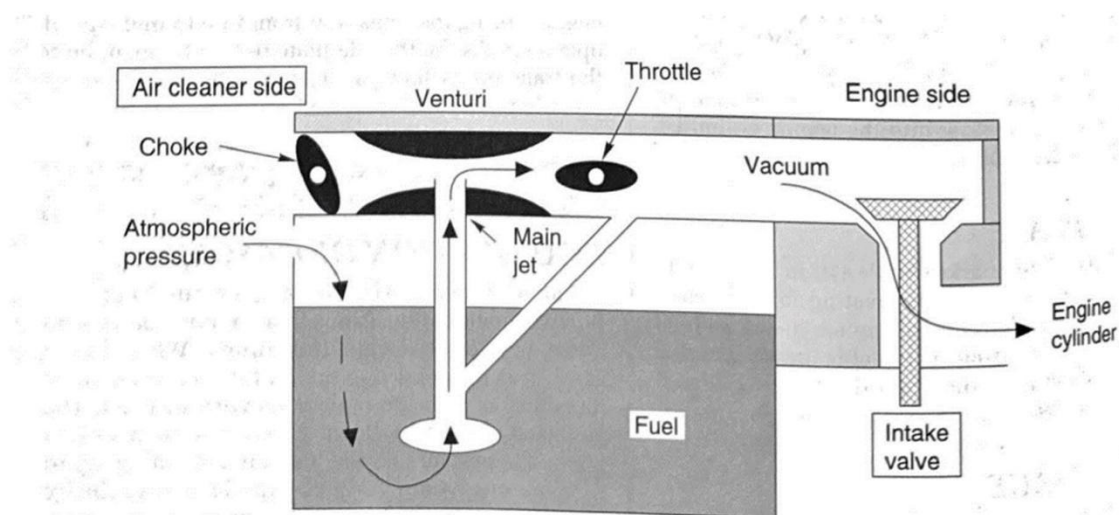


Fig. 4-7 Choke system. (Courtesy of William A. Schuster)

Ex.1006, Fig. 4-7.

[0059]. When air flows through the venturi, the velocity increases and pressure decreases through the narrow portion (the “Venturi effect”), which pulls fuel from the float bowl/chamber through the main jet and mixes it with air.

IV. OVERVIEW OF THE ASSERTED PRIOR ART

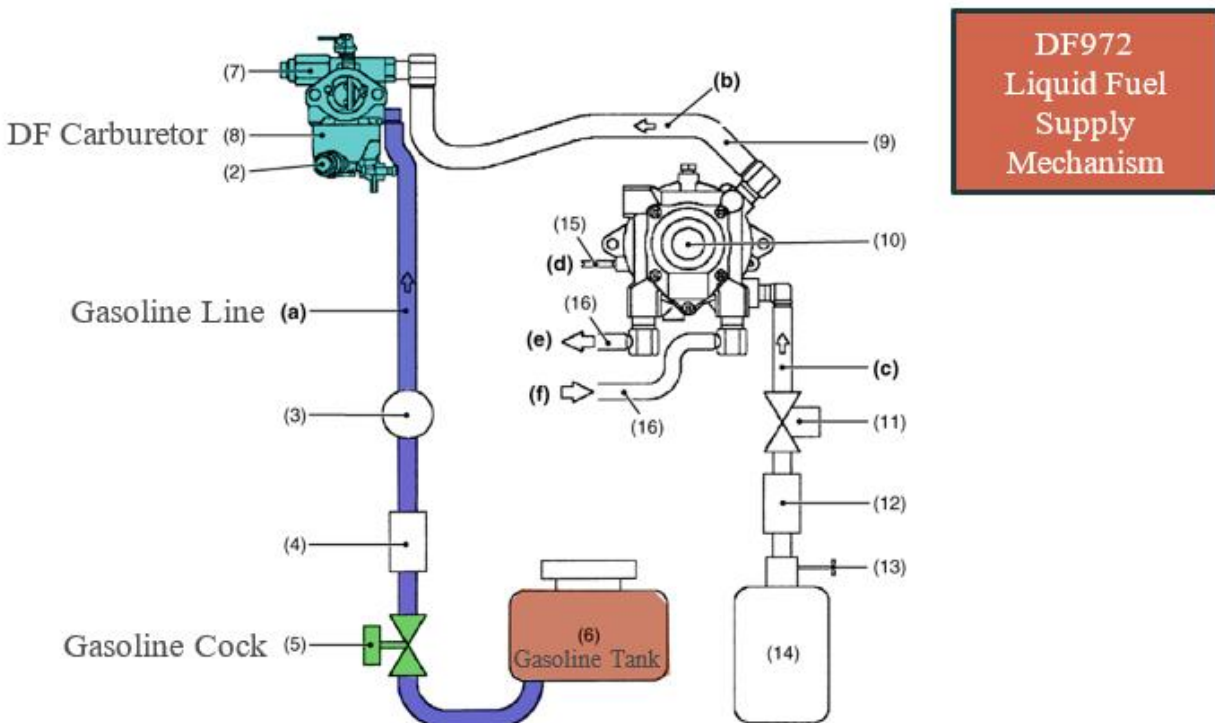
A. Overview of Kubota DF-972-E2 Workshop Manual (“Workshop Manual”)

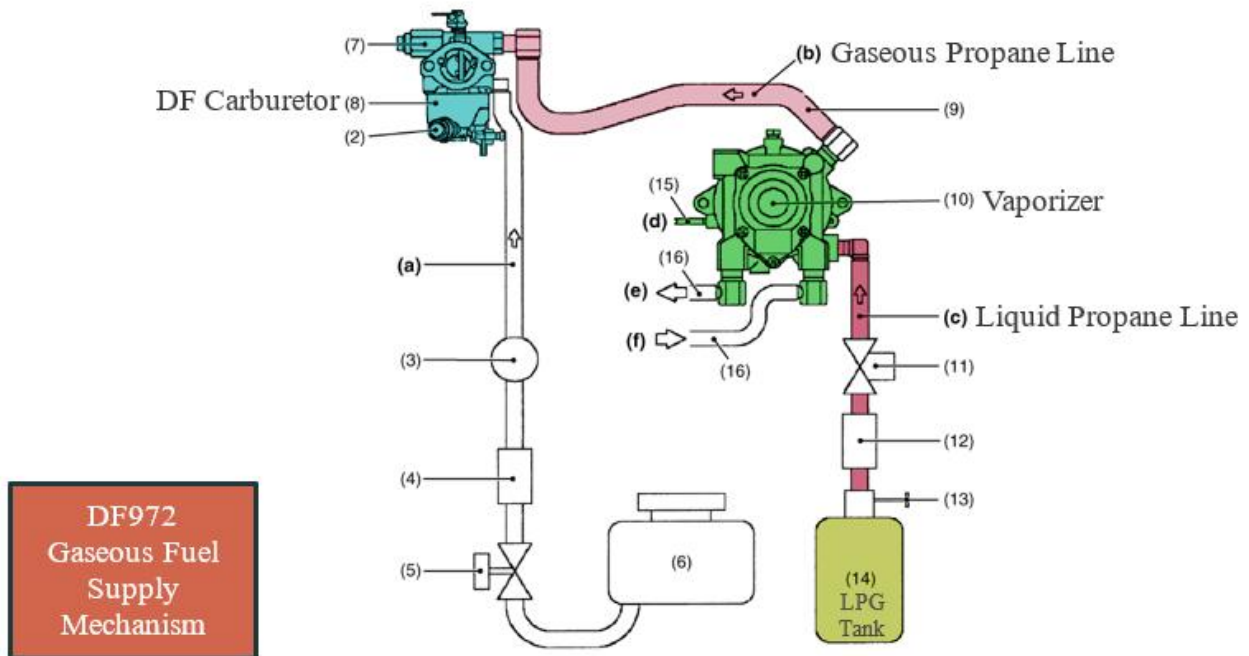
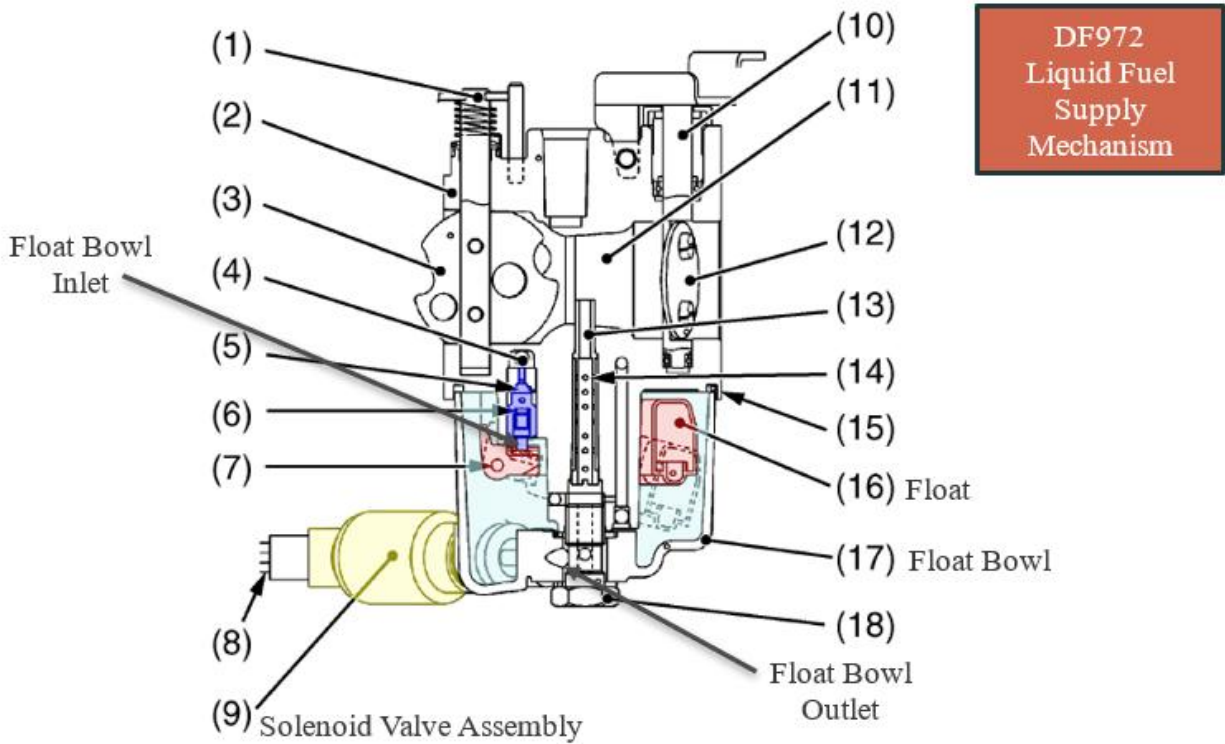
[0060]. The Workshop Manual was published/publicly available at least by June 2009 (Ex.1010, 4-10; Ex.1011, 4-14), before the earliest priority date of the ‘145 Patent (i.e., June 12, 2015).

[0061]. The Workshop Manual is a non-confidential document that was publicly accessible to purchasers, end-users, and service personnel working on

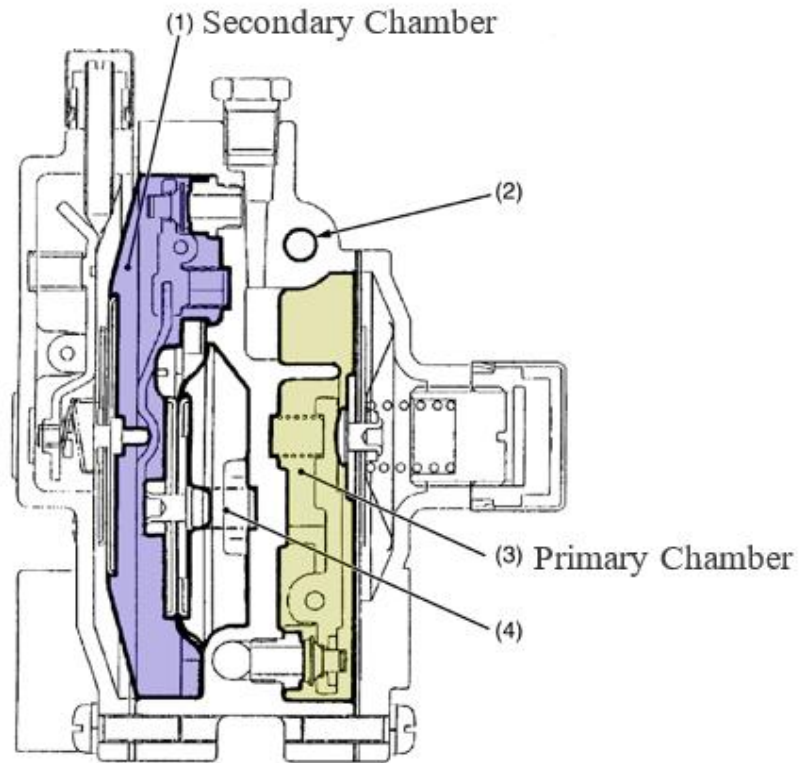
Kubota DF-972 engines, through their exercise of reasonable diligence (e.g., requesting a copy directly from Kubota, obtaining a copy from a Kubota service center, etc.). Id. The Workshop Manual was created for dissemination to the interested public to provide instructions about how to safely assemble/disassemble, maintain, and service the DF-972 engine, and is prior art to the '145 Patent under 35 U.S.C. §102(a). Weber, Inc. v. Provisur Technologies, Inc., 92 F.4th 1059, 1067–69 (Fed. Cir. 2024).

[0062]. The Workshop Manual describes the Kubota DF-972-E2 engine—a dual fuel engine with an alternator to function as a generator that runs alternatively off of gasoline or LPG. Ex.1009, 65. The Workshop Manual discloses a carburetor through which gasoline and LPG are routed, as shown below:



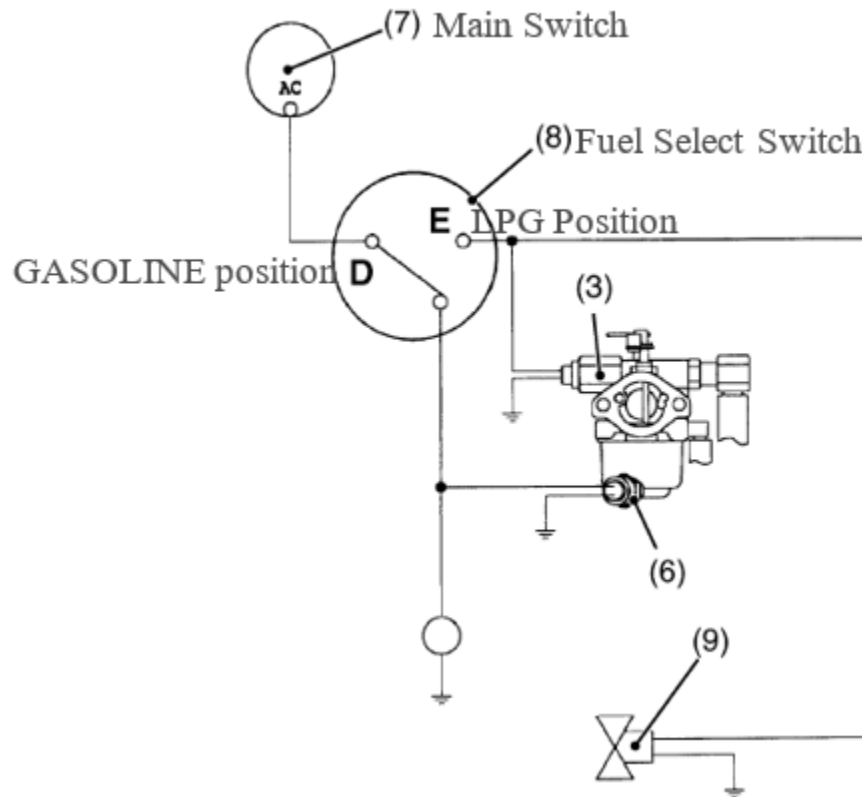


DF972
Gaseous Fuel
Supply
Mechanism



Id., 65, 67, 69 (annotated).

[0063]. The Workshop Manual teaches a fuel select switch that controls whether a gasoline cut off solenoid (located downstream of the float bowl) allows gasoline to pass through the carburetor, or whether an LPG cut off solenoid allows LPG to pass through the carburetor, to power the engine/generator, shown below:



Ex.1009, 68 (annotated).

B. JPS61283734A (“Nakafushi”)

[0064]. Nakafushi (Ex.1004 (original); Ex.1005 (certified translation)) was filed in 1985 and published in 1986. Nakafushi is prior art under §102(a).

[0065]. Nakafushi is directed to an engine configured to selectively use gasoline or LPG as fuel. Ex.1005, [0001]. Nakafushi notes that when engine operation is switched from gasoline to LPG, a residual amount of gasoline remains in the float chamber (i.e., float bowl) and gets mixed with the LPG, resulting in over-rich air-to-fuel ratio. Id., [0003]-[0004]. Also, because the residual gasoline is drained from the float chamber, when the engine is switched back to gasoline,

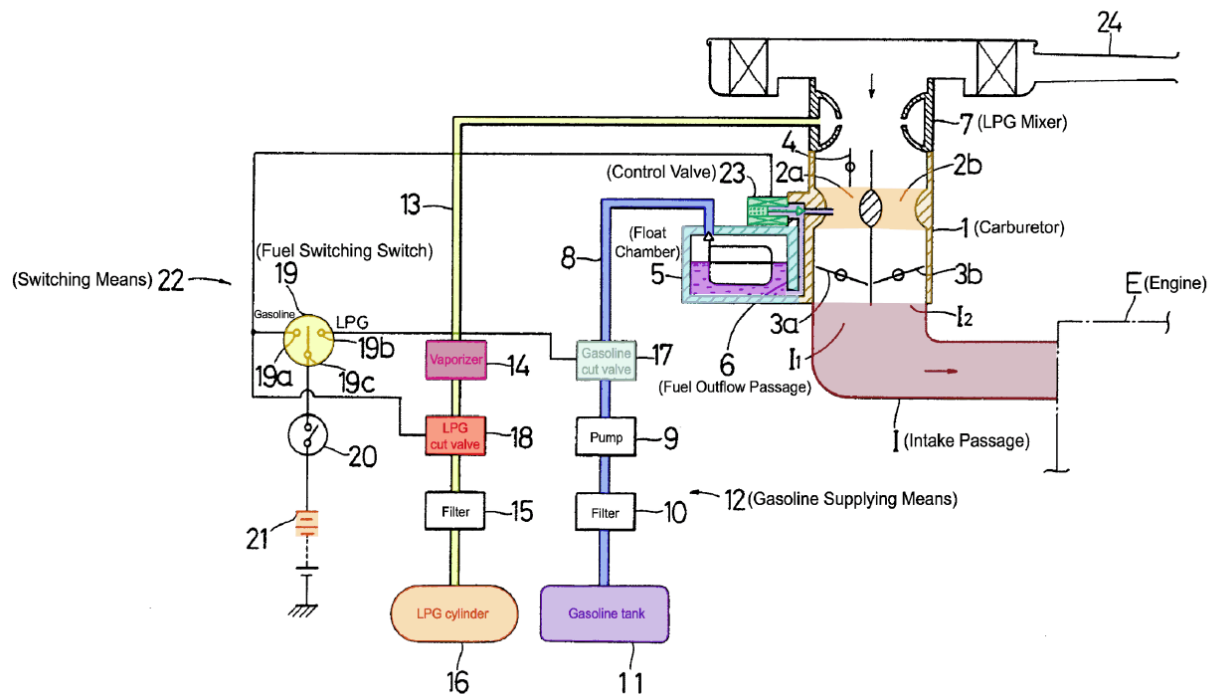
gasoline delivery is delayed until the level of gasoline in the float chamber

recovers. *Id.*, [0004]. During this delay, the air-to-fuel ratio becomes over-lean. *Id.*

Nakafushi solves these problems by including a control valve 23 downstream of the float chamber to prevent it from being emptied of gasoline when switching to LPG operation. *Id.*, [0006]-[0008], FIG. 1.

[0066]. Nakafushi discloses a carburetor 1 having venturi portions 2a and 2b and an intake passage I, as seen below:

FIG. 1



Id., [0010], FIG. 1 (annotated).

[0067]. Gasoline is stored in tank 11 and pumped to float chamber 5 through gasoline supply passage 8, which is opened and closed by gasoline cut

valve 17. Ex.1005, [0012]-[0013]. Gasoline in the float chamber 5 is sucked into the venturi portions 2a and 2b through a fuel outflow passage 6. *Id.*, [0010].

Control valve 23 opens and closes the fuel outflow passage 6, thus controlling gasoline flow from the float chamber 5 to the intake passage I. *Id.*, [0014].

[0068]. LPG is stored in cylinder 16 and travels to LPG mixer 7 in the carburetor through LPG supply passage 13, which is opened and closed with LPG cut valve 18. *Id.*, [0011]-[0013].

[0069]. Nakafushi discloses a fuel switching switch 19 that controls which fuel is fed to the engine. *Id.*, [0013]-[0014]. When switch 19 is set to the gasoline side contact 19a: (1) LPG cut valve 18 closes to block the LPG supply; (2) gasoline cut valve 17 opens to allow gasoline flow through passage 8 to the carburetor float chamber; and (3) control valve 23 opens to allow gasoline flow from the float chamber to the intake. *Id.*

[0070]. Conversely, when the switch 19 is set to the LPG side contact 19b: (1) gasoline cut valve 17 and control valve 23 are closed to block the flow of gasoline; and (2) LPG cut valve 18 is opened, allowing LPG to flow through passage 13 to the carburetor mixer 7. *Id.*

[0071]. Closing control valve 23, which is downstream of the float chamber, prevents residual gasoline from exiting the float chamber when switching to LPG operation. *Id.*, [0014], FIG. 1. Because gasoline is not drained from the

float chamber, that gasoline is more readily available to fuel the engine upon

switching back to gasoline operation. *Id.*

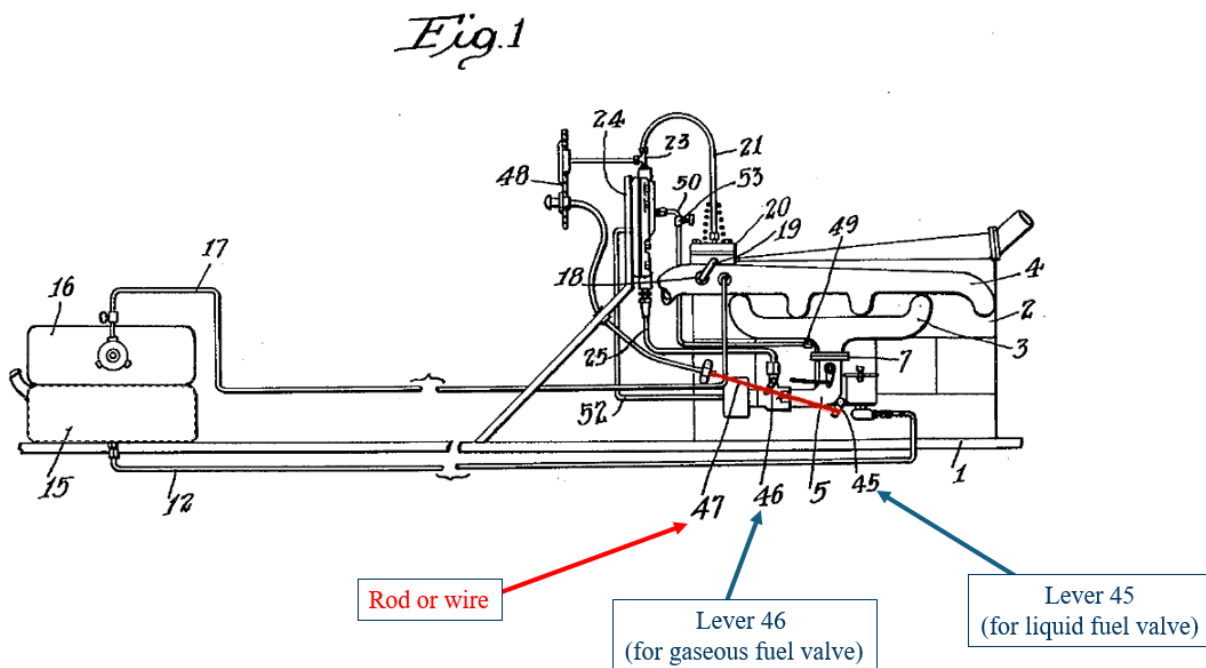
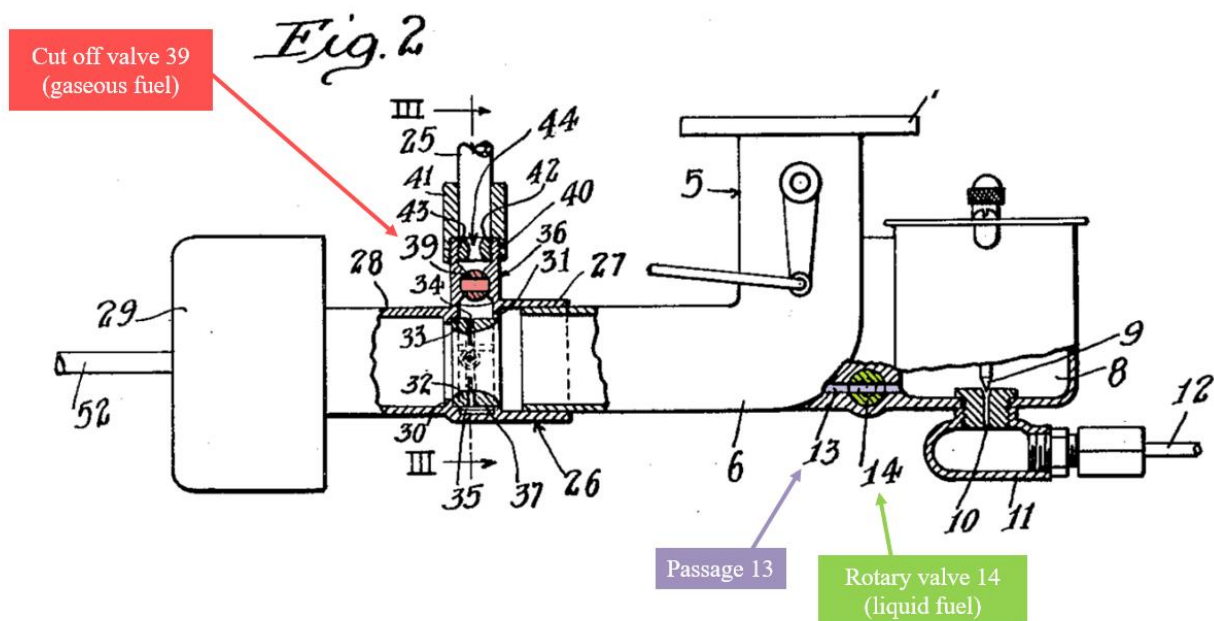
[0072]. Thus, some 30 years earlier than the ‘145 Patent, Nakafushi addressed the alleged “problems” identified by the ‘145 Patent, and disclosed the same solution.

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

[0073]. Holzapfel issued in 1933. Ex.1008. It is prior art under §102(a).

[0074]. Holzapfel discloses “a fuel system embodying the supplying of liquid fuel and gaseous fuel to an engine in alternation at will.” Ex.1008, 1:1-5.

[0075]. A “rod or wire 47” controls the levers 46 and 47 for the gaseous and liquid valves. Ex.1008, 1:100-106, 2:86-123, FIGS. 1-2. The liquid valve 47 is a rotary valve located in the fuel passage between the float bowl in the intake. *Id.*

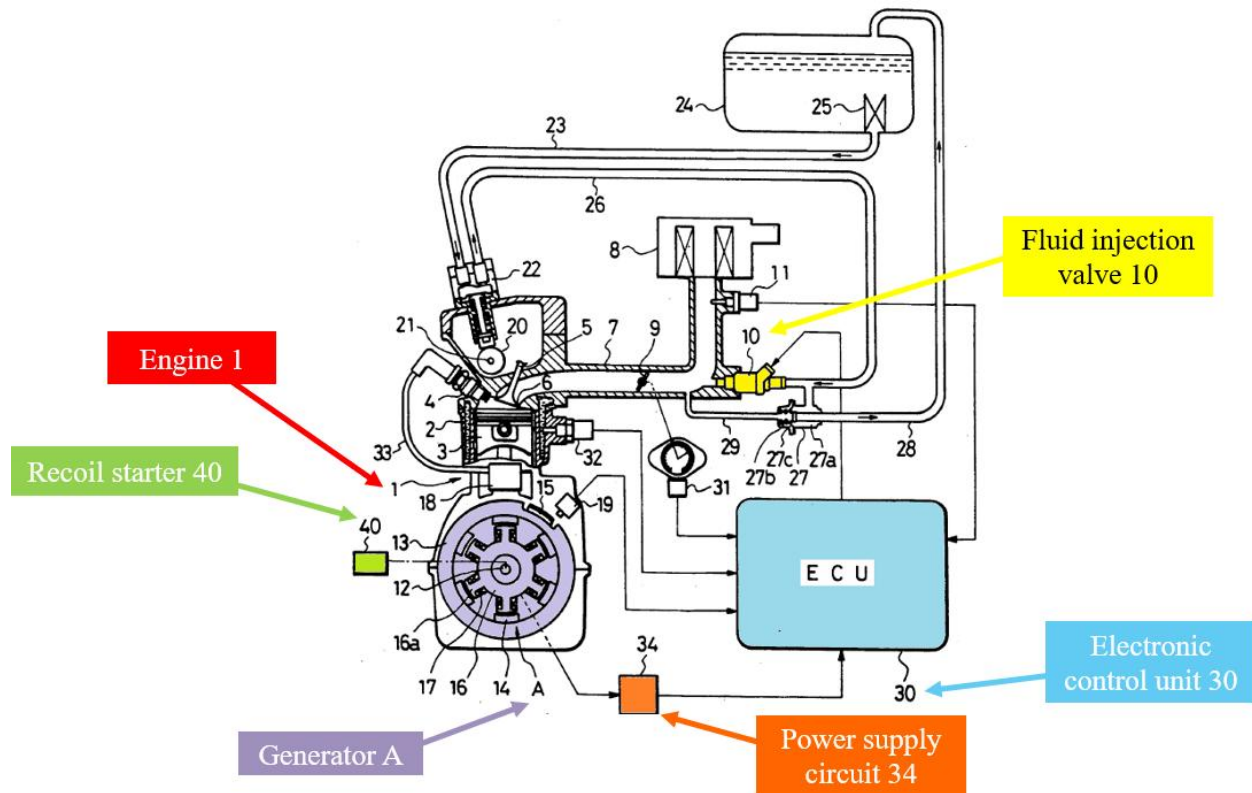


Ex.1008, FIGS. 1-2 (annotated).

D. U.S. Patent No. 5,161,496 (“Matsushima”)

[0076]. Matsushima issued in 1992. Ex.1012. It is prior art under §102(a).

[0077]. Matsushima discloses an internal combustion engine and generator equipped with no battery that is started using a manual recoil starter 40:



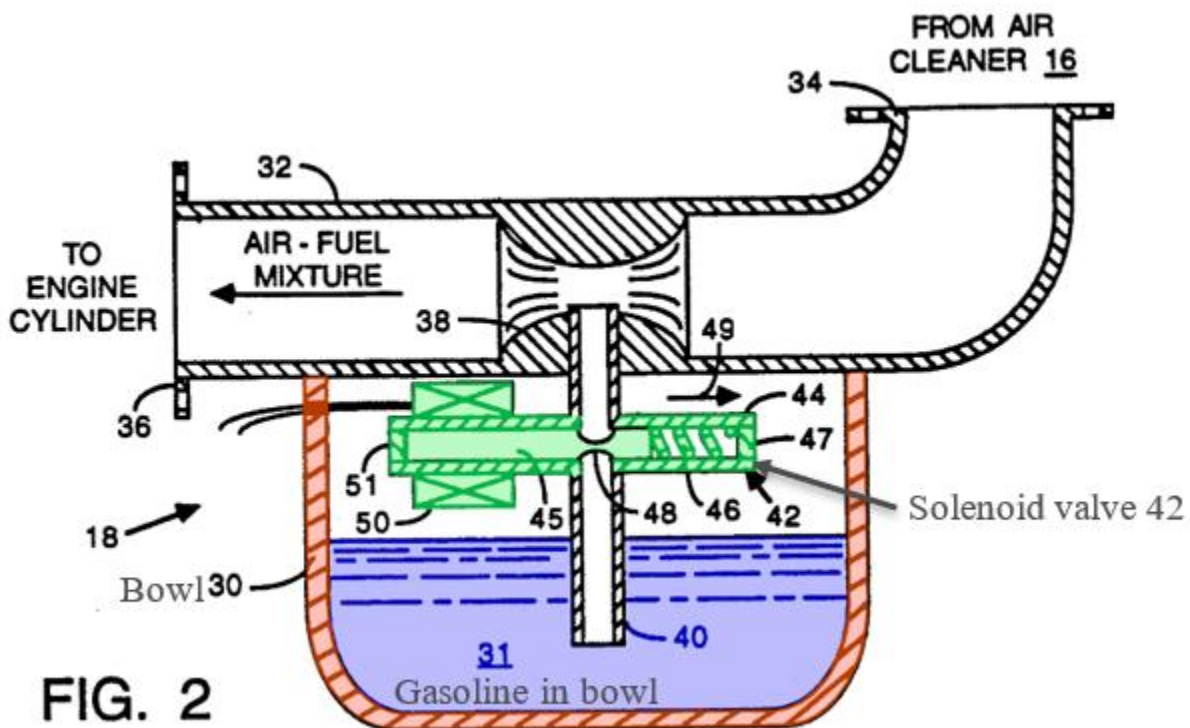
Ex.1012, FIG. 1 (annotated), 1:38-2:2, 3:53-66, 4:43-6.

[0078]. During engine startup, the generator supplies voltage to an electronic control unit (ECU) 30, as well as fuel pump 22, spark plug 4, and fuel injection valve 10. *Id.*, 5:1-48. Power supply circuit 34 rectifies, smooths, and stabilizes output voltage from the generator. *Id.*, 4:43-46.

E. U.S. Patent No. 5,301,644 (“Olmr”)

[0079]. Olmr issued in 1994. Ex.1007. Olmr is prior art under §102(a).

[0080]. Olmr teaches locating a solenoid valve within the float bowl 30 of the carburetor. Ex.1007, 1:33-48, 2:30-42, FIG. 2. Specifically, solenoid valve 42 “provide[s] a mechanism for cutting off the supply of fuel to an internal combustion engine when the engine is being stopped,” as seen in Olmr’s FIG. 2:



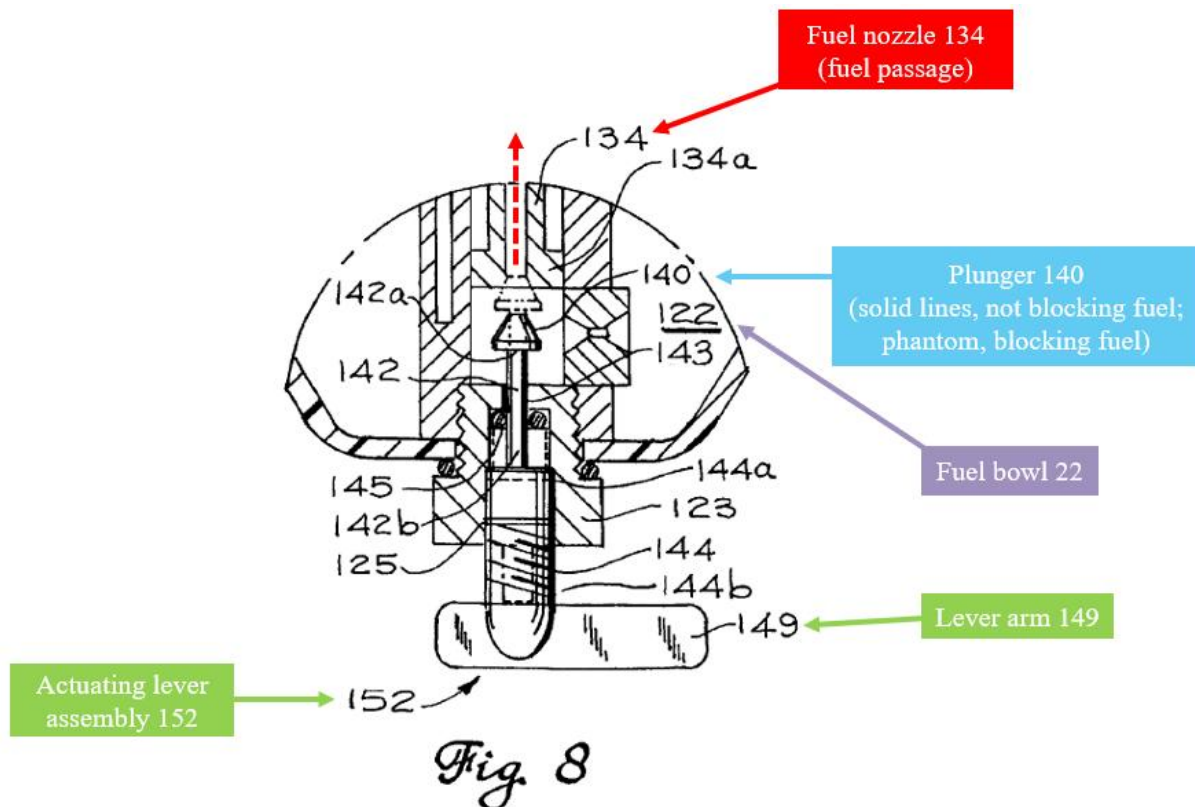
Id., 1:33-37, FIG. 2 (annotated).

F. U.S. Patent No. 6,213,083 (“Winberg”)

[0081]. Winberg issued in 2001. Ex.1013. It is prior art under §102(a).

[0082]. Winberg discloses a fuel shutoff system in the float bowl of an engine. Ex.1013, Abstract, FIGS. 1-8, 3:61-4:33, 5:34-6:16, 7:31-55, 7:65-8:52. The fuel shutoff includes a blocking member or plunger 40/140 that blocks and unblocks the flow of fuel from the float bowl to the fuel passage in fuel nozzle 34/134, thus blocking the flow of fuel from the float bowl to the throat. Id., FIGS. 1-8, 5:34-6:16, 7:31-55, 7:65-8:52.

[0083]. In the embodiment of FIG. 8, the fuel shutoff actuates by rotating a connecting member 142 using a lever arm 149 attached to a lever assembly 152, which moves plunger 140 between a blocking position and a non-blocking position:



The image contains two technical drawings of a carburetor assembly, labeled Fig. 3A and Fig. 3.

Fig. 3A (Blocking Fuel): This diagram shows the carburetor in a state where fuel flow is blocked. A plunger (40) is positioned to block the fuel passage (34b) at the end of the fuel nozzle (34). The fuel bowl (22) is shown with a plunger (40) blocking the fuel passage (34b). A Bowden cable (98) is connected to the actuator lever assembly (100).

Fig. 3 (Not Blocking Fuel): This diagram shows the carburetor in a state where fuel flow is not blocked. The plunger (40) is retracted, allowing fuel to pass through the fuel passage (34b) into the throat (20). The actuator lever assembly (100) is shown in a different position, indicating that the Bowden cable (98) has moved the plunger (40) to allow fuel flow.

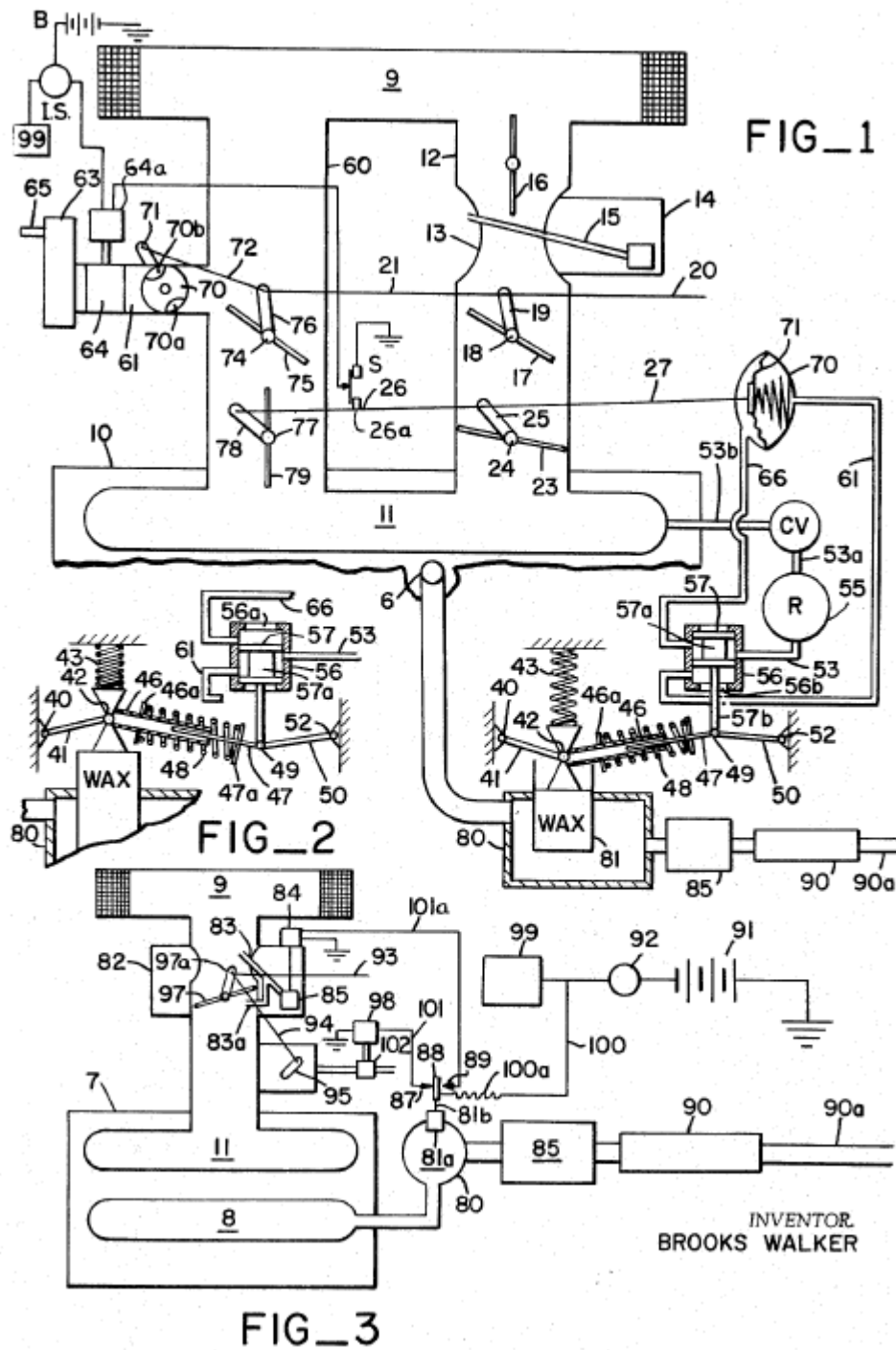
Common Components and Labels:

- Carburetor 14:** The main assembly shown in both diagrams.
- Throat 20:** The passage through which fuel flows.
- Fuel bowl 22:** The chamber where fuel is stored.
- Plunger 40:** A component that can block or unblock the fuel passage. It is labeled "Plunger 40 (blocking fuel)" in Fig. 3A and "Plunger 40 (not blocking fuel)" in Fig. 3.
- Actuator lever assembly 100:** A mechanical assembly that moves the plunger (40) via a Bowden cable.
- Bowden cable 42 and its outer sheath 44a and inner wire 46:** The cable that transmits motion from the actuator lever assembly to the plunger.
- Bowden cable 98:** The cable that connects the actuator lever assembly to the plunger.
- End 34b of fuel nozzle 34 (fuel passage):** The point where fuel enters the throat.

G. U.S. Patent No. 3,718,000 (“Walker”)

Petitioner MWE Investments, LLC, et al.
Exhibit 1003, Page 47

discloses that when control rod 26 is moved to the left (as shown in FIG. 1), gas shut off valve 79 and the valve operated by solenoid 64a will be wide open for operating on gas carburetor 60 and gasoline shut off valve 23 will be tight closed, as shown in FIG. 1, to shut off operation on gasoline and operate on gas carburetor 60 and gas flow to carburetor 60 will be open by the operation of solenoid 64a when switch S forms a ground. Ex.1015, 2:24-32.



Ex.1015, Figures 1-3.

V. THE CHALLENGED CLAIMS

[0086]. This Declaration address claims 1-16 of the '145 patent based

on the following grounds:

Ground	Basis	Challenged Claims	Reference(s)
1	§103	1-7 and 10	Workshop Manual
2	§103	8-9	Workshop Manual, Matsushima, and Olmr
3	§103	1-10	Nakafushi, Matsushima, and Olmr
4	§103	1-10	Holzapfel, Matsushima, and Olmr
5	§103	11-16	Workshop Manual, Matsushima, and Winberg
6	§103	11-16	Nakafushi, Matsushima, and Winberg
7	§103	11, 13, and 14	Holzapfel
8	§103	12, 15, and 16	Holzapfel, Matsushima, and Winberg

VI. CLAIM TERMS

[0087]. I have been instructed that claims should be given their ordinary and customary meaning as understood by a POSA viewing the claim terms in the context of the entire patent. Petitioner has not identified any claim terms that need construction in order to address the issues raised by this petition, but Petitioner reserves the right to respond to any constructions offered by Patent Owner or the Board.

VII. THE CHALLENGED CLAIMS ARE UNPATENTABLE BASED ON THE PRIOR ART

A. Ground 1: Claims 1-5 and 10 are Rendered Obvious by the Workshop Manual.

1. Claim 1

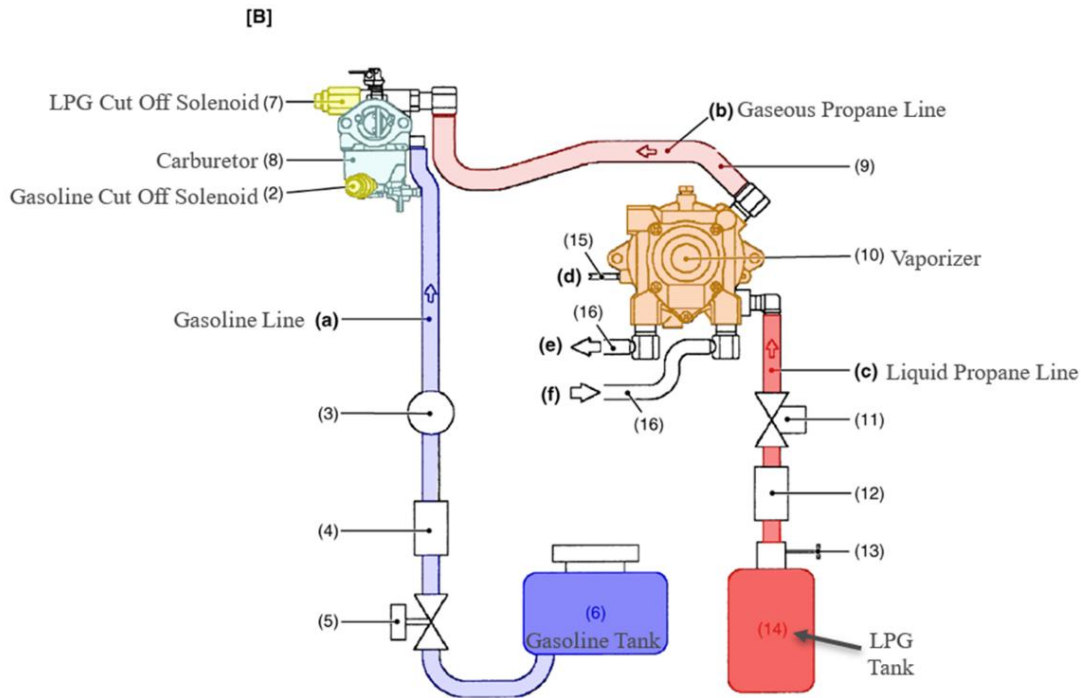
a. Element [1.0]: “A dual fuel generator comprising:”

[0088]. Workshop Manual teaches a dual fuel engine. Ex.1009, 65. It would have been obvious to a POSA to have implemented Workshop Manual’s dual fuel engine in a generator, as dual fuel generators were well known as of the earliest priority date of the ‘145 Patent. Ex.1016, pp.1-31; Ex.1017, p.1.

b. Element [1.1]: “an engine operable on a gaseous fuel and a liquid fuel;”

[0089]. Element [1.1] recites “an engine operable on a gaseous fuel and a liquid fuel.”

[0090]. The Workshop Manual teaches that the DF-972 engine uses both “[g]asoline fuel” (a liquid fuel) and “LPG fuel” (a gaseous fuel) Id., 65. The figure below discloses the DF-972 fuel system:



Ex.1009, p.65. (Annotated)

[0091]. The Workshop Manual discloses operation on LPG. Ex.1009, 1, 8, 30, 64-69, 84. 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.” Id., 65, 69 (describing the vaporizer operation).

[0092]. As confirmed by the ’145 Patent, gasoline is liquid fuel and LPG is a gaseous fuel. Ex.1001, 4:9-14. Accordingly, a POSA would have understood that Workshop Manual teaches [1.1].

c. Element [1.2]: “an electrical power generator driven by the engine and comprising a charging coil;”

[0093]. Element [1.2] recites “an electrical power generator driven by the engine and comprising a charging coil.”

[0094]. The Workshop Manual’s dual fuel engine includes “a rotating magnet type generator” (i.e., an alternator). Ex.1009, 77. The alternator is driven by the engine (belt and pulley system). *Id.*, 33. The alternator comprises a charging coil. *Id.*, 132. The Workshop Manual specifies that the alternator outputs 150W at 12V. *Id.*, 8. Thus, Workshop Manual discloses an electrical power generator, powered by operation of the DF-972 engine, and comprising a charging coil. Accordingly, a POSA would have understood that Workshop Manual teaches [1.2].

d. Element [1.3]: “a switch to change operation of the engine between gaseous fuel and liquid fuel;”

[0095]. Element [1.3] recites “a switch to change operation of the engine between gaseous fuel and liquid fuel.”

[0096]. The Workshop Manual discloses a switch (i.e., “Fuel Select Switch”) that changes operation of the engine between gaseous fuel and liquid fuel:

With the fuel select switch (8) in the “GASOLINE”

position “D” ..., 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

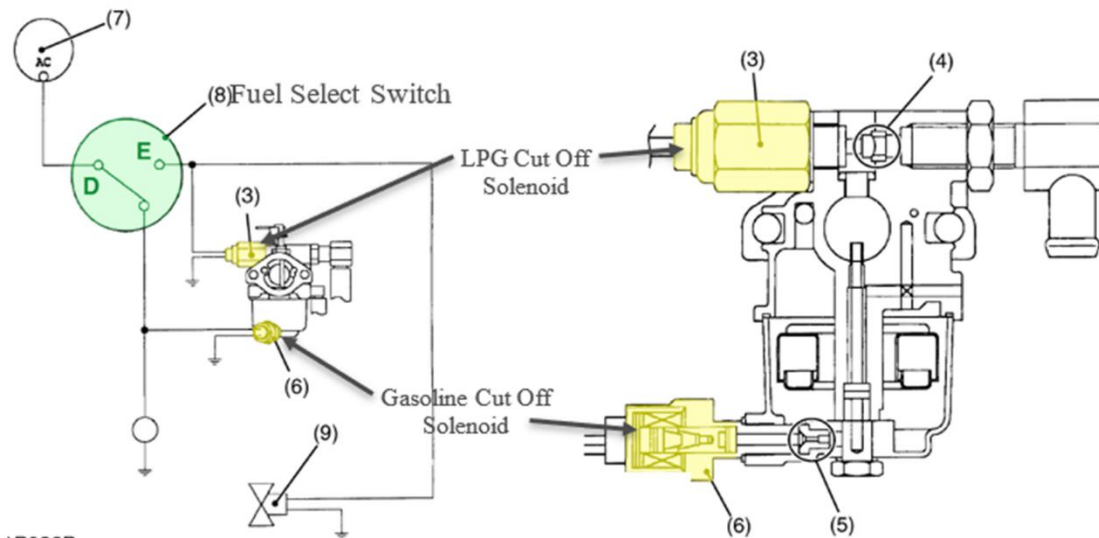
select switch (8) is turned to the “LPG” position “E,” the

battery current stops to the gasoline cut off solenoid...

[t]hen, the gasoline fuel flow is shut.

Ex.1009, 68.

[0097]. This switch is also shown in the Workshop Manual figures:



Id. (annotated).

[0098]. Accordingly, a POSA would have understood that Workshop Manual teaches [1.3].

- e. **Element [1.4]: “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;”**

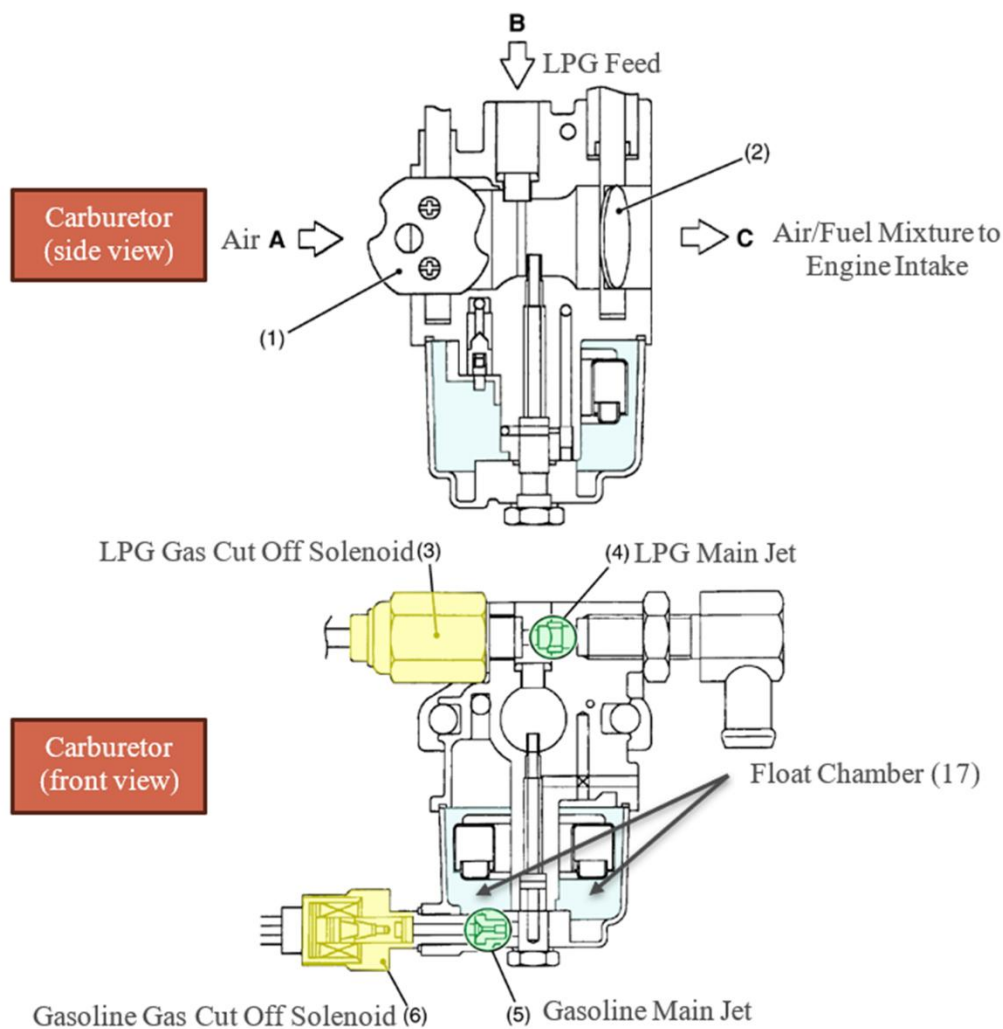
[0099]. Element [1.4] recites “a carburetor attached to an intake of the engine to mix air and fuel and connect to a gaseous fuel source and a liquid fuel source.”

[0100]. The Workshop Manual discloses a carburetor that mixes air and fuel:

The mixer meters both fuel and air, and procedures [sic: produces] an air/fuel mixture that has the proper ratio as required by the engine. When the engine starts, the LPG furl [sic: fuel] flows out from main jet (4) to venture a constant amount and is mixed with air quantity corresponding to the opening of the throttle valve (1) and is supplied to the cylinder.

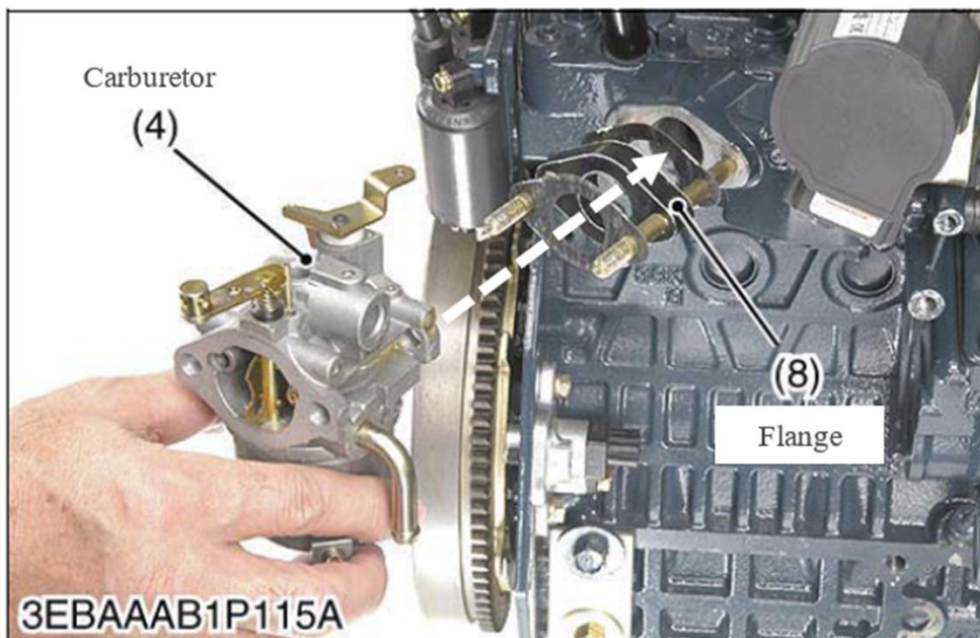
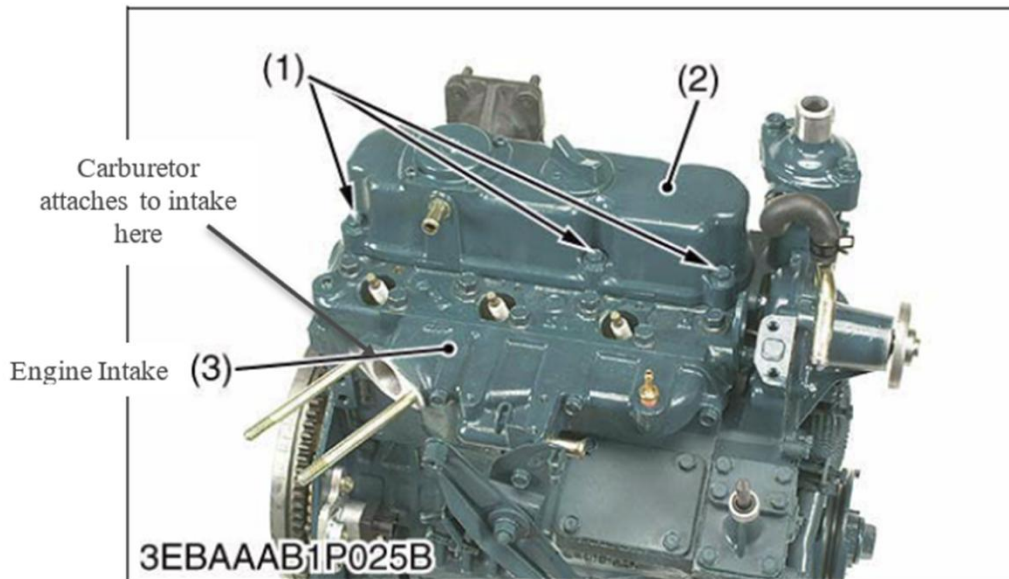
Ex.1009, 68.

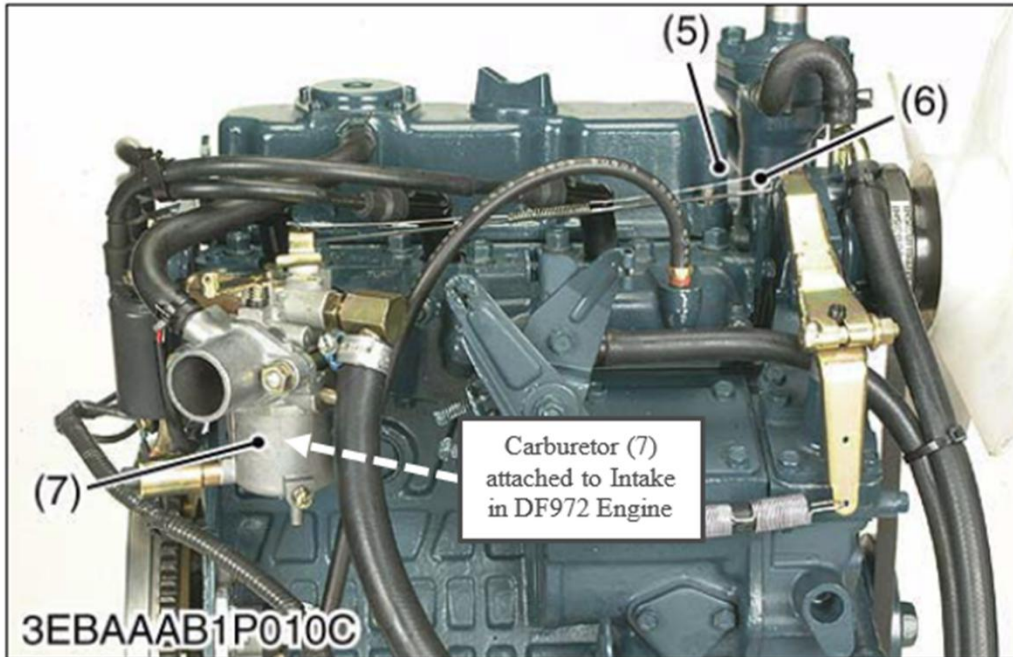
[0101]. Workshop Manual figures illustrate the carburetor operation:



Id. (annotated).

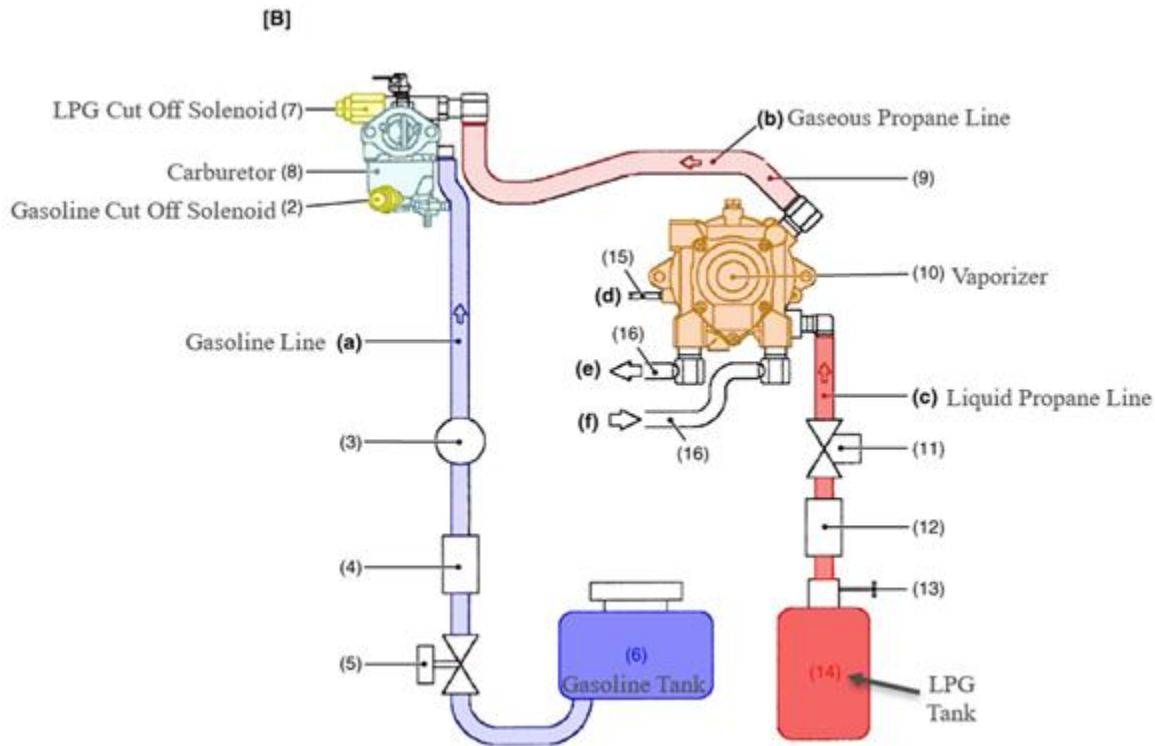
[0102]. The Workshop Manual shows the carburetor is attached to the engine intake:





Ex.1009, 115, 119 (annotated).

[0103]. The Workshop Manual also discloses that the carburetor connects to the gaseous fuel source (LPG) and a liquid fuel source (gasoline):



Ex.1009, 65 (annotated).

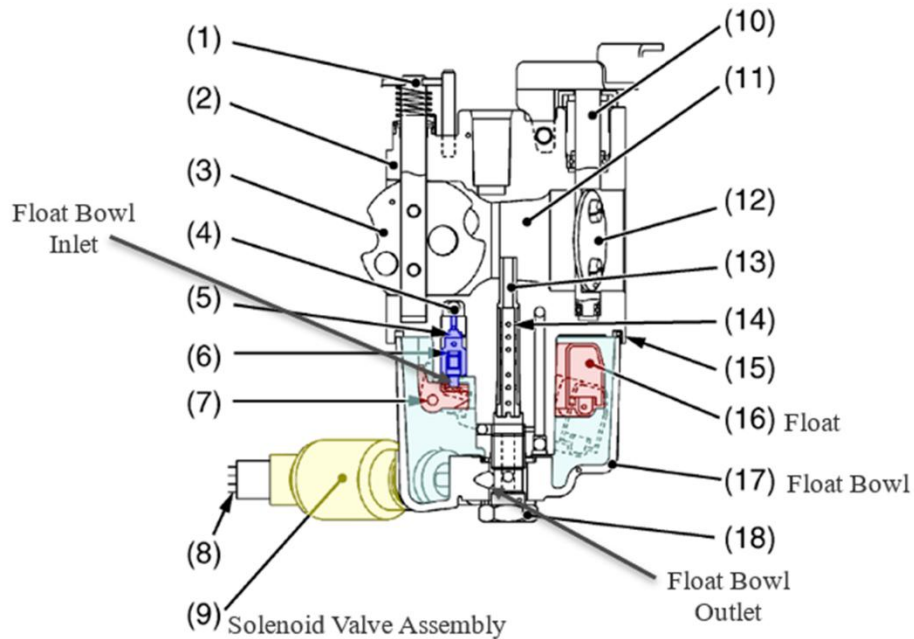
[0104]. A POSA would have understood that Workshop Manual teaches a carburetor attached to the engine that mixes air and fuel, that thereby connects the gaseous fuel source and the liquid fuel source, as recited in Element [1.4].

f. **Element [1.5]: “a liquid fuel cut-off solenoid to interrupt liquid fuel flow to the engine upon actuation of the switch from liquid fuel to gaseous fuel; and”**

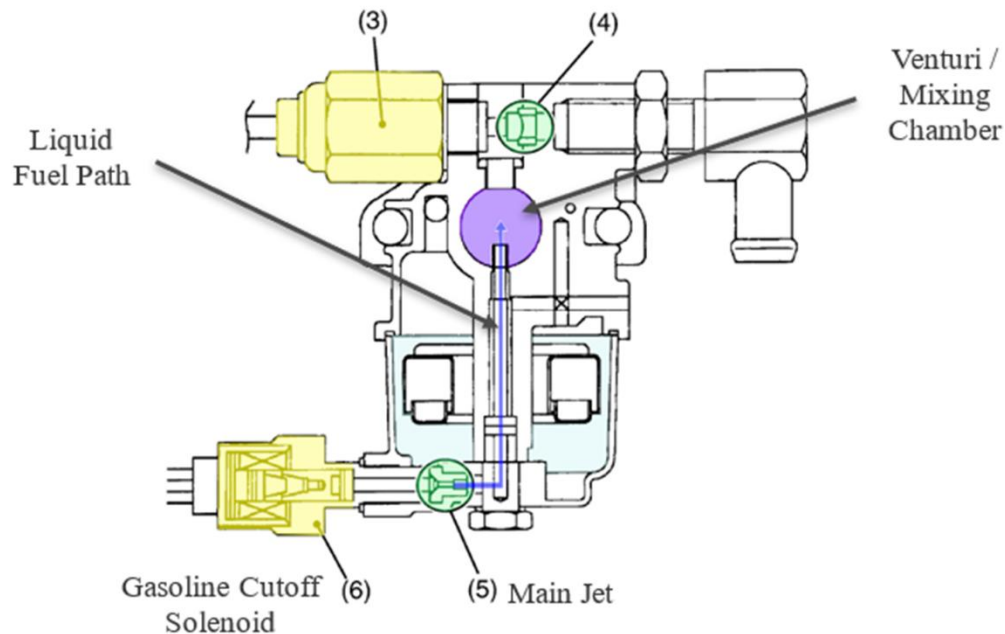
[0105]. Element [1.5] recites “a liquid fuel cut-off solenoid to interrupt liquid fuel flow to the engine upon actuation of the switch from liquid fuel to gaseous fuel.”

[0106]. The Workshop Manual discloses Gasoline Cut Off Solenoid

(Ex.1009, 65), which is a “liquid fuel cut-off solenoid.” As discussed (*supra* §VII.A.1.e), the fuel select switch changes operation of the engine between gaseous fuel and liquid fuel which results in the liquid fuel cut off solenoid interrupting liquid fuel. Ex.1009, 65, 68. “When the fuel select switch (8) in turned to the “LPG” position “E,” the battery current stops to the gasoline cut off solenoid...[t]hen, the gasoline fuel flow is shut.” (emphasis added). *Id.*, 68.



Id., 67 (annotated).



Id., 68 (annotated).

[0107]. Accordingly, a POSA would have understood that Workshop Manual teaches [1.5].

- g. **Element [1.6]: “a voltage regulator coupled to the charging coil to receive power therefrom and that operates to provide a regulated voltage to the liquid fuel cut-off solenoid.”**

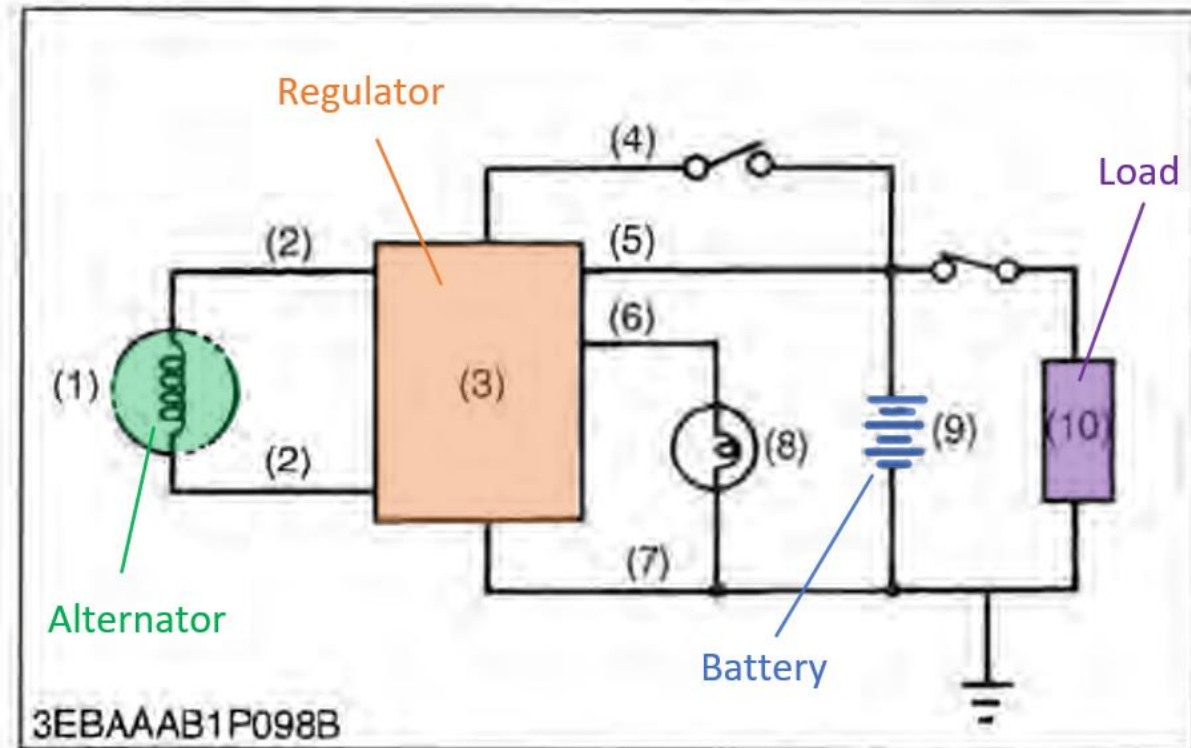
[0108]. Element [1.6] recites “a voltage regulator coupled to the charging coil to receive power therefrom and that operates to provide a regulated voltage to the liquid fuel cut-off solenoid.”

[0109]. As discussed (*supra* §VII.A.1.c), the Workshop Manual teaches that the DF-972 engine includes an electrical power generator (i.e., a “rotating

magnet type generator”). This rotating magnet type generator is an alternator.

Ex.1009, 77.

[0110]. The Workshop Manual further discloses that the alternator is coupled to a voltage regulator:



Id., 77 (annotated).

[0111]. The Workshop Manual teaches the “regulator converts AC into DC which flows through the power consuming circuits [e.g., load (10)] and the battery, and also charges the battery.” Ex.1009, 77.

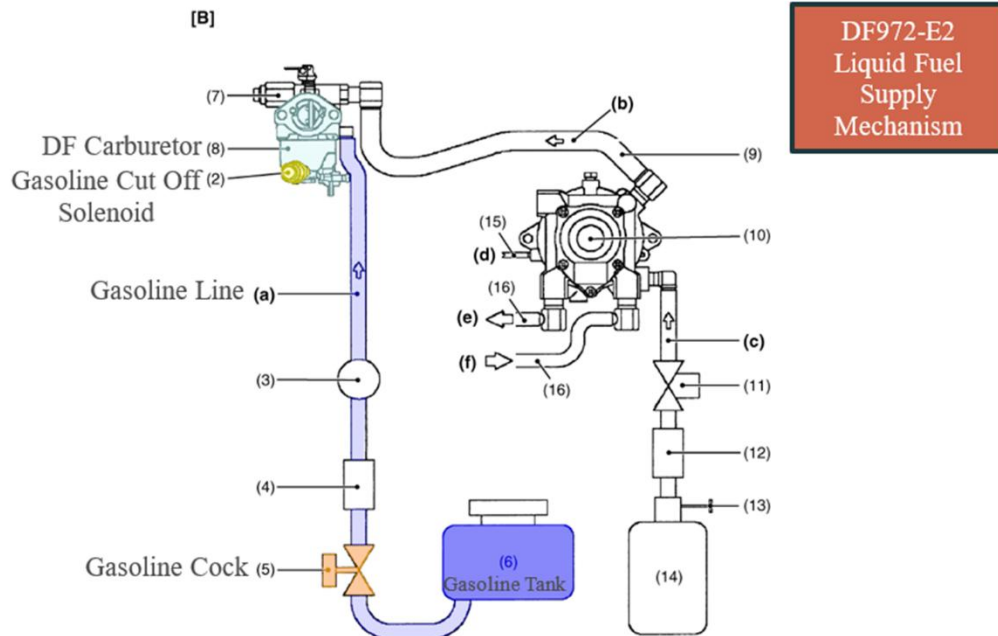
[0112]. As discussed (*supra* §VII.A.1.f), the liquid fuel cut off solenoid is powered by the rotating magnet type generator because operation of the solenoid

depends on current flow generated by the rotating magnet type generator. The voltage regulator provides a regulated voltage to the liquid fuel cut off solenoid because the rotating magnet type generator generates AC, which is converted to DC by the regulator, which is then stored in the battery that supplies current to the gasoline fuel cut-off solenoid. Accordingly, a POSA would have understood that Workshop Manual teaches [1.6].

2. **Claim 2: “The dual fuel generator of claim 1 further comprising: a liquid fuel valve along a liquid fuel line coupling the liquid fuel source to the carburetor; and a gaseous fuel valve along a gaseous fuel line coupling the gaseous fuel source to the carburetor.”**

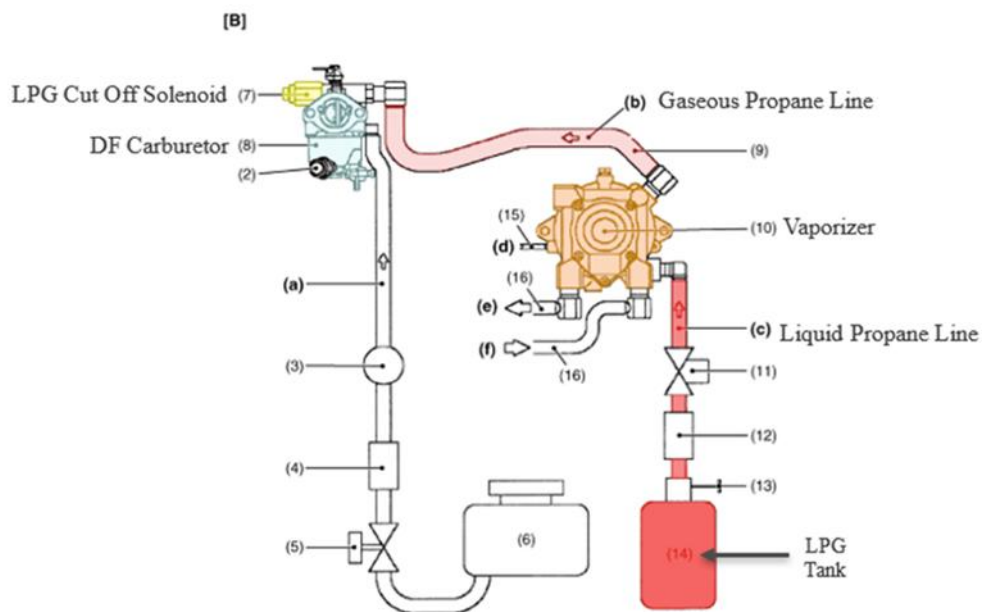
[0113]. Claim 2 depends from claim 1 and recites “a liquid fuel valve along a liquid fuel line coupling the liquid fuel source to the carburetor; and a gaseous fuel valve along a gaseous fuel line coupling the gaseous fuel source to the carburetor.”

[0114]. The Workshop Manual discloses a liquid fuel valve (Gasoline Cock (5)) along a liquid fuel line (Gasoline Line (a)). Ex.1009, 65. The Gasoline Cock is positioned on the Gasoline Line coupling the gasoline tank to the carburetor:



Ex.1009, 65 (annotated).

[0115]. The Workshop Manual teaches an LPG fuel line coupling LPG Tank (14) to DF Carburetor (8), as illustrated below:



Ex.1009, 65 (annotated).

[0116]. The Workshop Manual described the LPG fuel line:

For 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 through the LPG filter (12) and LPG shut off solenoid valve (11).

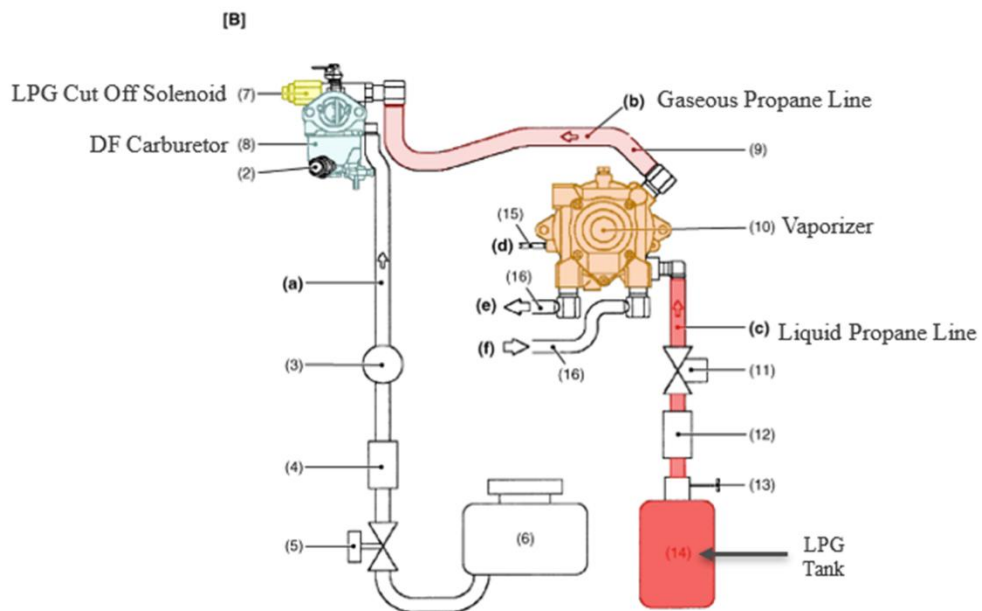
The liquid fuel is evaporated in vaporizer and is sent to the DF carburetor (8) as a gaseous fuel of gas pressure near the atmospheric pressure. The DF carburetor (8) mixes the gas and air is supplied in the cylinder.

Ex.1009, 65.

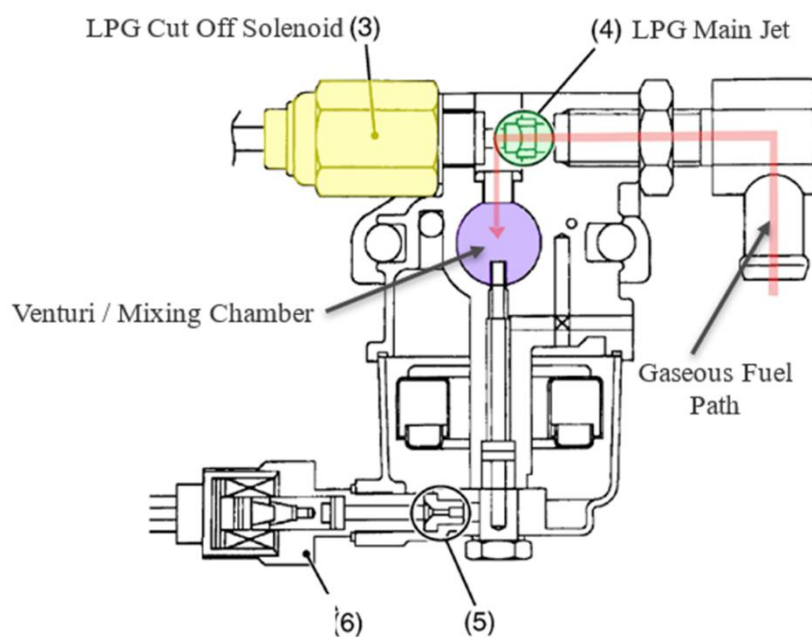
[0117]. Workshop Manual discloses three structures, each of which teaches “a gaseous fuel valve.” Workshop Manual discloses LPG Manual Valve (13), which is a gaseous fuel valve positioned on the LPG fuel line. *Id.* Workshop Manual also discloses LPG Cut Off Solenoid (7) and LPG Cut Off Solenoid Valve (11), each of which is a gaseous fuel valve positioned on the LPG fuel line.

Ex.1009, 65, 68.

[0118]. As shown below, LPG Manual Valve (13), LPG Cut Off Solenoid Valve (11), and LPG Cut Off Solenoid (7) all are positioned on the LPG fuel line coupling the LPG tank to the carburetor:



Ex.1009, 65 (annotated).



Id., 65, 68 (annotated).

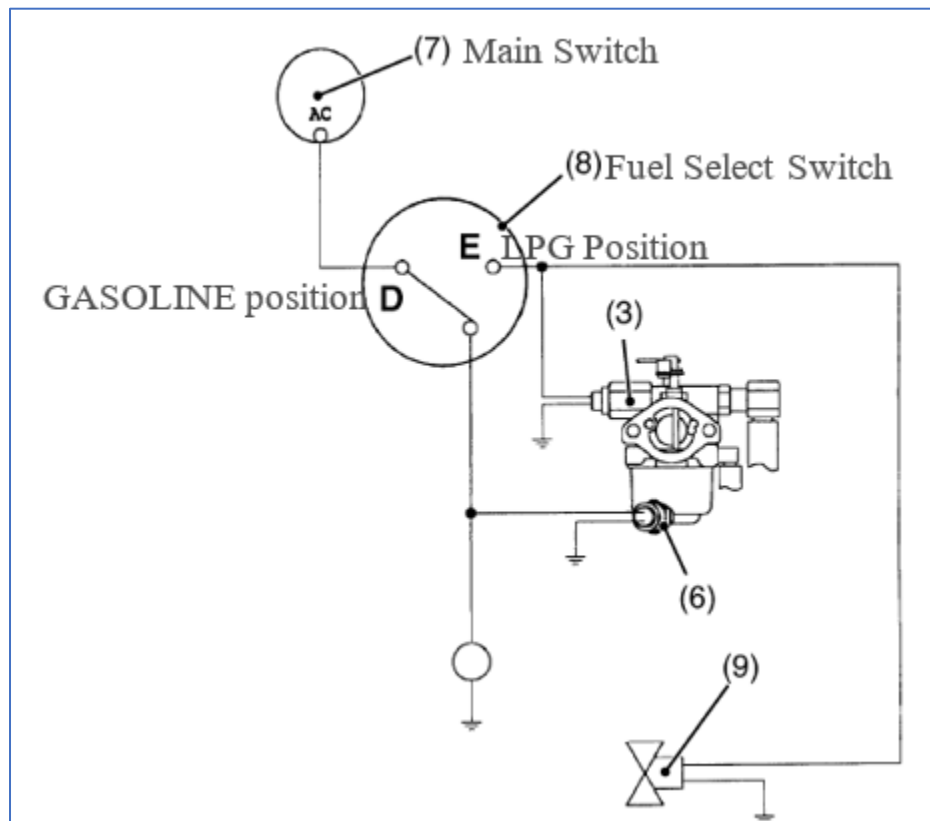
[0119]. LPG Cut Off Solenoid and LPG Cut Off Solenoid Valve each

opens and closes the LPG fuel line coupling the LPG tank to the carburetor.

Ex.1009, 65, 68. (“When the fuel select switch (8) is turned to the “LPG” position

“E”, the battery current...flows to the LPG cut off solenoid (3) and LPG shut off

solenoid valve (9). Then...LPG fuel flows to the mixing chamber.”). Ex.1009, 68.



Id.

[0120]. Accordingly, a POSA would have understood that Workshop Manual teaches claim 2.

3. Claim 3: “The dual fuel generator of claim 2, wherein each of the liquid fuel valve and the gaseous fuel valve comprises a mechanical valve.”

[0121]. Claim 3 depends from Claim 2 and recites “wherein each of the liquid fuel valve and the gaseous fuel valve comprises a mechanical valve.”

[0122]. The Workshop Manual discloses a liquid fuel valve, Gasoline Cock (5), which is a mechanical valve. §VII.A.2, *supra*. The Workshop Manual discloses LPG Manual Valve (13), which is a mechanical valve. §VII.A.2, *supra*.

[0123]. Workshop Manual also discloses LPG Cut Off Solenoid (7) and LPG Cut Off Solenoid Valve (11), each of which mechanically interrupts the flow of LPG from the LPG fuel source to the carburetor.

[0124]. To the extent LPG Cut Off Solenoid and/or LPG Cut Off Solenoid Valve is not considered a mechanical valve, a POSA would have understood that a mechanical valve can substitute for LPG Cut Off Solenoid and/or LPG Cut Off Solenoid Valve, and would have had a reasonable expectation of success in doing so. A POSA would understand that a mechanical valve and a solenoid valve both will function to mechanically interrupt the flow of LPG. A POSA would have understood that a mechanical valve is less prone to malfunction and does not rely on electrical power to function in fuel flow applications, and can be substituted for solenoid valves in such applications. For example, a POSA would understand that fewer components, reduced cost, possibility of premature

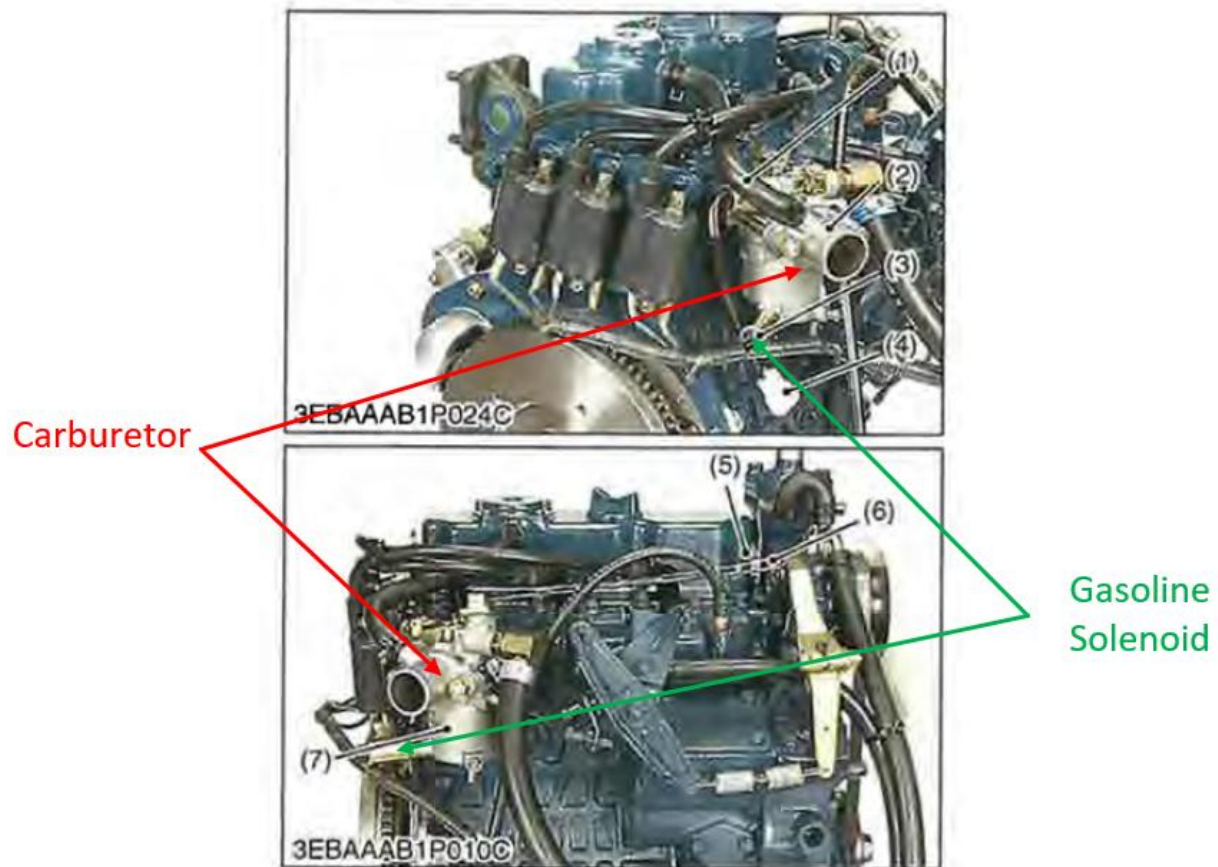
failure (e.g., coil failure), higher maintenance requirements, sensitivity to fluctuations in electrical voltage, and the inability to function without power would be reasons for a POSA to substitute the solenoid valve for the mechanical fuel valve.

[0125]. Accordingly, a POSA would have understood that Workshop Manual teaches claim 3.

4. Claim 4: “The dual fuel generator of claim 2, wherein the liquid fuel cut-off solenoid is attached to the carburetor.”

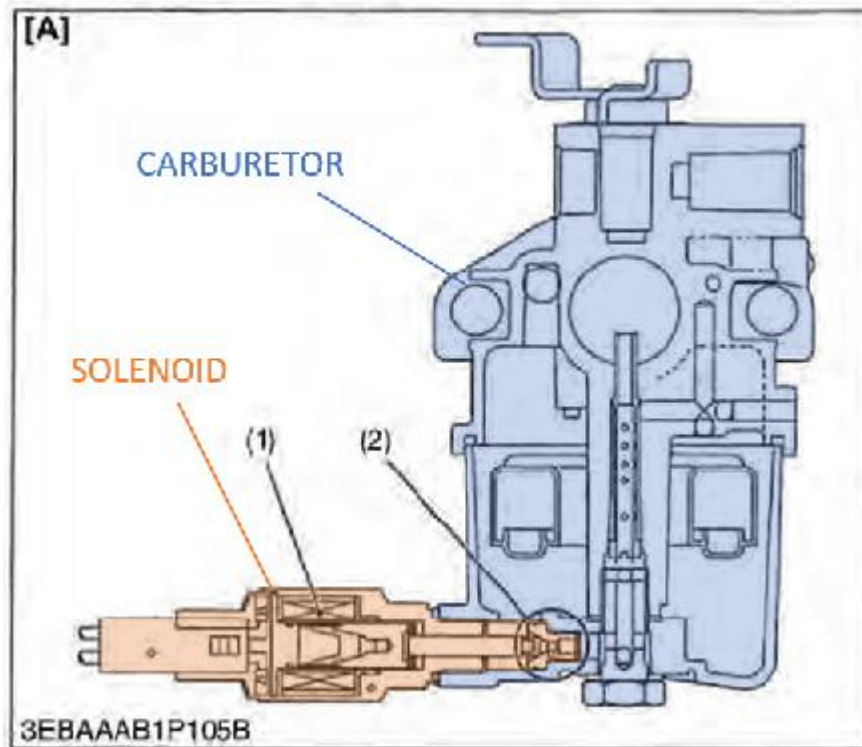
[0126]. Claim 4 depends from Claim 2 and recites “wherein the liquid fuel cut-off is attached to the carburetor.”

[0127]. The Workshop Manual discloses the liquid fuel cut-off (Gasoline Cut Off Solenoid) is attached to the carburetor:



Ex.1009, p.115 (annotated)

[3] SOLENOID



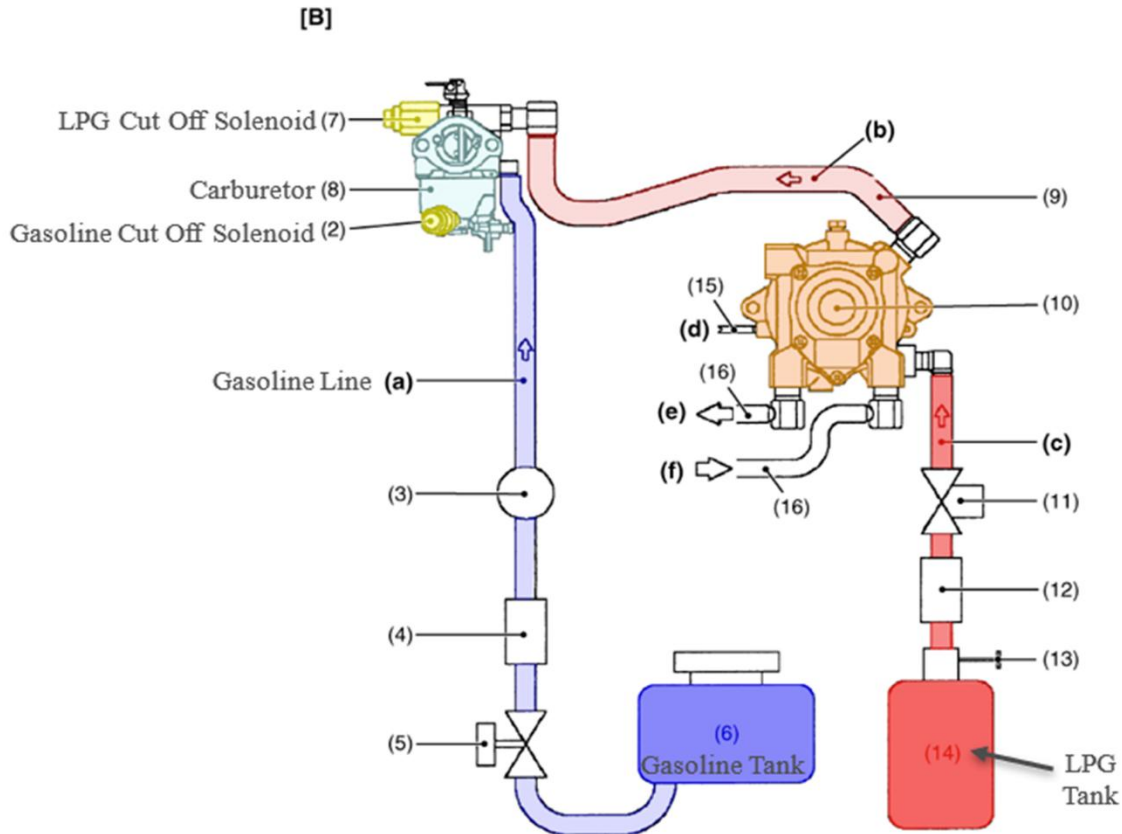
Ex.1009, p.80 (annotated)

[0128]. Accordingly, a POSA would have understood that Workshop Manual teaches claim 4.

5. **Claim 5: “The dual fuel generator of claim 1, wherein the gaseous fuel is LPG and the liquid fuel is gasoline.”**

[0129]. Claim 5 depends from Claim 1 and recites “wherein the gaseous fuel is LPG and the liquid fuel is gasoline.”

[0130]. The Workshop Manual’s dual fuel engine operates on gasoline and LPG:



Ex.1009, 65 (annotated); §VII.A.1.b, *supra*.

[0131]. Accordingly, a POSA would have understood that Workshop Manual teaches claim 3.

8. **Claim 10: “The dual fuel generator of claim 1, wherein the electrical power generator comprises a magneto or an alternator.”**

[0132]. Claim 10 depends from Claim 1 and recites “wherein the electrical power generator comprises a magneto or an alternator.”

[0133]. As discussed (*supra* §VII.A.1.c), the Workshop Manual teaches that the DF-972 engine includes an electrical power generator (i.e. a “rotating magnet type generator”). This rotating magnet type generator is an alternator.

Ex.1009, 77. Accordingly, a POSA would have understood that Workshop Manual teaches claim 10.

B. Ground 2: Claims 6-9 are Rendered Obvious by the Combination of Workshop Manual, Matsushima, and Olmr.

- 1. Claim 6: “The dual fuel generator of claim 1, wherein the switch is an electro-mechanical switch connecting one fuel source to the carburetor and connected to the electrical power generator, and wherein the liquid fuel cut-off solenoid is connected to open and close a fuel path to the engine in response to reception of electrical power from the switch”**

[0134]. Claim 6 depends from Claim 1 and recites “wherein the switch is an electro-mechanical switch connecting one fuel source to the carburetor and connected to the electrical power generator, and wherein the liquid fuel cut-off solenoid is connected to open and close a fuel path to the engine in response to reception of electrical power from the switch.”

[0135]. As discussed (supra §VII.A.1.d), the DF-972’s fuel select switch changes operation of the engine between gaseous fuel and liquid fuel by selectively powering the Gasoline Cut Off and LPG Cut Off solenoids.

Specifically, the fuel select switch is user actuatable and uses a mechanical part to control the flow of electrical current, thus making it an electro-mechanical switch. Because operation of fuel select switch dictates which fuel is supplied to the carburetor, it connects one fuel source to the carburetor. *Id.*

[0136]. As discussed (*supra* §VII.A.1.c), the Workshop Manual discloses an engine with an alternator that provides electrical current to the power consuming circuits in the engine. Because the fuel select switch is an electro-mechanical switch controlling current flow, it is connected to the electrical power generator.

[0137]. Workshop Manual's fuel select switch changes operation of the engine between gaseous fuel and liquid fuel. §VII.A.1.d., *supra*. The fuel select switch is user actuatable and uses a mechanical part to control the flow of electrical current, making it an electro-mechanical switch. Because operation of fuel select switch dictates which fuel is supplied to the carburetor, it connects one fuel source to the carburetor.

[0138]. Workshop Manual's fuel select switch is connected to the electric power generator via the battery. Ex.1009, 68. A POSA would have understood that the fuel select switch could be connected to the generator in the absence of the battery (to power the solenoids), just as Matsushima's components (such as its fluid injection valve 10) are connected to its generator. Ex.1012, FIG. 1, 5:1-48.

[0139]. As discussed (*supra* §VII.A.1.f), the liquid fuel cut off solenoid opens and closes the liquid fuel path upon actuation of the fuel select switch. Also (*supra* §VII.A.1.d), fuel select switch selectively powers the liquid fuel cut off

solenoid via current flow. Thus, the fuel select switch dictates whether the liquid fuel cut off solenoid opens or closes a fuel path to the engine in response to reception of electrical power from the switch.

[0140]. Accordingly, a POSA would have understood that Workshop Manual and Matsushima teaches claim 6.

2. **Claim 7: “The dual fuel generator of claim 6, wherein the switch selectively powers the solenoid valve by controlling electrical connection between the solenoid valve and the electrical power generator.”**

[0141]. Claim 7 depends from Claim 6 and recites “wherein the switch selectively powers the solenoid valve by controlling electrical connection between the solenoid valve and the electrical power generator.”

[0142]. The liquid fuel cut off solenoid opens and closes a fuel path in response to reception of current due to the positioning of the fuel select switch. §VII.B.1, *supra*. As discussed (*supra* §VII.A.6), the liquid fuel cut off solenoid opens and closes a fuel path in response to reception of current due to the positioning of the fuel select switch. Thus, because operation of the liquid fuel cut off solenoid depends on current generated by the rotating magnet type generator which is provided to the battery of the generator (*supra* §VII.A.1.g), the fuel select switch selectively powers the liquid fuel cut off solenoid by controlling the electrical connection between the liquid fuel cut off solenoid and the rotating magnet type generator.

[0143]. Accordingly, a POSA would have understood that the combination of Workshop Manual and Matsushima teaches claim 7.

3. **Claim 8: “The dual fuel generator of claim 1, wherein the liquid fuel cut-off solenoid is normally open to provide liquid fuel to the engine when the liquid fuel cut-off solenoid is unpowered.”**

[0144]. As discussed (*supra* §VII.A.1), Workshop Manual teaches all limitations of claim 1. Claim 8 depends from claim 1 and recites: “wherein the liquid fuel cut-off solenoid is normally open to provide liquid fuel to the engine when the liquid fuel cut-off solenoid is unpowered.”

[0145]. As discussed (*supra* §VII.A.1.f), Workshop Manual discloses a liquid fuel cut-off solenoid. It would have been obvious to a POSA to use Olmr’s solenoid valve 42 in place of Workshop Manual’s liquid fuel cut-off solenoid. Olmr’s solenoid valve is normally open (Ex.1007, 3:43-52), and the decision to configure a solenoid as normally open or normally closed is mere design choice.

[0146]. A POSA would have been motivated to use Olmr’s normally-open solenoid and would have had a reasonable expectation of success in doing so based on the teachings of Olmr:

Electricity is not required to hold the valve in this position during engine starting and normal running. This is a key feature since many small gasoline engines do not utilize a battery or other source of power for starting.

Thus upon commencement of engine operation, a source of electricity is not required as solenoid valve is in the normally open position. In addition, should the valve control circuit fail, the spool valve plunger 45 will fail in the normally open position allowing continued operation of the engine.

Ex.1007, 3:43-52.

[0147]. Accordingly, a POSA would have understood that the combination of Workshop Manual and Olmr teaches claim 8.

2. **Claim 9: “The dual fuel generator of claim 8, wherein the dual fuel generator is a batteryless dual fuel generator and the engine is a pull-start engine, the batteryless dual fuel generator further comprising a pull-starter that drives the electrical power generator to power and close the liquid fuel cut-off solenoid while starting the engine on gaseous fuel.”**

[0148]. Claim 9 depends from claim 8 and recites: “wherein the dual fuel generator is a batteryless dual fuel generator and the engine is a pull-start engine, the batteryless dual fuel generator further comprising a pull-starter that drives the electrical power generator to power and close the liquid fuel cut-off solenoid while starting the engine on gaseous fuel.”

[0149]. Matsushima discloses a batteryless engine including a pull-start (recoil starter 40). Ex.1012, 1:6-11 (“adapted for use in...engines with no battery”), 4:63-5:21.

[0150]. It would have been obvious to a POSA to incorporate

Matsushima's pull-start to supply electrical power in Workshop Manual's engine.

Matsushima's pull-starter drives an electrical power generator to power various components while starting its engine (including its fuel pump, spark plug, and fuel injection valve). Ex.1012, Abstract, 5:1-48. Incorporating Matsushima's pull-starter assembly with Workshop Manual's engine would similarly allow the pull-starter assembly to drive a generator to power and close Workshop Manual's liquid fuel cut-off solenoid while starting the engine on gaseous fuel. *Id.*

[0151]. A POSA would have been motivated to incorporate

Matsushima's pull-starter and would have had a reasonable expectation of success.

Workshop Manual and Matsushima both relate to the same class of small spark-ignition engines that are offered with either battery-dependent electric start or battery-independent recoil (pull) start. Incorporating a pull-start into Workshop Manual's dual-fuel engine and removing the battery would improve reliability in cold or remote applications, reduce cost and weight of the generator.

[0152]. A POSA would have reasonably expected success in adopting

Matsushima's recoil mechanism for use in Workshop Manual's dual-fuel engine.

A POSA would have found it straightforward to mount Matsushima's recoil mechanism on Workshop Manual's engine with only routine mechanical adaptation. As of the earliest priority date of the '145 Patent, the use of recoil

starters was common on small engines. Accordingly, a POSA would have understood that the combination of Workshop Manual and Matsushima teaches claim 9.

C. Ground 3: Claims 1-10 are Rendered Obvious by the Combination of Nakafushi, Matsushima, and Olmr.

1. Motivation to Combine Nakafushi and Matsushima and Reasonable Expectation of Success.

[0153]. Nakafushi and Matsushima both relate to internal combustion engines. §VI.B, *supra*; §VI.D, *supra*. Internal combustion engines, including internal combustion engines operable on propane or gasoline, were well known in the art as of the earliest priority date of the ‘145 Patent. §II.A, *supra*. The use of internal combustion engines in a generator, including internal combustion engines operable on propane or gasoline, also was well known in the art as of the earliest priority date of the ‘145 Patent. Ex.1016, pp.1-31; Ex.1017, p.1. A POSA would have been motivated to combine Nakafushi and Matsushima, and would have had a reasonable expectation of success in combining Nakafushi and Matsushima, because both relate to internal combustion engines, and the use of such engines in a generator was well known as of the earliest priority date of the ‘145 Patent.

2. Claim 1

a. Element [1.0]: “A dual fuel generator comprising:”

[0154]. Nakafushi and Matsushima disclose dual fuel engines. It would have been obvious to a POSA to have implemented a dual fuel engine in a generator, as dual fuel generators were well known as of the earliest priority date of the '145 Patent. Ex.1016, pp.1-31; Ex.1017, p.1

b. Element [1.1]: “an engine operable on a gaseous fuel and a liquid fuel;”

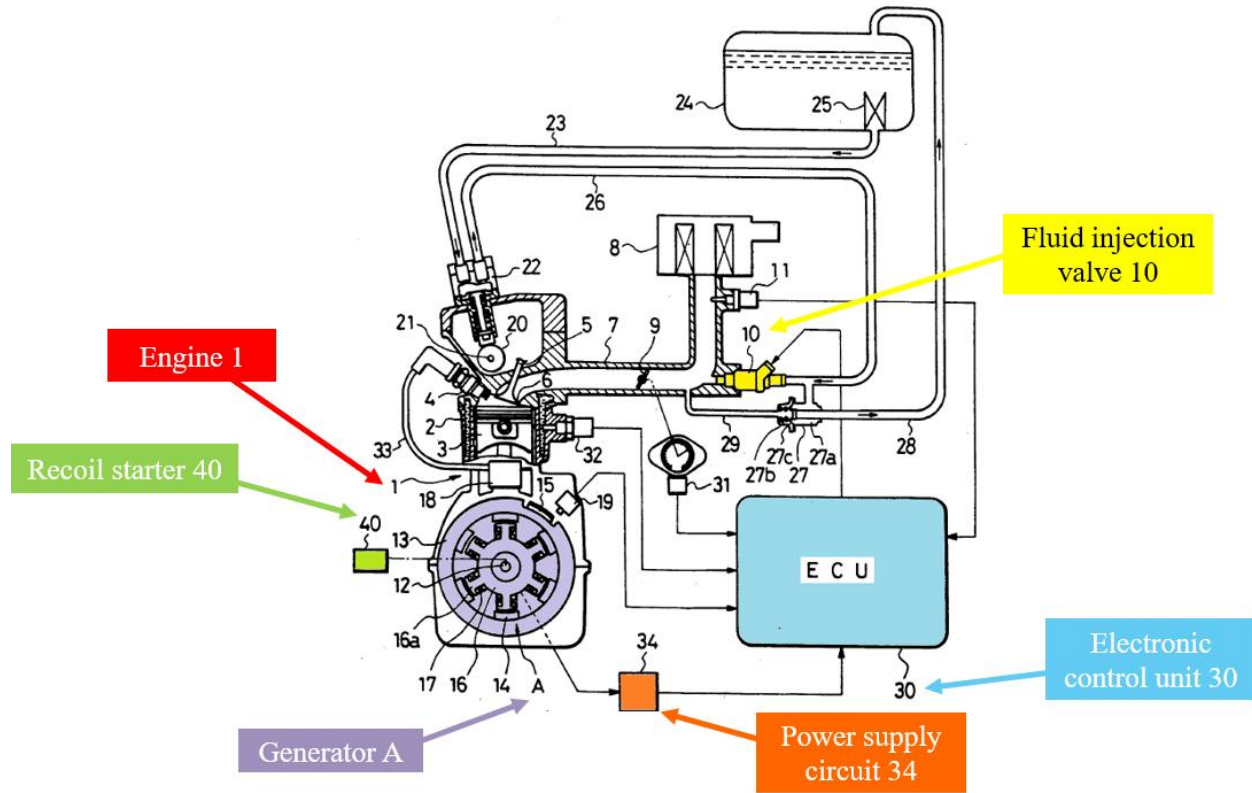
[0155]. Element [1.1] recites “an engine operable on a gaseous fuel and a liquid fuel.”

[0156]. Nakafushi’s engine uses gasoline (a “liquid fuel”) and LPG (a “gaseous fuel”) as fuel. Ex.1005, [0001].

c. Element [1.2]: “an electrical power generator driven by the engine and comprising a charging coil;”

[0157]. Element [1.2] recites “an electrical power generator driven by the engine and comprising a charging coil.”

[0158]. Matsushima discloses “AC generator A,” shown in FIG. 1 below:



Ex.1012, FIG. 1 (annotated), 3:53-66.

[0159]. Generator A comprises flywheel 13 as a rotor having six first magnets 14 mounted on the inner peripheral surface of flywheel 13, and stator core 16 having six projections 16a and windings 17 wound around the respective projections 16a. Ex.1012, 3:53-66. The first magnets 14, the stator core 16, and the windings 17 of the generator A form a power supply unit. Id. Flywheel 13 is rigidly fixed to the crankshaft 12 of engine 1. Id. Flywheel 13 is rotated with the rotation of crankshaft 12, generating a voltage across the windings by rotation of flywheel 13. Ex.1012, 5:13-18. Accordingly, a POSA would have understood that

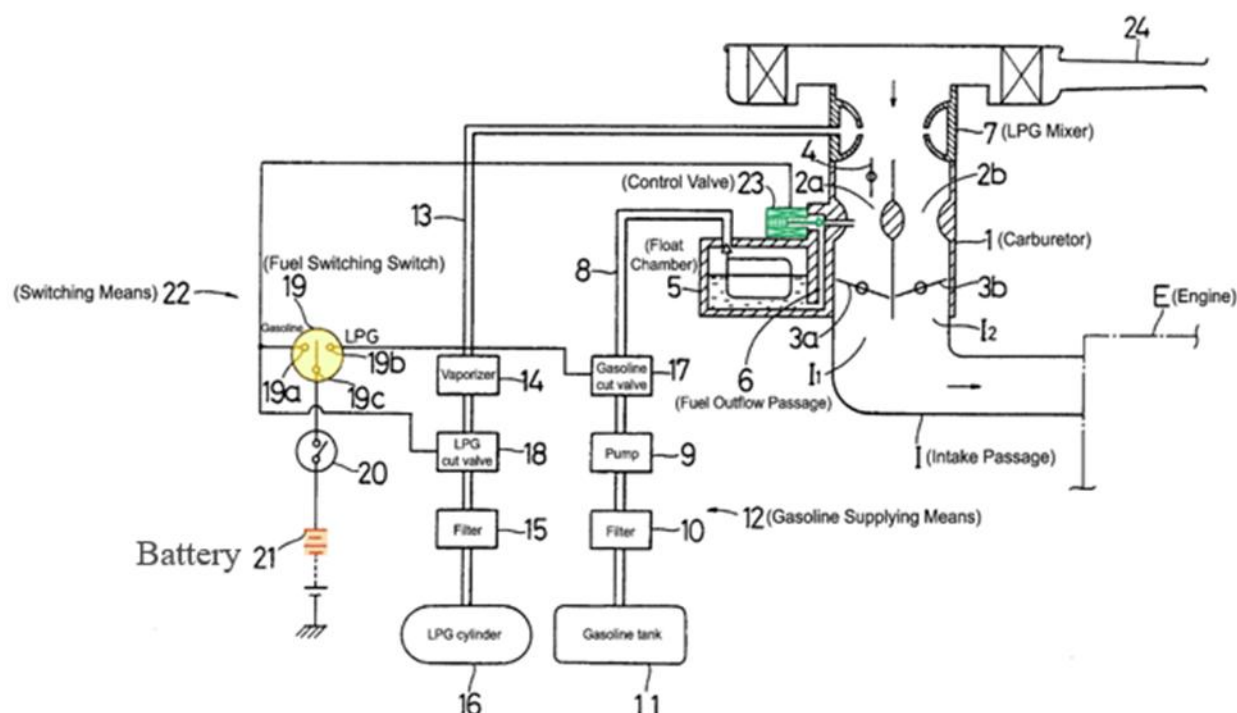
generator A is “an electrical power generator driven by the engine and comprising a charging coil” as recited in [1.2].

d. Element [1.3]: “a switch to change operation of the engine between gaseous fuel and liquid fuel;”

[0160]. Element [1.3] recites “a switch to change operation of the engine between gaseous fuel and liquid fuel.”

[0161]. Nakafushi discloses “fuel switching switch 19” that changes operation of the engine between gaseous fuel and liquid fuel. Ex.1005, [0013]. Specifically, the switch 19 has a “gasoline-side contact point 19a and an LPG side contact point 19b,” and Nakafushi teaches that “the control valve 23 is connected to the gasoline contact point 19a of the fuel switching switch 19” and that LPG cut valve 18 and gasoline cut valve 17 are “connected to a gasoline-side contact point 19a and an LPG side contact point 19b of [switch 19], respectively.” *Id.*, [0013]-[0014]. These elements are highlighted in FIG. 1 below:

FIG. 1



Id., FIG. 1 (annotated).

[0162]. Nakafushi discloses that when switch 19 is switched to the gasoline contact point 19a side, a cut signal is sent to the LPG cut valve 18 and simultaneously, control valve 23 receives a signal to open. Ex.1005, [0013]-[0014]. In contrast, when fuel switch 19 is switched to the LPG contact point 19b side, the reverse occurs where a cut signal is sent to the gasoline cut valve 17 to stop gasoline flow while the LPG valve 18 is opened. *Id.* Thus, movement of switch 19 allows for simultaneous operation of control valves 17, 18, and 23, which in turn changes operation of the engine between gaseous fuel and liquid fuel. *Id.*

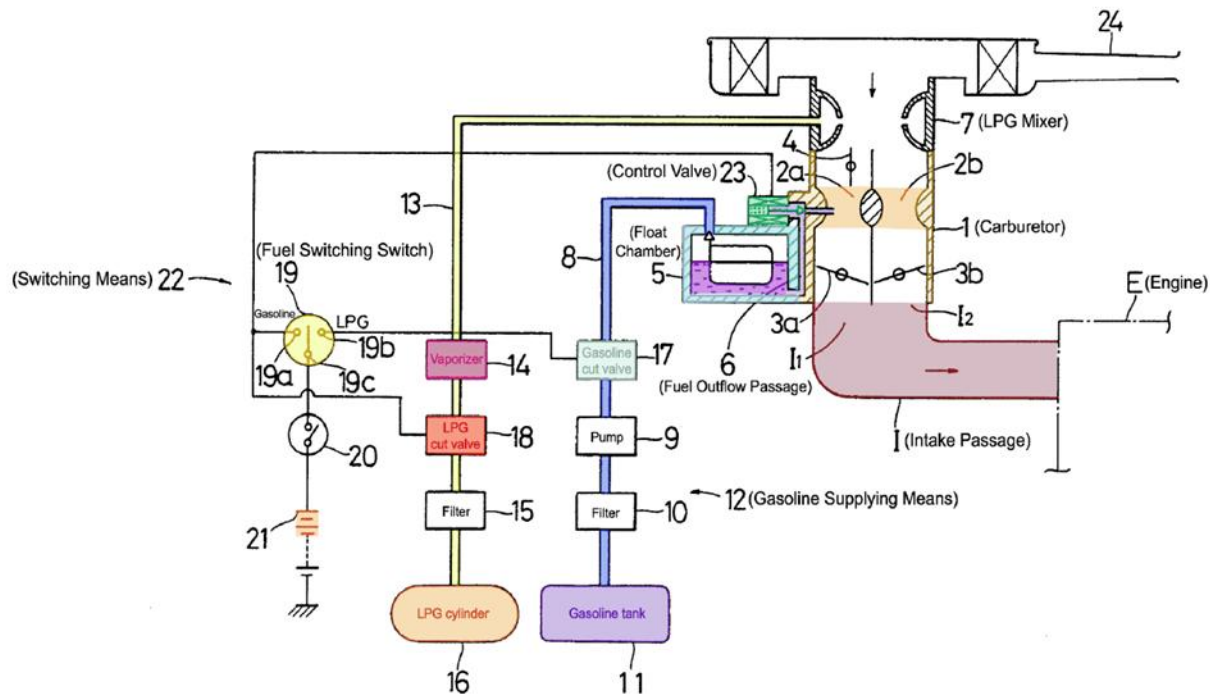
[0163]. Accordingly, a POSA would have understood that Nakafushi teaches [1.3].

e. Element [1.4]: “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;”

[0164]. Element [1.4] recites “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.”

[0165]. Nakafushi discloses carburetor 1 attached to the intake of the engine E, as seen in FIG. 1 below:

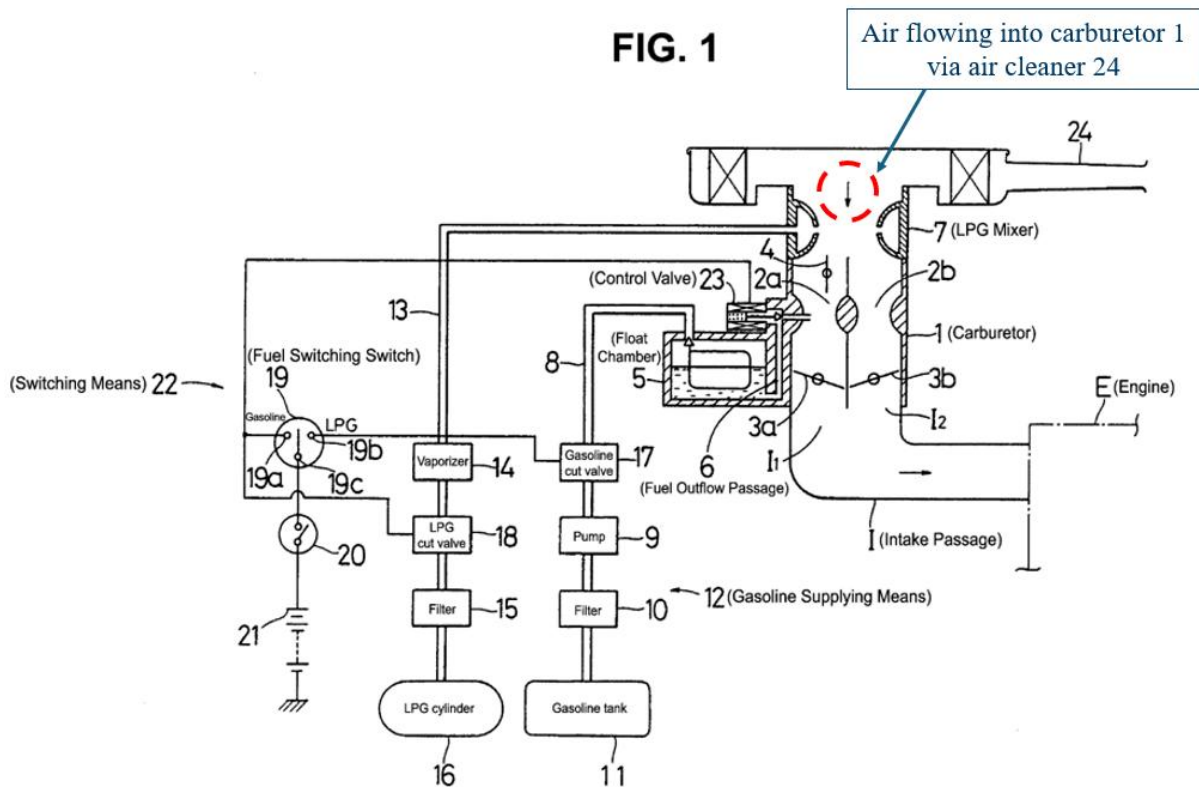
FIG. 1



Ex.1005, FIG. 1 (annotated).

[0166]. Nakafushi states “E denotes an engine with a specification of an existing carburetor, I denotes an intake passage connected to the engine E, and a two-barrel type carburetor 1 is disposed in the intake passage I.” Ex.1005, [0010]. The intake passage I of Nakafushi’s carburetor 1 has venturi portions 2a and 2b. *Id.*

[0167]. Nakafushi discloses air flowing into carburetor 1 through air cleaner 24 to mix with gasoline or LPG in venturi portions 2a and 2b, as seen in FIG. 1:



Id., FIG. 1 (annotated), [0015].

[0168]. A POSA would have understood that engines such as those disclosed in Nakafushi operated by mixing fuel (either gasoline or LPG in the case

of Nakafushi) with air prior to combustion in the engine, as confirmed by Nakafushi's numerous references to the "air-fuel ratio" in regard to gasoline (and/or LPG) being mixed with air. *Id.*, [0004]-[0005], [0008], [0016]. A POSA would have recognized Nakafushi's disclosure of a dual fuel engine that mixed air with the gaseous fuel (i.e., LPG) or liquid fuel (i.e., gasoline) in the carburetor, which is attached to the intake for delivery to the engine.

[0169]. Accordingly, a POSA would have understood that Nakafushi teaches carburetor 1 attached to an intake of the engine to mix air and fuel, that thereby connects the gaseous fuel source and the liquid fuel source, as recited in Element [1.4].

f. Element [1.5]: "a liquid fuel cut-off solenoid to interrupt liquid fuel flow to the engine upon actuation of the switch from liquid fuel to gaseous fuel; and"

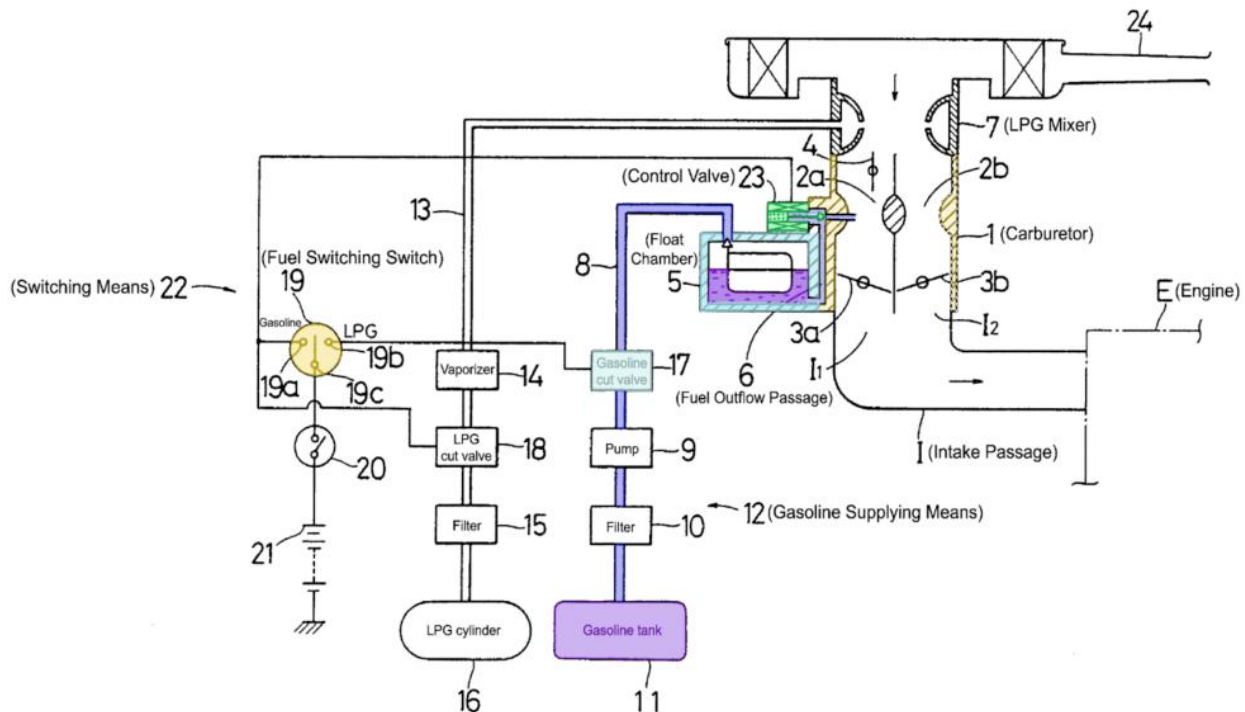
[0170]. Element [1.5] recites "a liquid fuel cut-off solenoid to interrupt liquid fuel flow to the engine upon actuation of the switch from liquid fuel to gaseous fuel."

[0171]. Nakafushi discloses two structures, gasoline cut valve 17 and control valve 23 (Ex.1005, [0013]-[0014], FIG. 1), each of which is a "liquid fuel cut-off." Nakafushi explains that "gasoline cut valve 17 [is] configured to close the gasoline supplying passage 8 in response to a cut signal" and "control valve 23

[is] configured to open and close the fuel outflow passage 6...so as to intervene in the fuel outflow passage 6.” Ex.1005, [0013]-[0014].

[0172]. Nakafushi’s gasoline supplying passage 8 connects the gasoline tank 11 to float chamber 5. *Id.*, [0012]. Nakafushi’s fuel outflow passage 6 connects the float chamber 5 to the carburetor’s venturi portions 2a and 2b, with the fuel outflow passage 6 downstream of the float chamber 5. *Id.*, [0010]. Gasoline supplying passage 8 and fuel outflow passage 6 both are on the path by which gasoline flows from gasoline tank 11 to the engine. This arrangement is shown in FIG. 1:

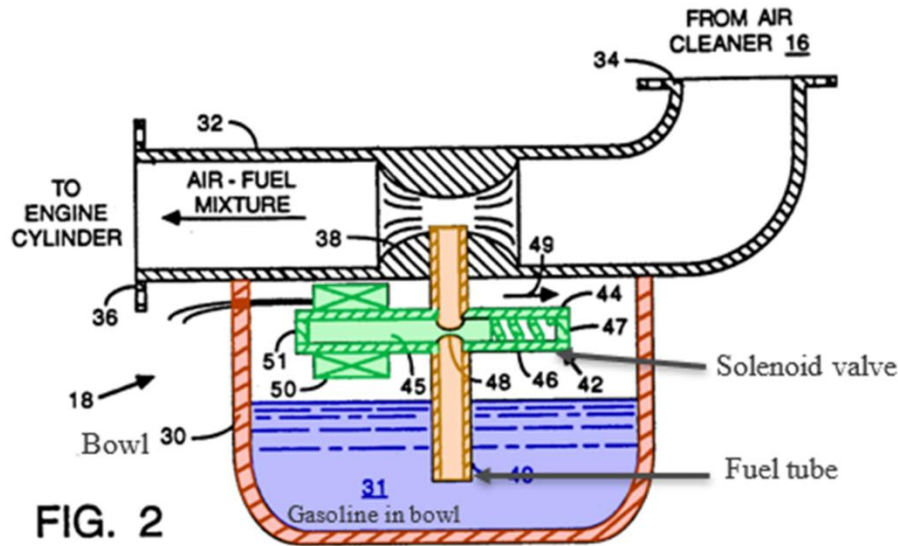
FIG. 1



Id., FIG. 1 (annotated)

[0173]. As discussed, (supra §VII.C.2.d), the fuel switching switch 19 changes operation of the engine between gaseous fuel and liquid fuel by selectively powering control valve 23 and LPG cut valve 18 and gasoline cut valve 17. The switch opens control valve 23 and gasoline cut valve 17, and closes the LPG valve 18 during gasoline operation, and vice versa for LPG operation. Ex.1005, [0013]-[0014]. Thus, upon actuation of the switch from liquid fuel to gaseous fuel, gasoline cut valve 17 and control valve 23 closes to interrupt liquid fuel.

[0174]. To the extent Nakafushi does not disclose that gasoline cut valve 17 and/or control valve 23 comprises a “solenoid,” it would have been obvious to a POSA to use a solenoid in view of Olmr. Olmr discloses a gasoline engine having solenoid 42 in a float bowl 30 that cuts off the flow of gasoline to the venturi 38 when the operator closes the kill switch. Ex.1007, 2:30-68, 4:11-27. Olmr’s FIG. 2 shows:



Ex.1007, FIG. 2 (annotated)

[0175]. Olmr's valve 42 is a solenoid connected to open and close a fuel path to the engine via venturi 38.

[0176]. A POSA would have found it obvious to use a solenoid, such as that disclosed by Olmr, for Nakafushi's gasoline cut valve 17 and/or control valve 23, as discussed below.

(1) Motivation to Combine

[0177]. A POSA would have been motivated to combine Nakafushi and Olmr. Nakafushi and Olmr both relate to gasoline engines and both seek to prevent the flow of gasoline from the float bowl to the engine intake upon cessation of gasoline operation of the engine. In Nakafushi, gasoline cut valve 17 and control valve 23 cuts the gasoline flow when the operation of the engine is

switched from gasoline to LPG. Nakafushi does not expressly label the type of valve is used, but Olmr expressly teaches using a solenoid (valve 42) for this same purpose. Ex.1007, 2:30-56; 1:33-36, FIG. 2. Olmr teaches an express example—a solenoid valve—for accomplishing the same function taught by Nakafushi, i.e., cutting gasoline flow when needed. It would have been a simple substitution to incorporate Olmr’s solenoid valve to accomplish the same function in Nakafushi.

(2) Reasonable Expectation of Success

[0178]. A POSA would have reasonably expected success in using Olmr’s solenoid valve 42 as Nakafushi’s gasoline cut valve 17 and/or control valve 23. As of the earliest priority date of the ‘145 Patent, the use of solenoid valves to cut off/control the flow of fuel was common, with Olmr being just one example.

[0179]. Furthermore, Nakafushi discloses a simple electrical circuit to open and close gasoline cut valve 17 and control valve 23 (Ex.1005, [0013]-[0014], FIG. 1), which a POSA would have recognized as being suitable to energize a solenoid valve, such as Olmr’s solenoid valve 43, to open and close the fuel pathway. Indeed, Olmr teaches an essentially identical electrical circuit for operating its solenoid valve. Ex.1007, 2:57-4:27, FIGS. 2-3. A POSA would have therefore reasonably expected that Olmr’s solenoid valve could be successfully implemented to serve as Nakafushi’s gasoline cut valve 17 and/or control valve 23

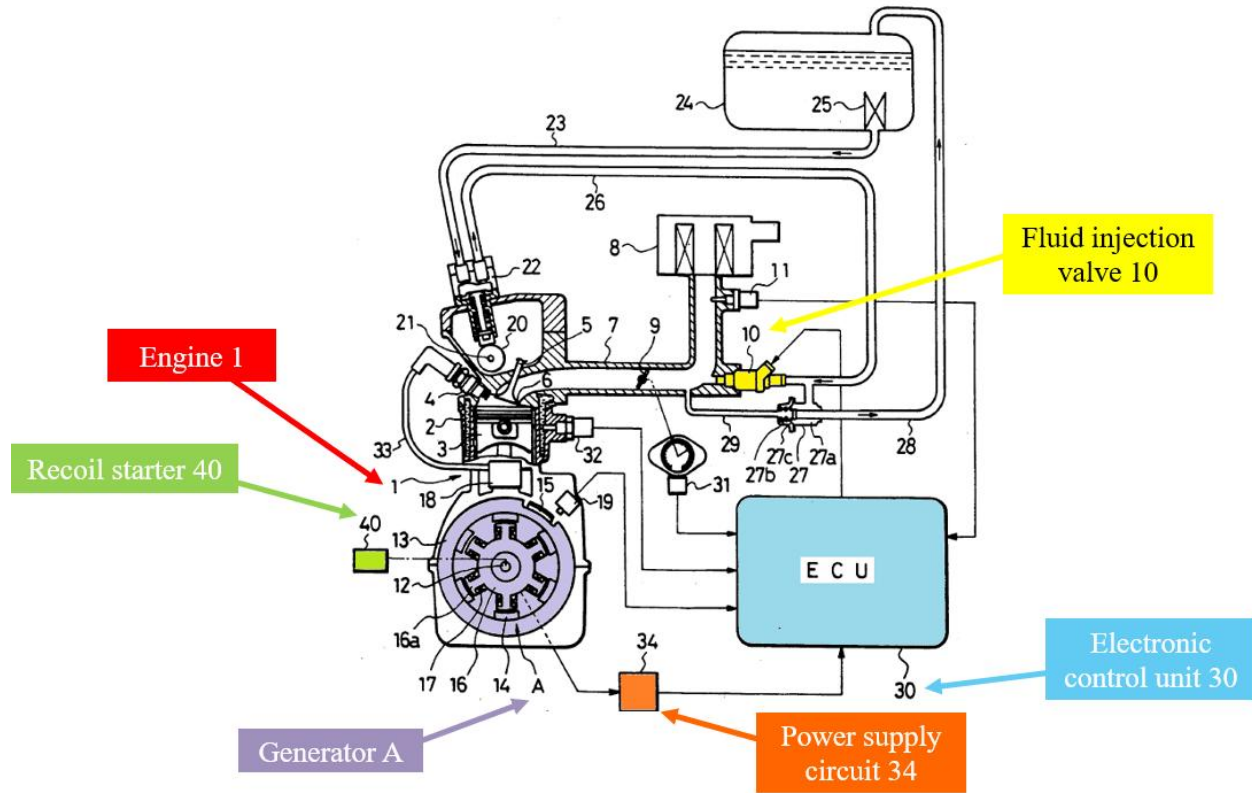
to accomplish the desired function of cutting off the supply of gasoline from Nakafushi's float chamber 5 to the intake of the engine.

[0180]. Accordingly, a POSA would have understood that the combination of Nakafushi and Olmr teaches [1.5].

g. Element [1.6]. “a voltage regulator coupled to the charging coil to receive power therefrom and that operates to provide a regulated voltage to the liquid fuel cut-off solenoid.”

[0181]. Element [1.6] recites “a voltage regulator coupled to the charging coil to receive power therefrom and that operates to provide a regulated voltage to the liquid fuel cut-off solenoid.”

[0182]. Matsushima's generator includes magnets mounted on the flywheel, a stator core, and a plurality of windings wound on the stator core and disposed to face the magnets during rotation of the flywheel, making Matsushima's generator an alternator. Ex.1012, 2:35-40. Matsushima discloses generator A is connected to “a power supply circuit 34 for rectifying, smoothing and stabilizing output voltage” from the generator. Ex.1012, 43-62; FIG. 1.



Ex.1012, FIG. 1 (annotated).

[0183]. Because the power supply stabilizes the output voltage from the alternator, it is a voltage regulator. A voltage regulator is a common component in power supply systems, designed to maintain a smooth and consistent output voltage despite fluctuations in input. Recognizing the potential variations in output voltage from the alternator or charging coil—and their adverse impact on the performance of the fuel cut-off solenoid valve—a POSA would be motivated to seek a regulated solution. When combined with Nakafushi's engine, the POSA would understand that Matsushima's alternator and power supply circuit 34 would

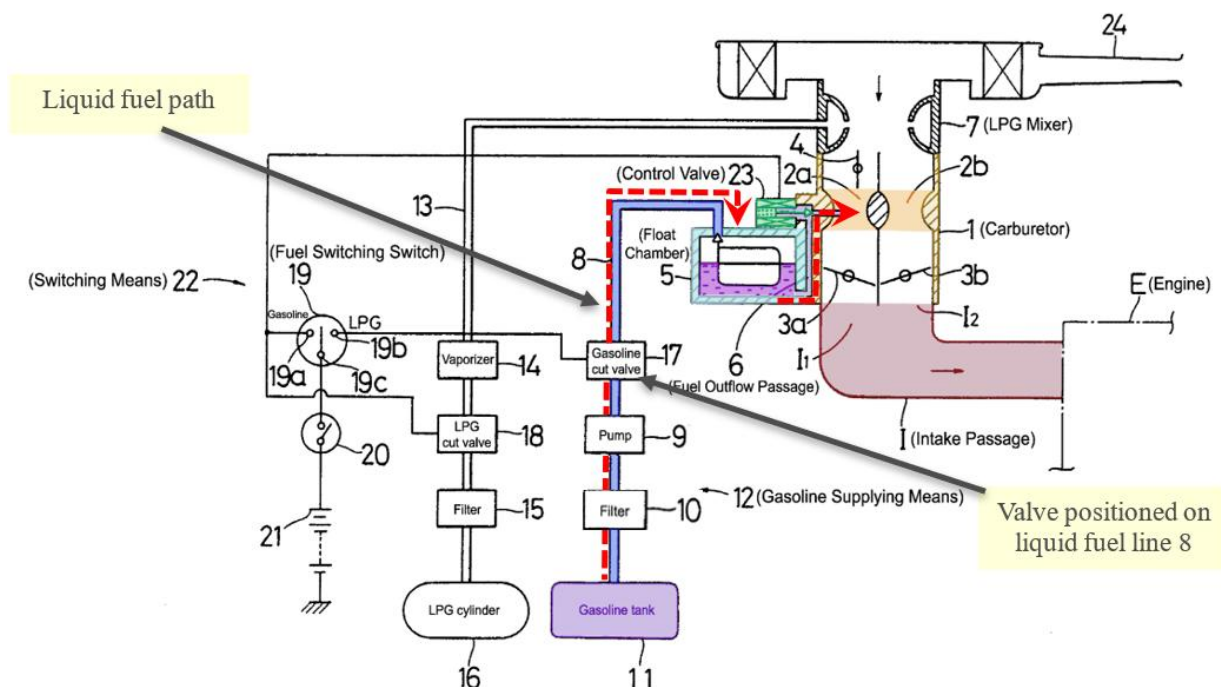
provide a regulated smooth voltage to Nakafushi's gasoline cut valve 17 and/or control valve 23 (each solenoid when combined with Olmr), as recited in [1.6].

3. **Claim 2: “The dual fuel generator of claim 1 further comprising: a liquid fuel valve along a liquid fuel line coupling the liquid fuel source to the carburetor; and a gaseous fuel valve along a gaseous fuel line coupling the gaseous fuel source to the carburetor.”**

[0184]. Claim 2 depends from claim 1 and recites “a liquid fuel valve along a liquid fuel line coupling the liquid fuel source to the carburetor; and a gaseous fuel valve along a gaseous fuel line coupling the gaseous fuel source to the carburetor.”

[0185]. Nakafushi discloses a liquid fuel valve (gasoline cut valve 17) “configured to close the gasoline supplying passage 8 in response to a cut signal...to intervene between the float chamber 5 and the pump 9.” Ex.1005, [0013]. FIG. 1 shows gasoline cut valve 17 positioned on the gasoline supply passage 8, which begins at the gasoline tank 11, leading to float chamber 5, which in turn is connected to carburetor 1 through fuel outflow passage 6, as illustrated below:

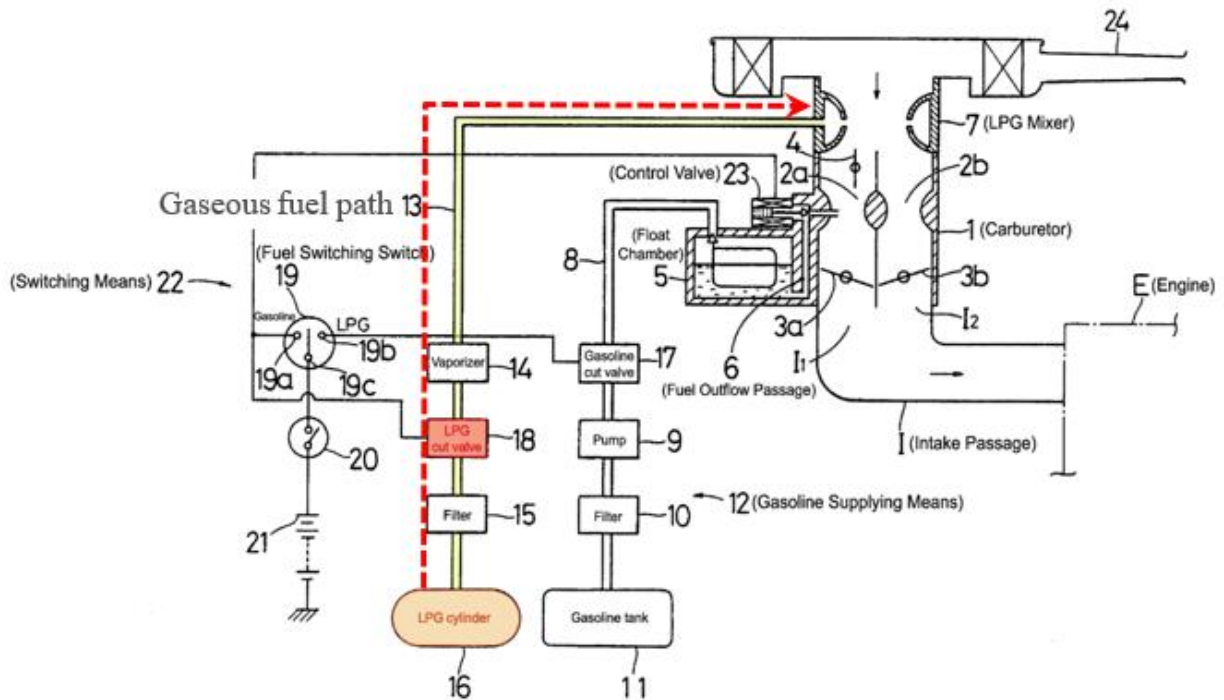
FIG. 1



Id., FIG. 1 (annotated).

[0186]. Nakafushi discloses a gaseous fuel valve (LPG cut valve 18) “configured to close the LPG supplying passage 13 in response to a cut signal...to intervene between the vaporizer 14 and the filter 15.” Ex.1005, [0013]. FIG. 1 shows LPG cut valve 18 positioned on the LPG supplying passage 13, which begins at the LPG cylinder 16, leading to vaporizer 14, which in turn is connected to carburetor 1, as illustrated below:

FIG. 1



Id., Fig. 1 (annotated).

[0187]. Accordingly, a POSA would have understood that the combination of Nakafushi, Matsushima, and Olmr teaches claim 2.

4. **Claim 3: “The dual fuel generator of claim 2, wherein each of the liquid fuel valve and the gaseous fuel valve comprises a mechanical valve.”**

[0188]. Claim 3 depends from Claim 2 and recites “wherein each of the liquid fuel valve and the gaseous fuel valve comprises a mechanical valve.”

[0189]. Nakafushi discloses a liquid fuel valve (gasoline cut valve 17), which mechanically interrupts the flow of gasoline to the carburetor. §VII.C.3,

supra. As discussed (*supra*, §VII.A.3) to the extent gasoline cut valve 17 is not considered a mechanical valve, a POSA would have understood that a mechanical valve can substitute for gasoline cut valve 17, and would have had a reasonable expectation of success in doing so.

[0190]. Nakafushi discloses a gaseous fuel valve (LPG cut valve 18), which mechanically interrupts the flow of LPG to the carburetor. §VII.C.3, *supra*. As discussed (*supra*, §VII.A.3) to the extent LPG cut valve 18 is not considered a mechanical valve, a POSA would have understood that a mechanical fuel valve can be substituted for LPG cut valve 18, and would have had a reasonable expectation of success in doing so.

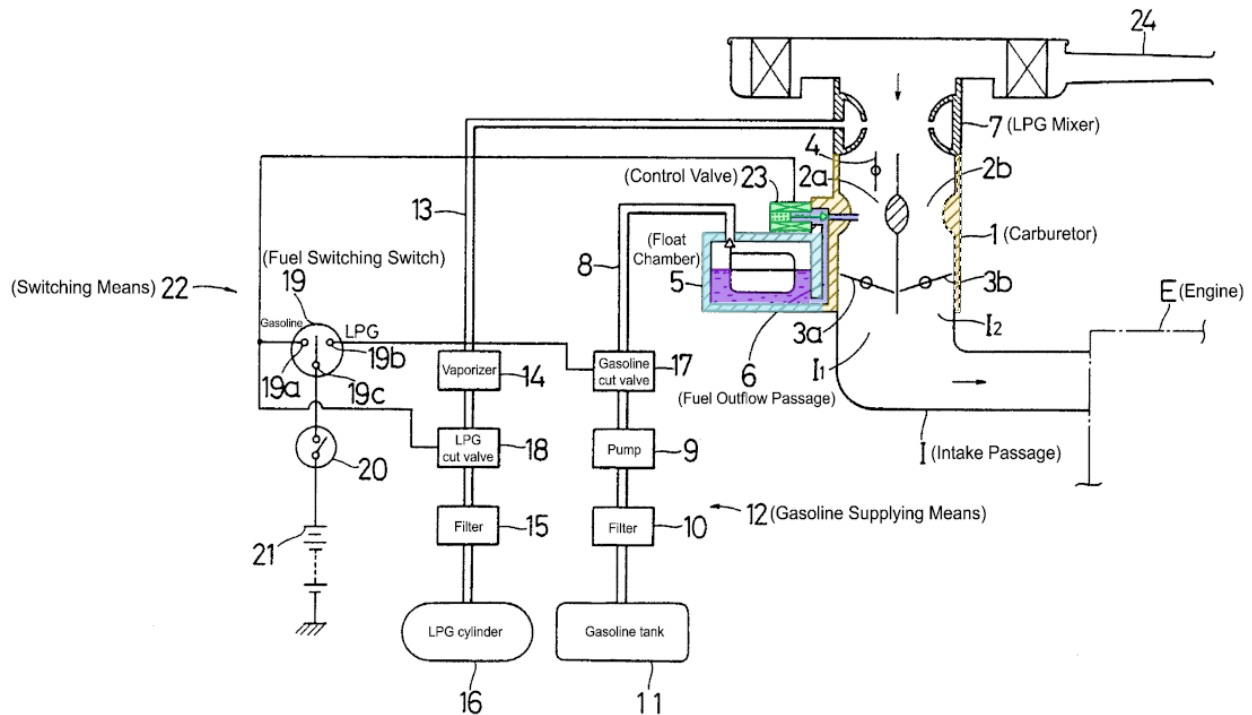
[0191]. Accordingly, a POSA would have understood that the combination of Nakafushi, Matsushima, and Olmr teaches claim 3.

5. Claim 4: “The dual fuel generator of claim 2, wherein the liquid fuel cut-off solenoid is attached to the carburetor.”

[0192]. Claim 4 depends from Claim 2 and recites “wherein the liquid fuel cut-off solenoid is attached to the carburetor.”

[0193]. Nakafushi’s FIG. 1 discloses a liquid fuel cut-off solenoid, control valve 23 (a solenoid when combined with Olmr), that is attached to the carburetor:

FIG. 1



Ex.1005, FIG. 1 (annotated).

[0194]. Accordingly, a POSA would have understood that the combination of Nakafushi, Matsushima, and Olmr teaches claim 4.

6. Claim 5: “The dual fuel generator of claim 1, wherein the gaseous fuel is LPG and the liquid fuel is gasoline.”

[0195]. Claim 5 depends from Claim 1 and recites “wherein the gaseous fuel is LPG and the liquid fuel is gasoline.”

[0196]. Nakafushi states “[t]he present invention relates to a gasoline-LPG combined engine configured to selectively use gasoline or LPG as a fuel.”

Ex.1005, [0001]. Accordingly, a POSA would have understood that the combination of Nakafushi, Matsushima, and Olmr teaches claim 5.

7. **Claim 6: “The dual fuel generator of claim 1, wherein the switch is an electro-mechanical switch connecting one fuel source to the carburetor and connected to the electrical power generator, and wherein the liquid fuel cut-off solenoid is connected to open and close a fuel path to the engine in response to reception of electrical power from the switch”**

[0197]. Claim 6 depends from Claim 1 and recites “wherein the switch is an electro-mechanical switch connecting one fuel source to the carburetor and connected to the electrical power generator, and wherein the liquid fuel cut-off solenoid is connected to open and close a fuel path to the engine in response to reception of electrical power from the switch.”

[0198]. As noted (supra §VII.C.2.d), the fuel switching switch 19 changes operation of the engine between gaseous fuel and liquid fuel by selectively powering control valve 23 and LPG cut valve 18, or gasoline cut valve 17. The switch 19 is user actuatable and moves mechanically between the contacts and operates by altering cut signals (i.e., electrical currents), making it an electro-mechanical switch. Because operation of switch 19 dictates which fuel is supplied to the carburetor, it connects one fuel source to the carburetor. *Id.*

[0199]. Nakafushi’s fuel selecting switch 19 is connected to battery 21. Ex.1009, 68. A POSA would have understood that the fuel selecting switch could be connected to the generator in the absence of the battery (to power the

solenoids), just as Matsushima's components (such as its fluid injection valve 10) are connected to its generator. Ex.1012, FIG. 1, 5:1-48.

[0200]. As discussed (supra §VII.C.2.f), the gasoline cut off solenoid opens and closes the liquid fuel path upon actuation of the fuel select switch. Also (supra §VII.C.2.d), fuel select switch selectively powers the gasoline cut off solenoid via current flow. Thus, the fuel select switch dictates whether the gasoline cut off solenoid opens or closes a fuel path to the engine in response to reception of electrical power from the switch. a POSA would have understood that the combination of Nakafushi, Matsushima, and Olmr teaches claim 6.

8. Claim 7: “The dual fuel generator of claim 6, wherein the switch selectively powers the solenoid valve by controlling electrical connection between the solenoid valve and the electrical power generator.”

[0201]. Claim 7 depends from claim 6 and recites: “wherein the switch selectively powers the solenoid valve by controlling electrical connection between the solenoid valve and the electrical power generator.”

[0202]. As discussed (supra §VII.C.7), Nakafushi's control valve 23 (a solenoid when combined with Olmr) opens and closes a fuel path in response to reception of electrical current from the fuel switching switch 19. Thus, Nakafushi's switch 19 would selectively power control valve 23 by controlling the electrical current between the control valve 23 and Matsushima's generator.

Accordingly, a POSA would have understood that the combination of Nakafushi, Matsushima, and Olmr teaches claim 7.

9. Claim 8: “The dual fuel generator of claim 1, wherein the liquid fuel cut-off solenoid is normally open to provide liquid fuel to the engine when the liquid fuel cut-off solenoid is unpowered.”

[0203]. Claim 8 depends from claim 1 and recites: “wherein the liquid fuel cut-off solenoid is normally open to provide liquid fuel to the engine when the liquid fuel cut-off solenoid is unpowered.”

[0204]. Gasoline cut valve 17 of Nakafushi is normally open. Ex.1005, [0013], FIG. 1. As discussed (*supra* §VII.C.2.f) it would have been obvious to a POSA to use Olmr’s solenoid valve 42 as Nakafushi’s gasoline cut valve 17. Olmr’s solenoid valve also is normally open (Ex.1007, 3:43-52).

[0205]. The control valve 23 of Nakafushi is normally closed. Ex.1005, [0014], FIG. 1. As discussed (*supra* §VII.C.2.f), it would have been obvious to a POSA to use Olmr’s solenoid valve 42 as Nakafushi’s control valve 23. Olmr’s solenoid valve is normally open (Ex.1007, 3:43-52), and the decision to configure a solenoid as normally open or normally closed is mere design choice.

[0206]. A POSA would have been motivated to use Olmr’s normally-open solenoid rather than a normally-closed solenoid based on the express teachings of Olmr. *Supra*, §VII.B.1.

[0207]. A POSA would have had a reasonable expectation of success in replacing Nakafushi's normally-closed solenoid with the normally-open solenoid of Olmr because it would have involved a simple substitution and a rewiring of Nakafushi's switch and both types (normally-closed and normally-open) were routinely used at the time of the invention. *Id.*

[0208]. Accordingly, a POSA would have understood that the combination of Nakafushi, Matsushima, and Olmr teaches claim 8.

10. Claim 9: “The dual fuel generator of claim 8, wherein the dual fuel generator is a batteryless dual fuel generator and the engine is a pull-start engine, the batteryless dual fuel generator further comprising a pull-starter that drives the electrical power generator to power and close the liquid fuel cut-off solenoid while starting the engine on gaseous fuel.”

[0209]. Claim 9 depends from claim 8 and recites: “wherein the dual fuel generator is a batteryless dual fuel generator and the engine is a pull-start engine, the batteryless dual fuel generator further comprising a pull-starter that drives the electrical power generator to power and close the liquid fuel cut-off solenoid while starting the engine on gaseous fuel.”

[0210]. As discussed (*supra* §VII.C.1), a POSA would have been motivated to combine Nakafushi and Matsushima, and would have had a reasonable expectation of success in combining Nakafushi and Matsushima.

[0211]. Matsushima discloses a batteryless engine including a pull-start (recoil starter 40). Ex.1012, 1:6-11 (“adapted for use in...engines with no battery”), 4:63-5:21. It would have been obvious to a POSA to incorporate Matsushima’s pull-start to supply electrical power in place of Nakafushi’s battery.

[0212]. Matsushima’s pull-starter drives an electrical power generator to power various components while starting its engine (including its fuel pump, spark plug and fuel injection valve). Ex.1012, Abstract, 5:1-48. Incorporating Matsushima’s pull-starter assembly with Nakafushi’s engine would similarly allow the pull-starter assembly to drive a generator to power and close Nakafushi’s control valve 23 and/or gasoline cut valve 17 (each a solenoid when combined with Olmr) while starting the engine on gaseous fuel. *Id.*

[0213]. A POSA would have been motivated to incorporate Matsushima’s pull-start and would have had a reasonable expectation of success Nakafushi and Matsushima both relate to the same class of small spark-ignition engines that are offered with either battery-dependent electric start or battery-independent recoil (pull) start. Incorporating a pull-start into Nakafushi’s dual fuel engine and removing the battery would improve reliability in cold or remote applications and reduce costs and weight of the generator.

[0214]. A POSA would have reasonably expected success in adopting Matsushima’s recoil mechanism for use in Nakafushi’s dual fuel engine. A POSA

would have found it straightforward to mount Matsushima's recoil mechanism on Nakafushi's engine with only routine mechanical adaptation. At the time of the invention, the use of recoil starters was common on small engines, and their installation required only routine mechanical tasks.

[0215]. Accordingly, a POSA would have understood that the combination of Nakafushi, Matsushima, and Olmr teaches claim 9.

11. Claim 10: "The dual fuel generator of claim 1, wherein the electrical power generator comprises a magneto or an alternator."

[0216]. Claim 10 depends from claim 1 and recites: "wherein the electrical power generator comprises a magneto or an alternator."

[0217]. Matsushima's generator includes magnets mounted on the flywheel, a stator core, and a plurality of windings wound on the stator core and disposed to face the magnets during rotation of the flywheel, making Matsushima's generator an alternator. Ex.1012, 2:35-40. Accordingly, a POSA would have understood that the combination of Nakafushi, Matsushima, and Olmr teaches claim 10.

D. Ground 4: Claims 1-5 and 8-10 are Rendered Obvious by the Combination of Holzapfel, Matsushima, and Olmr.

1. Motivation to Combine Holzapfel and Matsushima and Reasonable Expectation of Success.

[0218]. Holzapfel and Matsushima both relate to internal combustion engines. §VI.C, *supra*; §VI.D, *supra*. Internal combustion engines, including internal combustion engines operable on propane or gasoline, were well known in the art as of the earliest priority date of the ‘145 Patent. §II.A, *supra*. The use of internal combustion engines in a generator, including internal combustion engines operable on propane or gasoline, also was well known in the art as of the earliest priority date of the ‘145 Patent. Ex.1016, pp.1-31; Ex.1017, p.1. A POSA would have been motivated to combine Holzapfel and Matsushima, and would have had a reasonable expectation of success in combining Holzapfel and Matsushima, because both relate to internal combustion engines, and the use of such engines in a generator was well known as of the earliest priority date of the ‘145 Patent.

2. Claim 1

a. Element [1.0]: “A dual fuel generator comprising:”

[0219]. Holzapfel and Matsushima disclose dual fuel engines. It would have been obvious to a POSA to have implemented a dual fuel engine in a generator, as dual fuel generators were well known as of the earliest priority date of the ‘145 Patent. Ex.1016, pp.1-31; Ex.1017, p.1.

b Element [1.1]: “an engine operable on a gaseous fuel and a liquid fuel;”

[0220]. Element [1.1] recites “an engine operable on a gaseous fuel and a liquid fuel.”

[0221]. The engine of Holzapfel is configured to operate on a gaseous fuel and on a liquid fuel. Ex.1008, 1:1-5.

c. Element [1.2]: “an electrical power generator driven by the engine and comprising a charging coil;”

[0222]. Element [1.2] recites “an electrical power generator driven by the engine and comprising a charging coil.”

[0223]. As discussed (§VII.C.2.c), a POSA would have understood that Matsushima discloses “an electrical power generator driven by the engine and comprising a charging coil” as recited in [1.2].

d. Element [1.3]: “a switch to change operation of the engine between gaseous fuel and liquid fuel;”

[0224]. Element [1.3] recites “a switch to change operation of the engine between gaseous fuel and liquid fuel.”

[0225]. Holzapfel discloses a “rod or wire 47” that changes operation of the engine between gaseous fuel and liquid fuel. Ex.1008, 2:116-23. Specifically, the rod or wire 47 simultaneously controls valves 14 and 39 by control of operating levers 45 and 46:

Fig.1

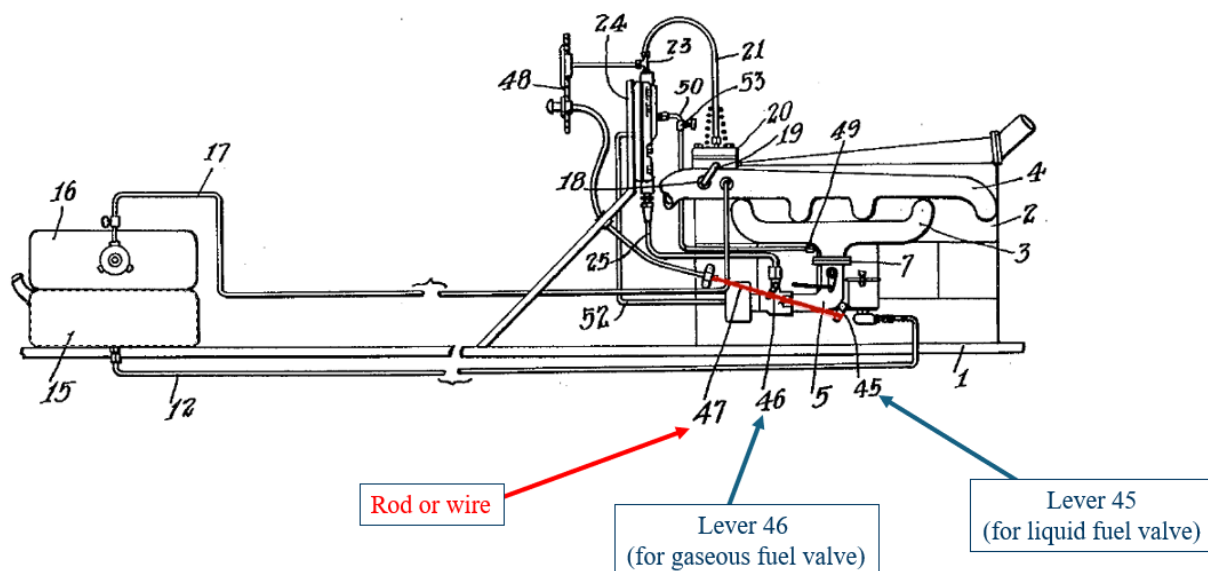
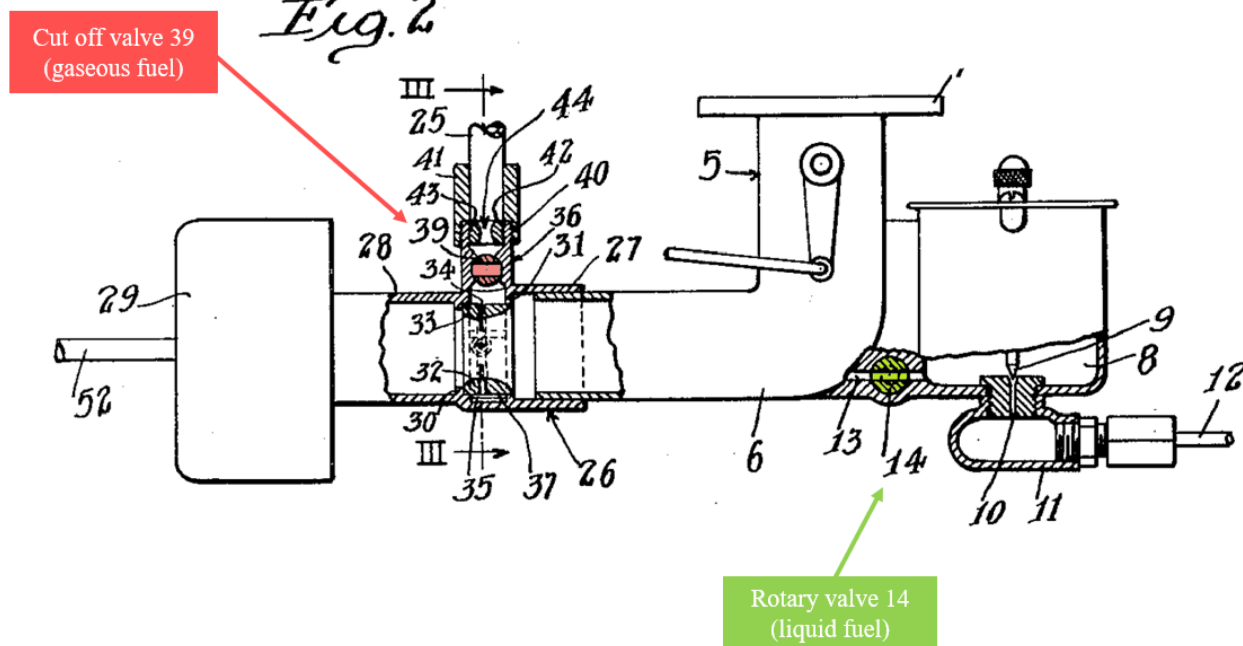


Fig.2



Ex.1008, FIGS. 1-2 (annotated), 2:105-07.

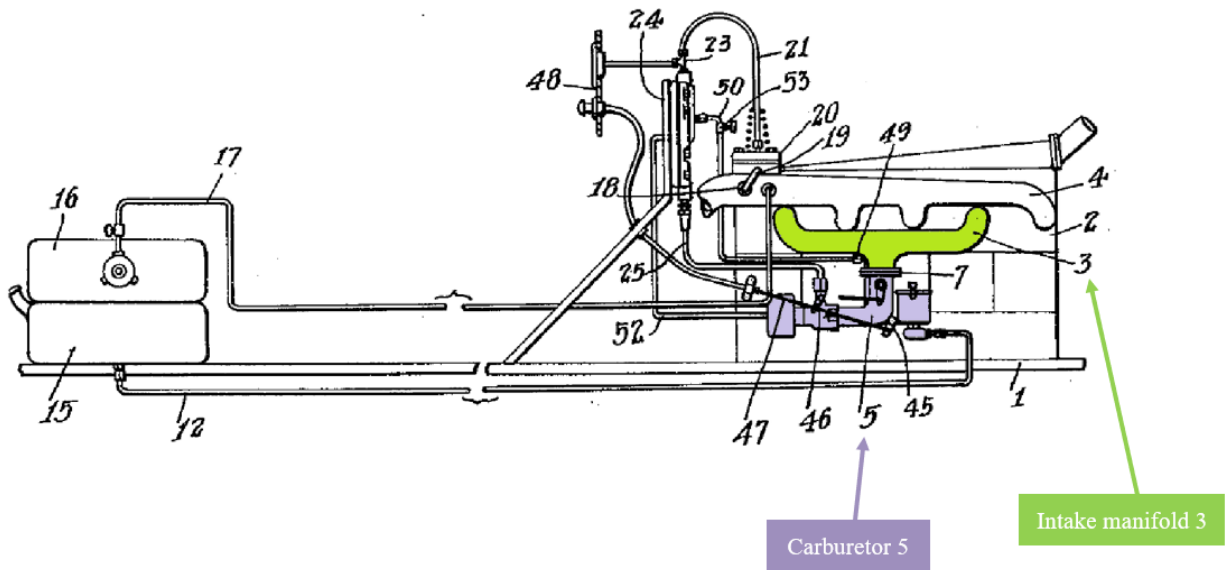
[0226]. When starting the engine, Holzapfel states that “valve 14 is closed and the valve 39 is open” such that “gaseous fuel will be supplied to the carburetor 5.” Ex.1008, 2:111-115. Then, “as soon as the engine is started it may be switched over to the liquid fuel by manipulating the rod or wire 47.” Ex.1008, 2:118-120. This action “reverse[s] the valves 14 and 39 so that the gaseous fuel supply is cut off and the liquid fuel supply connected to feed the carburetor.” Ex.1008, 2:121-123.

[0227]. Thus, movement of rod or wire 47 allows for simultaneous operation of valves 14 and 39 which in turn changes operation of the engine between gaseous fuel and liquid fuel. *Id.* Accordingly, a POSA would have understood that Holzapfel teaches [1.3].

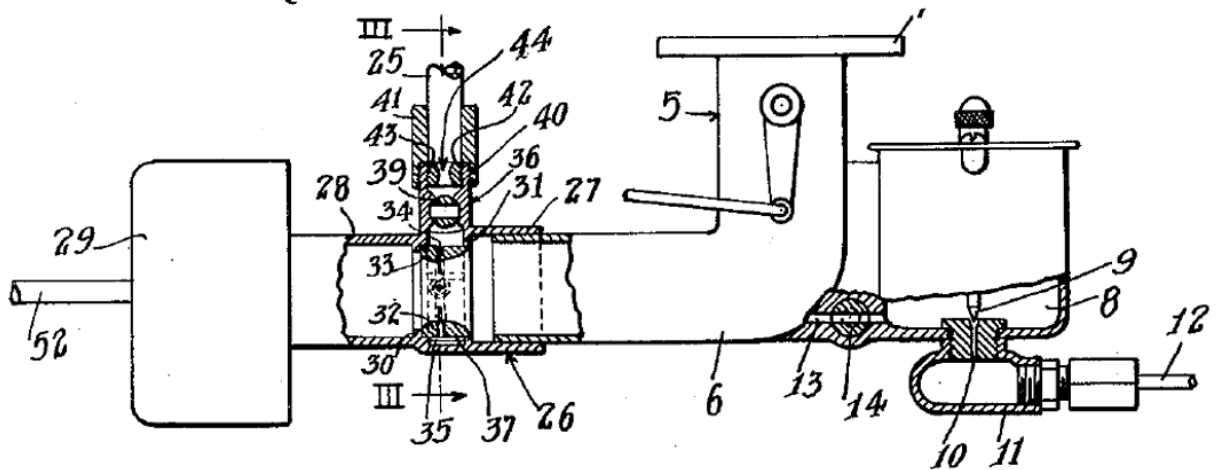
e. Element [1.4]: “a carburetor attached to an intake of the engine to mix air and fuel and connect to a gaseous fuel source and a liquid fuel source;”

[0228]. Element [1.4] recites “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.”

[0229]. Holzapfel discloses a carburetor 5 that is connected to the intake manifold 3, as seen in FIGS. 1-2 below:

Fig. 1*Fig. 2*

Carburetor



Ex.1008, FIG. 2, 1:84-86.

[0230]. Holzapfel states the other end of the carburetor constitutes an “inlet opening through which air may be sucked for mixing with the fuel injected into the carburetor.” Ex.1008, 1:87-89. The carburetor is “equipped with a float

chamber or fuel reservoir 8 which may be of any suitable construction to provide a supply of [liquid] fuel at atmospheric pressure ready for injection into the tube 6 of the carburetor 5.” Ex.1008, 1:89-94. The float chamber 8 communicates with the carburetor by means of passage 13. Ex.1008, 1:100-04. Holzapfel further discloses “the gaseous fuel supply through outlet tube 25 may be mixed with air and passed into the tube 6 of the carburetor 5 so that such air and gas mixture may pass into the intake manifold 3 of the engine 2.” Ex.1008, 2:39-44.

[0231]. Thus, a POSA would have understood that Holzapfel teaches carburetor 5 attached to the engine that mixes air and fuel, that thereby connects the gaseous fuel source and the liquid fuel source, as recited in Element [1.4].

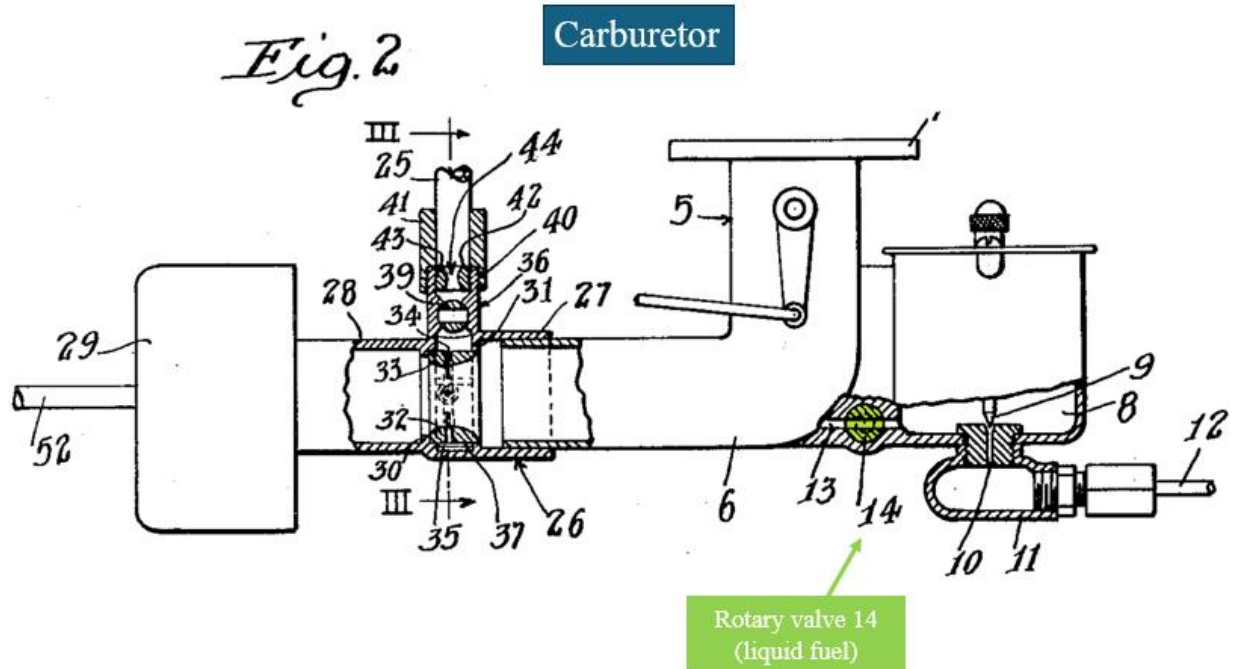
f. Element [1.5]: “a liquid fuel cut-off solenoid to interrupt liquid fuel flow to the engine upon actuation of the switch from liquid fuel to gaseous fuel; and”

[0232]. Holzapfel discloses rotary valve 14 (Ex.1008, 1:104, FIG. 2), which is a “liquid fuel cut-off” for purposes of Element [1.5]. As discussed (supra §VII.D.2.d), the rod or wire 47 controls valve 14 such that the switching from gaseous fuel to liquid fuel results in the opening of valve 14.

[0233]. Holzapfel discloses that when rod or wire 47 and valves 14 and 39 are in the position opposite that shown in FIG. 2, valve 14 is closed (interrupting liquid fuel flow to the engine) and valve 39 is open (permitting the

gaseous fuel source to couple to the engine). Ex.1008, 2:100-123, FIG. 2. FIG. 2

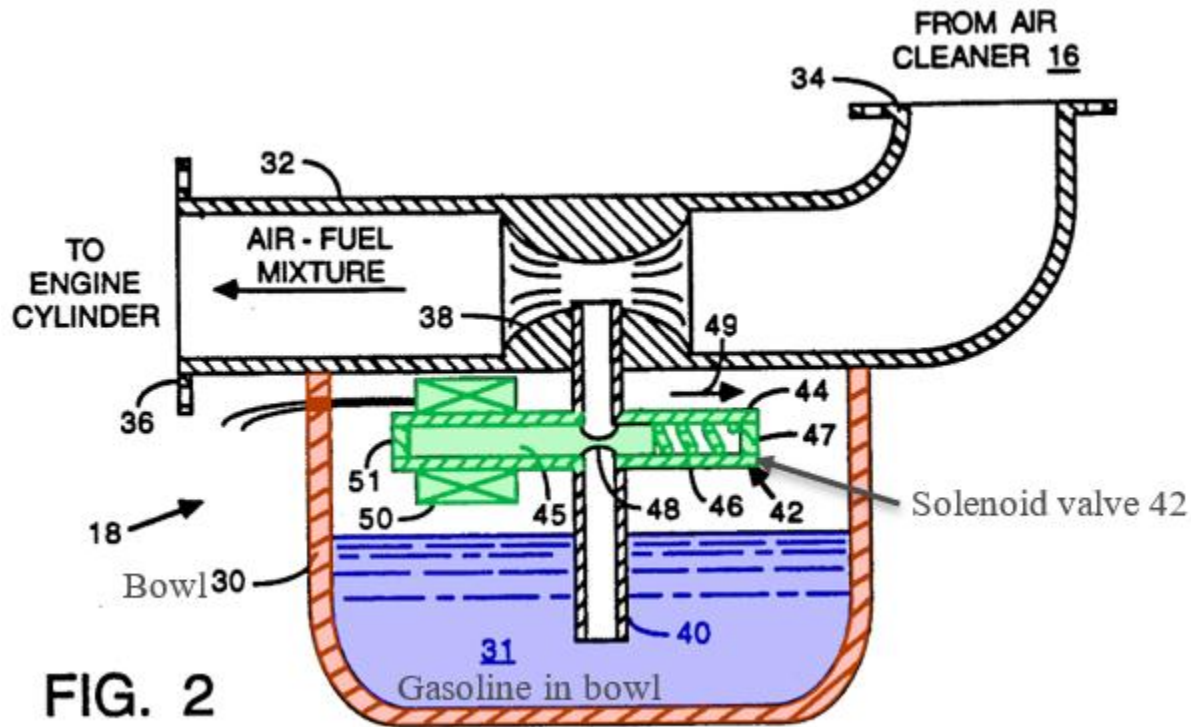
also shows that valve 14 is incorporated into the carburetor:



Ex.1008, FIG. 2.

[0234]. Thus, rotary valve 14 is incorporated into the carburetor to interrupt liquid fuel upon actuation of the rod or wire 47 from liquid fuel to gaseous fuel.

[0235]. Olmr discloses a gasoline engine having solenoid 42 in a float bowl 30 that cuts off the flow of gasoline to the venturi 38 when the operator closes the kill switch. Ex.1007, 2:30-68, 4:11-27. Olmr's FIG. 2 shows:



Id., FIG. 2 (annotated).

[0236]. Olmr's valve 42 is a solenoid connected to open and close a fuel path to the engine via venturi 38.

[0237]. A POSA would have found it obvious to use a solenoid, such as that disclosed by Olmr, in place of Holzapfel's valve 14, as discussed below.

(1) Motivation to Combine

[0238]. A POSA would have been motivated to combine Holzapfel and Olmr. Holzapfel and Olmr both relate to engines and both seek to prevent the flow of gasoline from the float bowl to the engine intake. In Holzapfel, valve 14 cuts the gasoline flow from float chamber 13 when the operation of the engine is

switched from gasoline to gaseous fuel. Olmr expressly teaches using a solenoid (valve 42) for this purpose. Ex.1007, 2:30-56; see also id., 1:33-36, FIG. 2. A POSA would have understood that solenoid valves offer several advantages, including fast response times, precise fuel flow control, and remote actuation. A POSA would have also understood tht solenoid valves can be substituted for mechanical valves in application that require fast response time, precise control and remote actuation. These benefits have led to their widespread use in engines and fuel flow applications. To this end, a POSA would been motivated to incorporate Olmr's solenoid valve to accomplish the same liquid fuel cutoff function described in Holzapfel.

(2) Reasonable Expectation of Success

[0239]. A POSA would have reasonably expected success in using Olmr's solenoid valve 42 as Holzapfel's valve 14. As of the earliest priority date of the '145 Patent, the use of solenoid valves to cut off/control the flow of fuel was common, with Olmr being just one example. A POSA would have recognized it as being suitable to energize a solenoid valve, such as Olmr's solenoid valve 43, to open and close a fuel pathway. A POSA would have therefore reasonably expected that Olmr's solenoid valve could be successfully implemented to serve as Holzapfel's valve 14 to accomplish the desired function of cutting off the supply of gasoline from Holzapfel's float chamber 8 to the intake of the engine. A POSA

also would have reasonably expected that Olmr's control circuit 52 and switch 82 that opens and closes Olmr's solenoid valve 42 could readily be adapted to replace Holzapfel's combination of rod/wire 47 and lever 45 that opens and closes Holzapfel's valve 14. As of the earliest priority date of the '145 Patent, the use of switches to control the energization of solenoid valves was common, with Olmr being just one example.

[0240]. Accordingly, a POSA would have understood that the combination of Holzapfel and Olmr teaches [1.5].

- g. Element [1.6]: “a voltage regulator coupled to the charging coil to receive power therefrom and that operates to provide a regulated voltage to the liquid fuel cut-off solenoid.”**

[0241]. Element [1.6] recites “a voltage regulator coupled to the charging coil to receive power therefrom and that operates to provide a regulated voltage to the liquid fuel cut-off solenoid.”

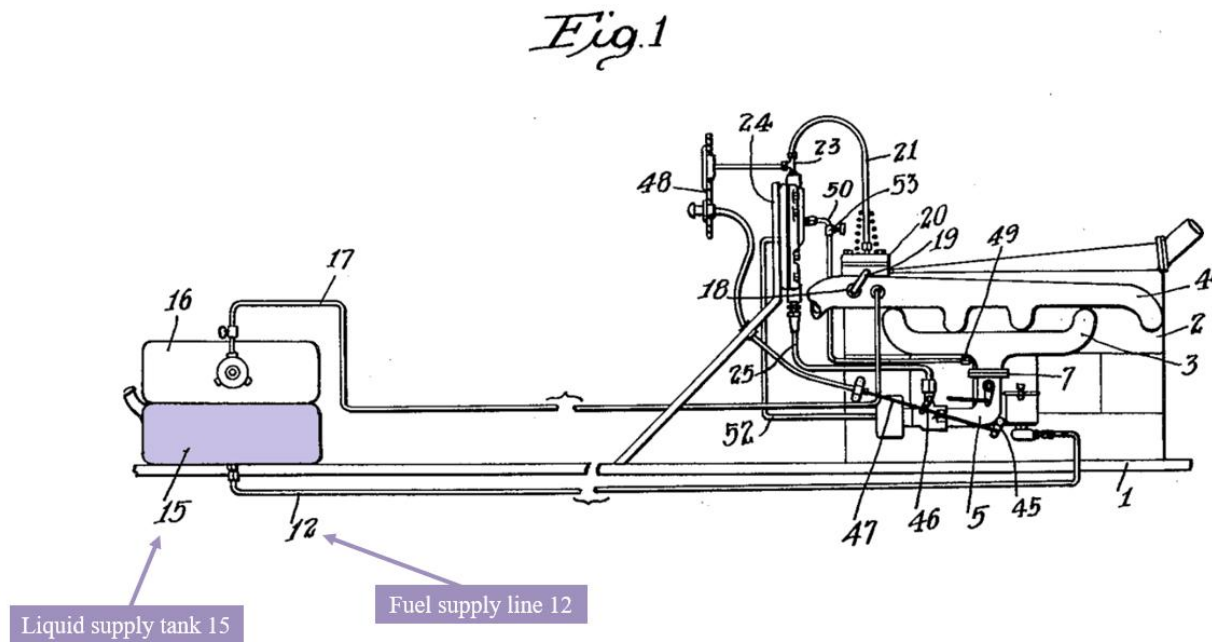
[0242]. As discussed (§VII.C.2.g), a POSA would have understood that Matsushima teaches “a voltage regulator coupled to the charging coil to receive power therefrom and that operates to provide a regulated voltage to the liquid fuel cut-off solenoid,” as recited in [1.6].

- 3. Claim 2: “The dual fuel generator of claim 1 further comprising: a liquid fuel valve along a liquid fuel line coupling the liquid fuel source to the carburetor; and a**

gaseous fuel valve along a gaseous fuel line coupling the gaseous fuel source to the carburetor.”

[0243]. Claim 2 depends from claim 1 and recites “a liquid fuel valve along a liquid fuel line coupling the liquid fuel source to the carburetor; and a gaseous fuel valve along a gaseous fuel line coupling the gaseous fuel source to the carburetor.”

[0244]. Holzapfel discloses “needle valve 9 [i.e., a “liquid fuel valve”] which obstructs the entrance of fuel into the [float] chamber 8 by closing off the passage 10.” Ex.1008, 1:95-99. FIG. 1 shows fuel supply line 12 is attached to liquid supply tank 15 through which fuel from the tank 15 may be passed to the float chamber 8 of the carburetor via inlet connection:



Ex.1008, FIG. 1., 1:108-110, 2:1-2.

8 by way of passage 10, where needle valve 9 operates by closing passage 10:



[0247]. Holzapfel discloses “cut off valve 39 [i.e., a “gaseous fuel valve”] which may be operated to either open the inlet passage 36 to the passage of gas therethrough, or to close the same so that gas cannot pass therethrough.”

[0248]. FIG. 1 shows gaseous fuel supply line 17 is attached to gaseous fuel supply tank 16 through which fuel from the tank 16 may be passed through

gas inlet stem 36:



Ex.1008, FIG. 1., 2:8-27, 2:85-90.

[0249]. FIG. 2 shows that gas inlet stem 36 connects to tube 6 of carburetor 5, where cut off valve 39 operates by closing inlet passage 36:

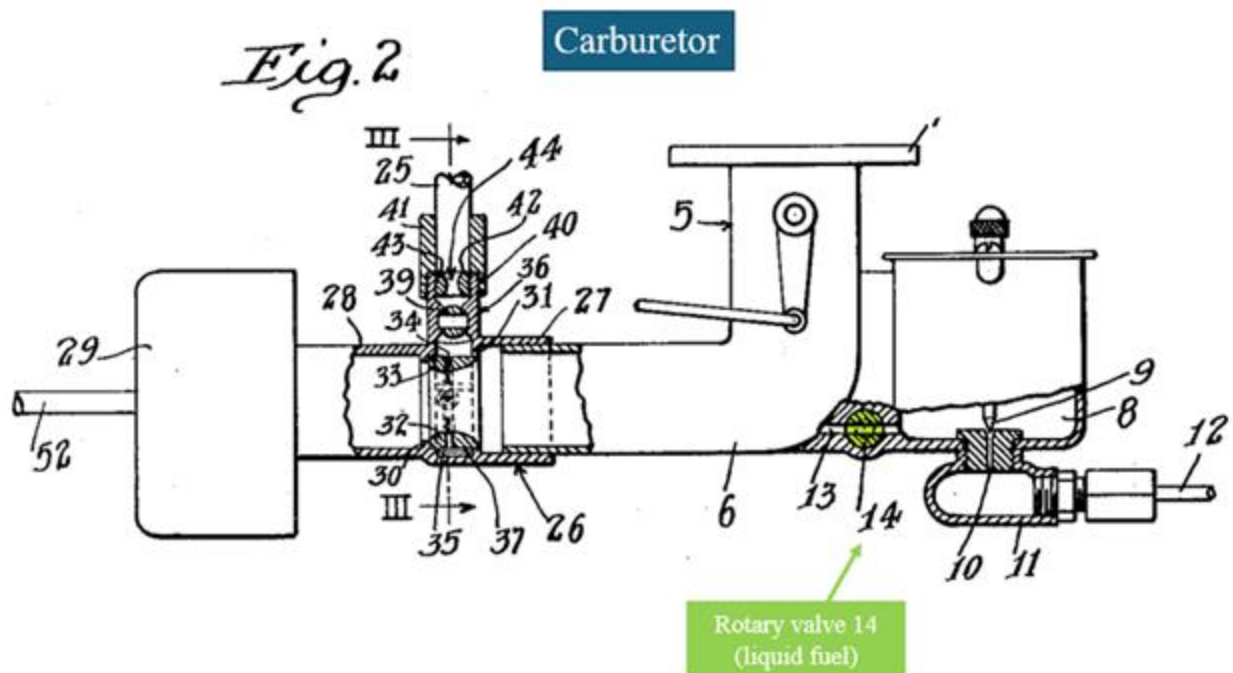
[0253]. Holzapfel discloses a liquid fuel valve (needle valve 9) which is a mechanical valve. §VII.C.3, *supra*.

[0254]. Holzapfel discloses a gaseous fuel valve (cut off valve 39), which is a mechanical valve. §VII.C.3, *supra*.

[0255]. Accordingly, a POSA would have understood that the combination of Holzapfel, Matsushima, and Olmr teaches claim 2.

5. **Claim 4: “The dual fuel generator of claim 2, wherein the liquid fuel cut-off solenoid is attached to the carburetor.”**

[0256]. Holzapfel’s FIG. 2 discloses a liquid fuel cut-off (i.e. a “rotary valve 14”) that is attached to the carburetor:



Ex.1008, FIG. 1 (annotated).

[0257]. Accordingly, a POSA would have understood that the combination of Holzapfel, Matsushima, and Olmr teaches claim 4.

6. Claim 5: “The dual fuel generator of claim 1, wherein the gaseous fuel is LPG and the liquid fuel is gasoline.”

[0258]. Claim 5 depends from Claim 1 and recites “wherein the gaseous fuel is LPG and the liquid fuel is gasoline.”

[0259]. The dual fuel engine of Holzapfel is configured to operate on “a normally gaseous fuel...which...is compressed and thereby maintained in liquefied condition.” Ex.1008, 2:8-12. LPG is a normally gaseous fuel that may be compressed and maintained in a liquefied condition. As discussed (*supra*, §III, §VI.A), LPG is commonly used in dual fuel engines. The dual fuel engine of Holzapfel also is configured to operate on gasoline. Ex.1008, 2:124-147.

Accordingly, a POSA would have understood that the combination of Holzapfel, Matsushima, and Olmr teaches claim 5.

7. Claim 6: The dual fuel generator of claim 1, wherein the switch is an electro-mechanical switch connecting one fuel source to the carburetor and connected to the electrical power generator, and wherein the liquid fuel cut-off solenoid is connected to open and close a fuel path to the engine in response to reception of electrical power from the switch.

[0260]. Claim 6 depends from Claim 1 and recites “wherein the switch is an electro-mechanical switch connecting one fuel source to the carburetor and connected to the electrical power generator, and wherein the liquid fuel cut-off

solenoid is connected to open and close a fuel path to the engine in response to reception of electrical power from the switch.”

[0261]. Matsushima teaches an electrical power generator, and a POSA would have been motivated to combine Holzapfel and Matsushima and would have had a reasonable expectation of success in doing so. *Supra*, §VII.D.2.c; §VII.D.1.

[0262]. Olmr’s electrically driven solenoid valve 42, electrical control circuit 52, and switch 82 can be substituted for Holzapfel’s valve 14, rod/wire 47, and lever 45, and POSA would have been motivated to make that substitution and would have had a reasonable expectation of success. *Supra*, §VII.D.2.f. Olmr’s solenoid valve 42 is a “liquid fuel cut-off solenoid,” *id.*, that, when combined with Hozapfel, functions to open and close a fuel path for one fuel source (gasoline) to the engine in response to reception of electrical power. Olmr’s switch 82 is user actuatable and moves mechanically between the contacts and operates by opening and closing electrical circuits, making it an electro-mechanical switch. Ex.1007, 4:11-18, FIG. 3. Switch 82 controls the electrical power to Olmr’s solenoid valve 42. *Id.*

[0263]. Accordingly, a POSA would have understood that the combination of Holzapfel, Matsushima, and Olmr teaches claim 6.

8. Claim 7: The dual fuel generator of claim 6, wherein the switch selectively powers the solenoid valve by controlling

electrical connection between the solenoid valve and the electrical power generator.

[0264]. Claim 7 depends from claim 6 and recites: “wherein the switch selectively powers the solenoid valve by controlling electrical connection between the solenoid valve and the electrical power generator.”

[0265]. As discussed (*supra* §VII.D.7), Olmr’s solenoid valve 42 opens and closes a fuel path in response to reception of electrical current from Olmr’s switch 82. Thus, Olmr’s switch 82 would selectively power solenoid valve 42 by controlling the electrical current between the solenoid valve 42 and Matsushima’s generator. Accordingly, a POSA would have understood that the combination of Holzapfel, Matsushima, and Olmr teaches claim 7.

9. Claim 8: “The dual fuel generator of claim 1, wherein the liquid fuel cut-off solenoid is normally open to provide liquid fuel to the engine when the liquid fuel cut-off solenoid is unpowered.”

[0266]. Claim 8 depends from claim 1 and recites: “wherein the liquid fuel cut-off solenoid is normally open to provide liquid fuel to the engine when the liquid fuel cut-off solenoid is unpowered.”

[0267]. As discussed (*supra* §VII.D.2.f), it would have been obvious to use Olmr’s solenoid valve 42 in place of Holzapfel’s valve 14. Olmr’s solenoid valve is normally open (Ex.1007, 3:43-52), and the decision to configure a solenoid as normally open or normally closed is mere design choice.

[0268]. A POSA would have been motivated to use Olmr's normally-open solenoid and would have had a reasonable expectation of success in doing so based on the teachings of Olmr:

Electricity is not required to hold the valve in this position during engine starting and normal running. This is a key feature since many small gasoline engines do not utilize a battery or other source of power for starting. Thus upon commencement of engine operation, a source of electricity is not required as solenoid valve is in the normally open position. In addition, should the valve control circuit fail, the spool valve plunger 45 will fail in the normally open position allowing continued operation of the engine.

Ex.1007, 3:43-52

[0269]. Accordingly, a POSA would have understood that the combination of Holzapfel, Matsushima, and Olmr teaches claim 8.

10. **Claim 9: "The dual fuel generator of claim 8, wherein the dual fuel generator is a batteryless dual fuel generator and the engine is a pull-start engine, the batteryless dual fuel generator further comprising a pull-starter that drives the electrical power generator to power and close the liquid fuel cut-off solenoid while starting the engine on gaseous fuel."**

[0270]. Claim 9 depends from claim 8 and recites: “wherein the dual fuel generator is a batteryless dual fuel generator and the engine is a pull-start engine, the batteryless dual fuel generator further comprising a pull-starter that drives the electrical power generator to power and close the liquid fuel cut-off solenoid while starting the engine on gaseous fuel.”

[0271]. As discussed (*supra* §VII.D.1), a POSA would have been motivated to combine Holzapfel and Matsushima, and would have had a reasonable expectation of success in combining Holzapfel and Matsushima.

[0272]. Matsushima discloses a batteryless engine including a pull-start (recoil starter 40). Ex.1012, 1:6-11 (“adapted for use in...engines with no battery”), 4:63-5:21. It would have been obvious to a POSA to incorporate Matsushima’s pull-start to supply electrical power in Holzapfel’s engine.

[0273]. Matsushima’s pull-starter drives an electrical power generator to power various components while starting its engine (including its fuel pump, spark plug and fuel injection valve). Ex.1012, Abstract, 5:1-48; Incorporating Matsushima’s pull-starter assembly with Holzapfel’s engine would similarly allow the pull-starter assembly to drive a generator to power and close Holzapfel’s valve 14 (a solenoid when combined with Olmr) while starting the engine on gaseous fuel. *Id.*

[0274]. A POSA would have been motivated to incorporate

Matsushima's pull-start and would have had a reasonable expectation of success.

Holzapfel and Matsushima both relate to the same class of small spark-ignition engines that are offered with either battery-dependent electric start or battery-independent recoil (pull) start. Incorporating a pull-start into Holzapfel's dual fuel engine would improve reliability in cold or remote applications and reduce costs.

[0275]. A POSA would have reasonably expected success in adopting Matsushima's recoil mechanism for use in Holzapfel's dual fuel engine. A POSA would have found it straightforward to mount Matsushima's recoil mechanism on Holzapfel's engine with only routine mechanical adaptation. As of the earliest priority date of the '145 Patent, the use of recoil starters was common on small engines, and their installation required only routine mechanical tasks.

[0276]. Accordingly, a POSA would have understood that the combination of Holzapfel, Matsushima, and Olmr teaches claim 9.

11. Claim 10: “The dual fuel generator of claim 1, wherein the electrical power generator comprises a magneto or an alternator.”

[0277]. Claim 10 depends from claim 1 and recites: “wherein the electrical power generator comprises a magneto or an alternator.”

[0278]. As discussed (§VII.C.11), a POSA would have understood that Matsushima discloses an “electrical power generator comprises a magneto or an

alternator.” Accordingly, a POSA would have understood that the combination of Nakafushi, Matsushima, and Olmr teaches claim 10.

E. Ground 5: Claims 11-16 are Rendered Obvious by the Combination of Workshop Manual, Matsushima, and Winberg.

1. Claim 11

a. Element [11.0]: “A dual fuel generator comprising:”

[0279]. Workshop Manual teaches a dual fuel engine that can be implemented in a generator. *Supra*, §VII.A.1.a.

b. Element [11.1]: “an engine operable on a gaseous fuel and a liquid fuel;”

[0280]. Workshop Manual teaches an engine operable on a gaseous fuel and a liquid fuel. *Supra*, §VII.A.1.b.

c. Element [11.2]: “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; and”

[0281]. Workshop Manual teaches 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. *Supra*, §VII.A.1.e.

d. Element [11.3]: “a manually actuated fuel shutoff coupled to the carburetor, the manually actuated fuel shutoff comprising: a first end in the carburetor that actuates to selectively allow or block a flow of fuel through the carburetor; and a second end external to the carburetor to actuate the first end.”

[0282]. Element [11.3] recites: “a manually actuated fuel shutoff coupled to the carburetor, the manually actuated fuel shutoff comprising: a first end in the carburetor that actuates to selectively allow or block a flow of fuel through the carburetor; and a second end external to the carburetor to actuate the first end.”

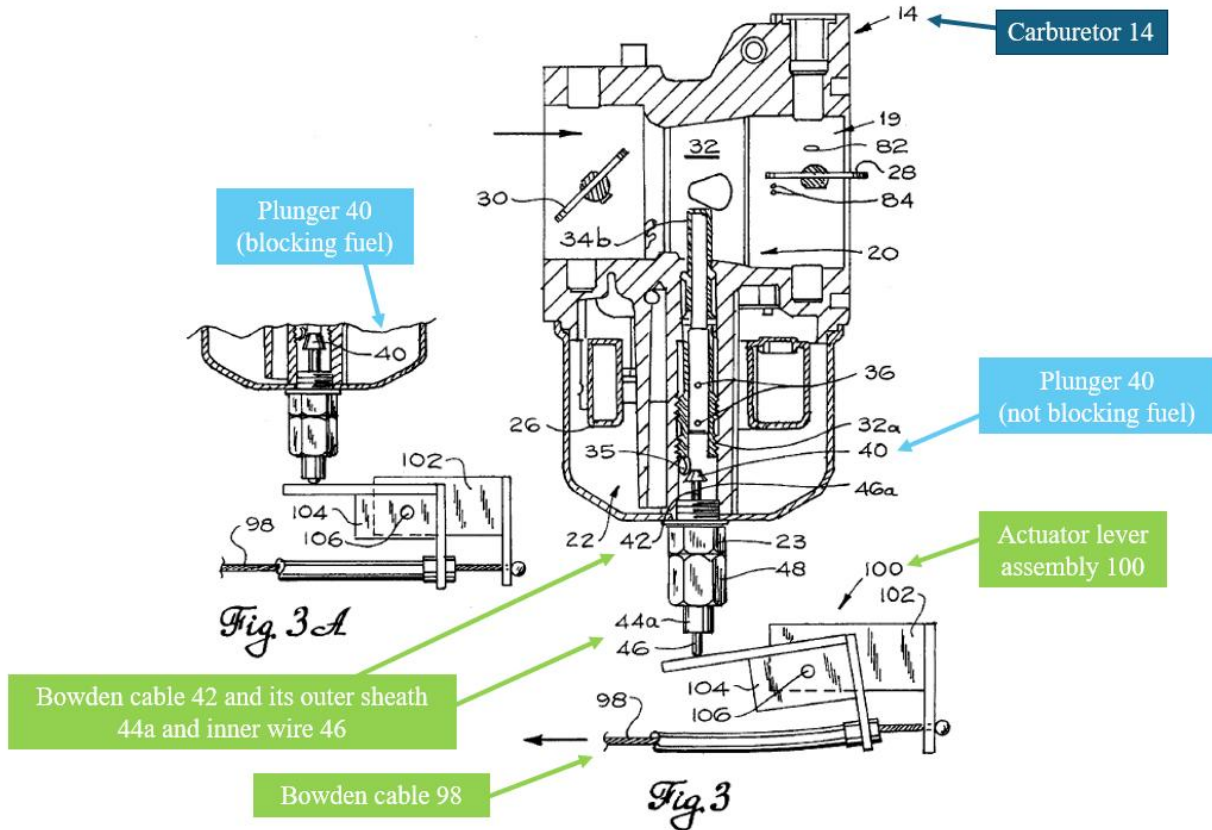
[0283]. Winberg’s fuel shutoff has a plunger 40/140, which is a first end in the carburetor that actuates to close the fuel passage. Ex.1013, 5:34-46, 7:31-55, 7:65-8:52, FIGS. 3-3A & 8.

[0284]. In the Figure 8 embodiment, Winberg’s fuel shutoff has an actuating lever assembly 152, which is a second end external to the carburetor to actuate the plunger (the first end). Ex.1013, 7:65-8:52, FIG. 8. Plunger 140 moves between a blocking position (shown in phantom in Figure 8) and a non-blocking position (shown in solid lines in Figure 8) by rotating actuating lever assembly 152 using lever arm 149:



Ex.1013, FIG. 8 (annotated), 7:65-8:52.

[0285]. In the Figure 3/3A embodiment, Winberg's fuel shutoff has an actuator lever assembly 100, which is a second end external to the carburetor to actuate the plunger 40 (the first end). *Id.* The plunger 40 moves between a blocking position (Figure 3A) and a non-blocking position (Figure 3) through the use of Bowden cables 42 and 98 interconnected with actuator lever assembly 100. *Id.*



Id., FIGS. 3-3A (annotated).

[0286]. Winberg's fuel shutoff is manually actuated in the Figure 8 embodiment and the Figure 3/3A embodiment. Ex.1013, Abstract, 2:14-24, 7:31-55, 7:65-8:52, FIGS. 3-3A & 8

[0287]. A POSA would have been motivated to combine Workshop Manual and Winberg. Workshop Manual and Winberg both relate to internal combustion engines. §VI.A, *supra*; §VI.F, *supra*. Workshop Manual and Winberg disclose of fuel shutoff systems in carburetors. Ex.1009, 67-68; Ex.1013, Abstract. Winberg discloses that its manually actuated fuel shutoff is useful in generators. Ex.1013, 7:57-64. A POSA would have understood that the valve configurations

of Winberg's manually actuated valves and the Workshop Manual's solenoid valves to be one of a finite number of valves, each having a reasonable expectation of success.

[0288]. A POSA also would have had a reasonable expectation of success, because Winberg's float bowl configuration was common for use with small engines, and Winberg discloses using its float bowl and fuel shutoff in engines with applications including generators. Ex.1013, 7:58. The float bowl and fuel nozzle configuration of Winberg and Workshop Manual are substantially the same, making it straightforward to substitute the Winberg fuel shutoff for the Workshop Manual fuel shutoff. Ex.1009, 67-68; Ex.1013, FIG. 4. In addition, a POSA have understand that mechanical valves, such as Winberg's fuel shutoff, and solenoids, such as the line valves in Workshop Manual, can be configured to operate simultaneously. Walker demonstrates such a solution in a dual fuel engine using gasoline and LPG. Ex.1015, 2:3-32.

[0289]. Accordingly, a POSA would have understood that Winberg teaches [11.3].

2. Claim 12: The dual fuel generator of claim 11, wherein the engine is a pull start, batteryless engine.

[0290]. Claim 12 depends from claim 11 and recites: "wherein the engine is a pull start, batteryless engine."

[0291]. Matsushima discloses a pull start, batteryless engine. *Supra*,

§VII.B.4. A POSA would have been motivated to combine Workshop Manual and Matsushima, and would have had a reasonable expectation of success in doing so.

Id. Accordingly, a POSA would have understood that the combination of Workshop Manual, Matsushima, and Winberg teaches claim 12.

3. Claim 13: “The dual fuel generator of claim 11, wherein the gaseous fuel is LPG and the liquid fuel is gasoline.”

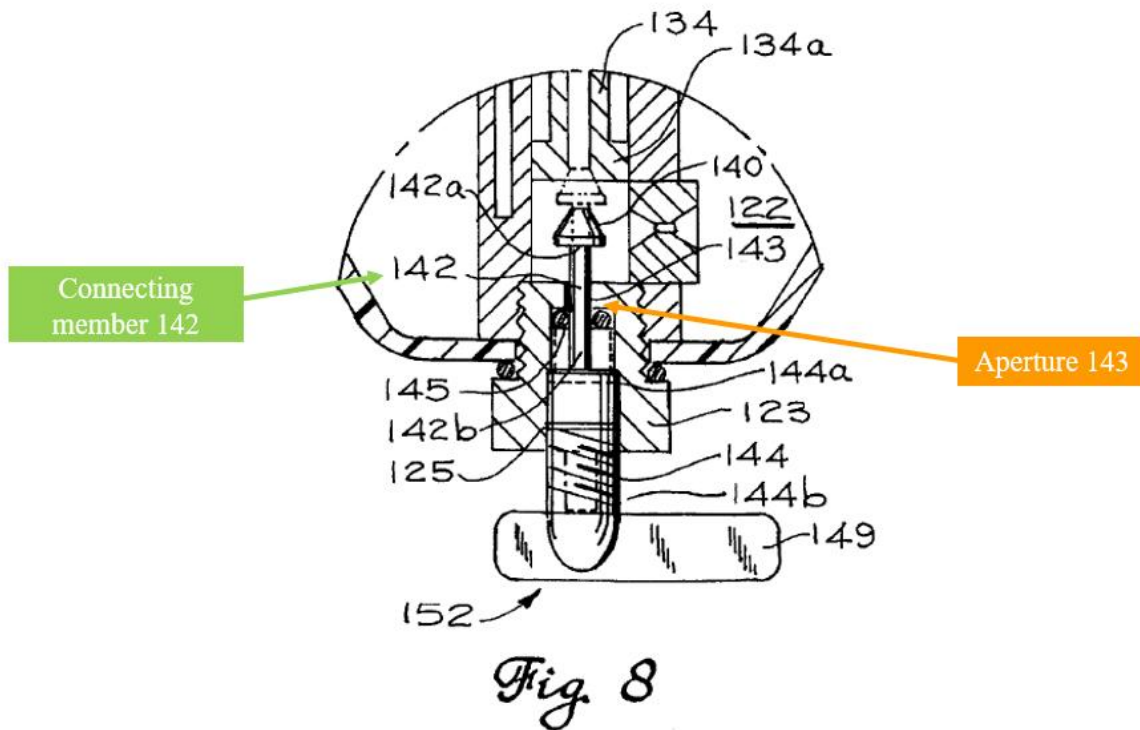
[0292]. Claim 13 depends from claim 11 and recites: “wherein the gaseous fuel is LPG and the liquid fuel is gasoline.”

[0293]. Workshop Manual discloses an engine operable on LPG and gasoline. *Supra*, §VII.A.5.

4. Claim 14: “The dual fuel generator of claim 11, wherein the manually actuated fuel shutoff comprises a rotating mechanical valve.”

[0294]. Claim 14 depends from claim 11 and recites: “wherein the manually actuated fuel shutoff comprises a rotating mechanical valve.”

[0295]. In the Figure 8 embodiment, Winberg discloses a rotating shaft (connecting member 142) that extends through an aperture 143 in the carburetor:



Ex.1013, FIG. 8 (annotated), 7:65-8:52.

[0296]. Winberg also discloses that

When lever arm 149 is rotated such that the pitch of the thread in threaded bore 125 advances threaded member 144 further into threaded bore 125, plunger 140 is advanced towards the intake end 134a of fuel nozzle 134 via connecting member 142. When plunger 140 contacts or substantially contacts the intake end 134a of fuel nozzle 134, plunger 140 blocks or substantially blocks the flow of fuel into fuel nozzle 134, and is therefore in the Stop or blocking position. As lever 149 arm is rotated such that the pitch of the thread in threaded bore 125 moves threaded member 144 further out of threaded bore 125, plunger 140 is moved away from intake end 134a of fuel nozzle 134 via connecting member 142. When plunger 140 is not in contact or Substantial contact with intake end 134a of fuel nozzle 134, plunger 140 does not block or substantially block fuel from flowing into fuel nozzle 34, and is therefore in the run or non-blocking position.

Ex.1013, 8:36-53.

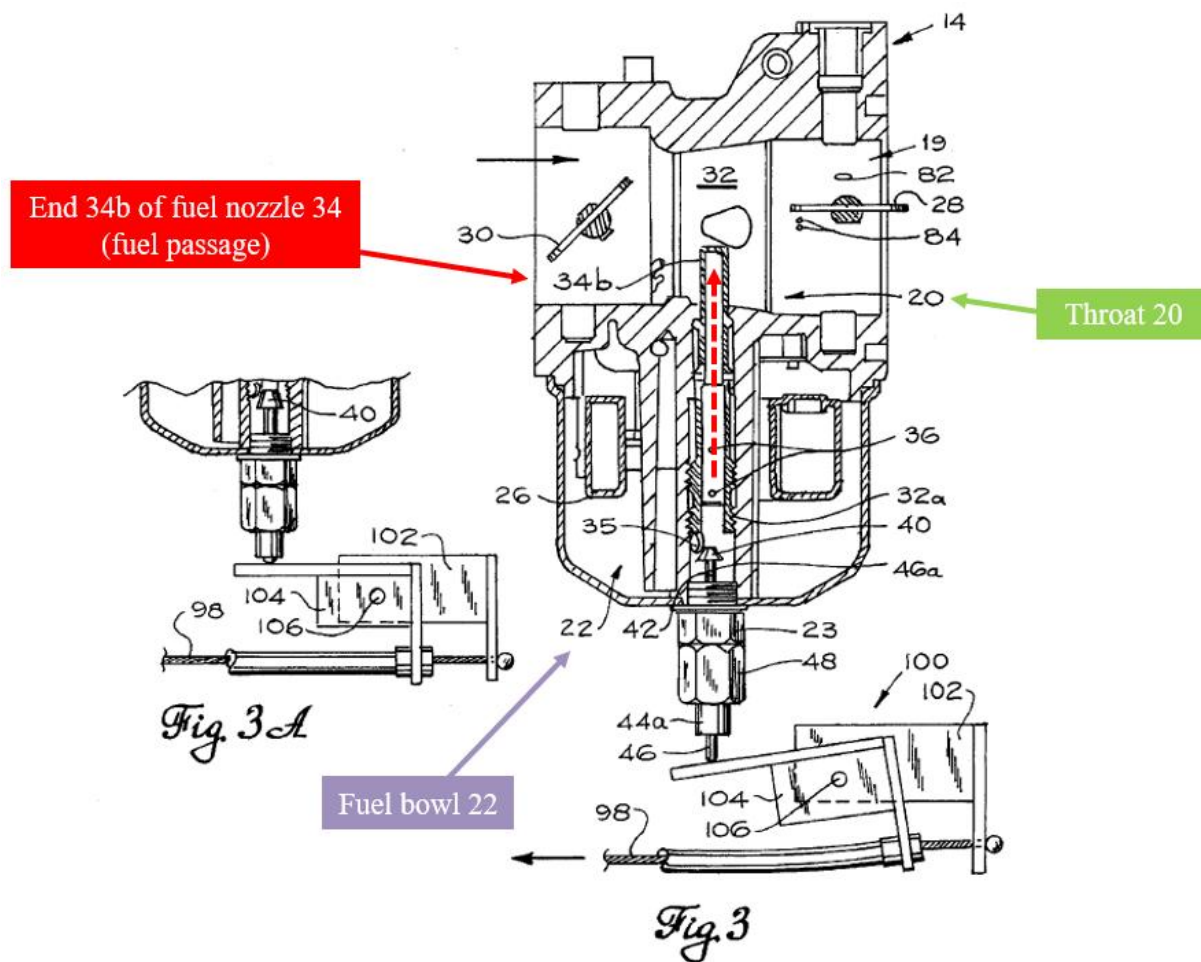
[0297]. Accordingly, a POSA would have understood that the combination of Workshop Manual, Matsushima, and Winberg teaches claim 14.

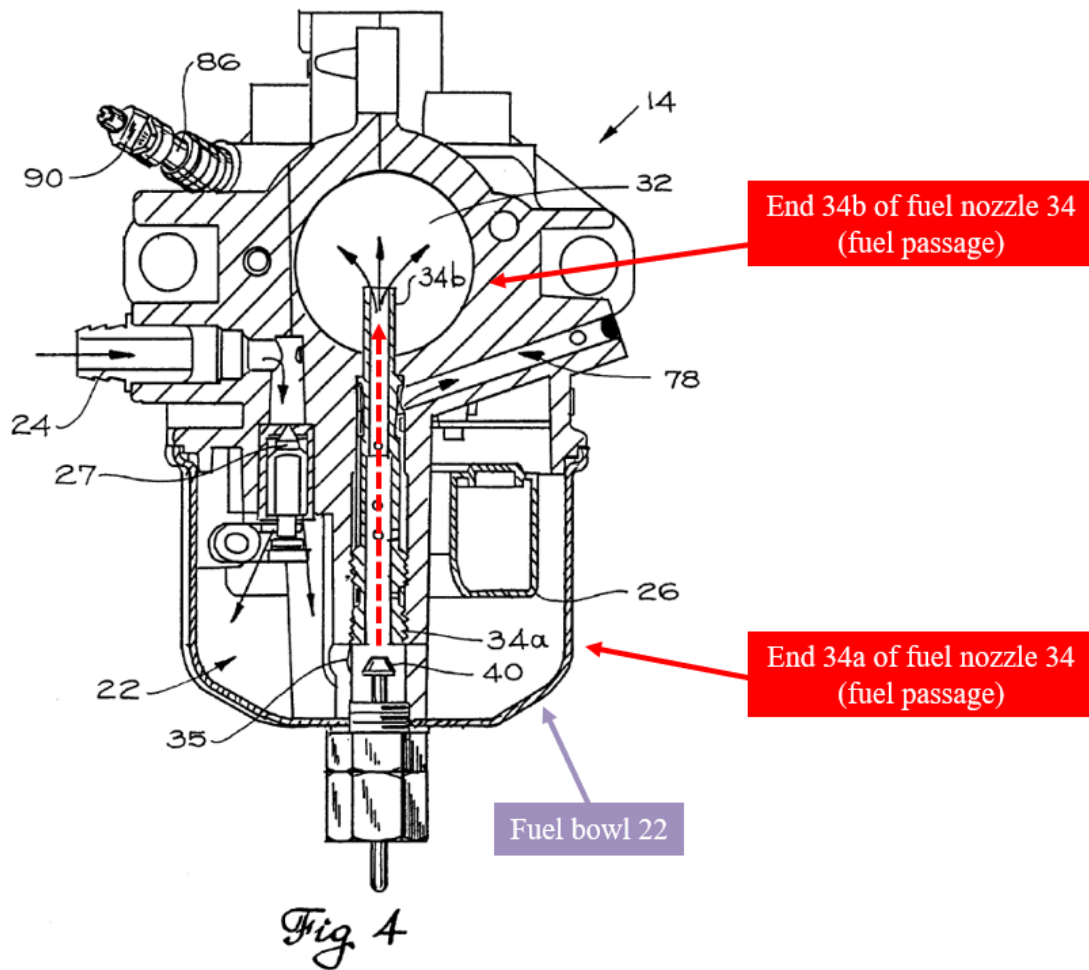
5. Claim 15

a. Element [15.1]: “The dual fuel generator of claim 14 wherein the carburetor comprises:”

[0298]. Element [15.1] recites a carburetor comprising “a float bowl, a throat, and a fuel passage extending from the float bowl to the throat.”

[0299]. Winberg discloses a carburetor 14, which has a float bowl (fuel bowl 22/122) and throat 20. Ex.1013, 3:61-4:32, 7:65-8:52; FIGS. 3A-5 & 8. The carburetor 14 has a fuel nozzle 34/134, which has a fuel passage extending from the float bowl to the throat. *Id.*, 4:12-33, 7:65-8:52, FIGS. 3A-5 & 8.







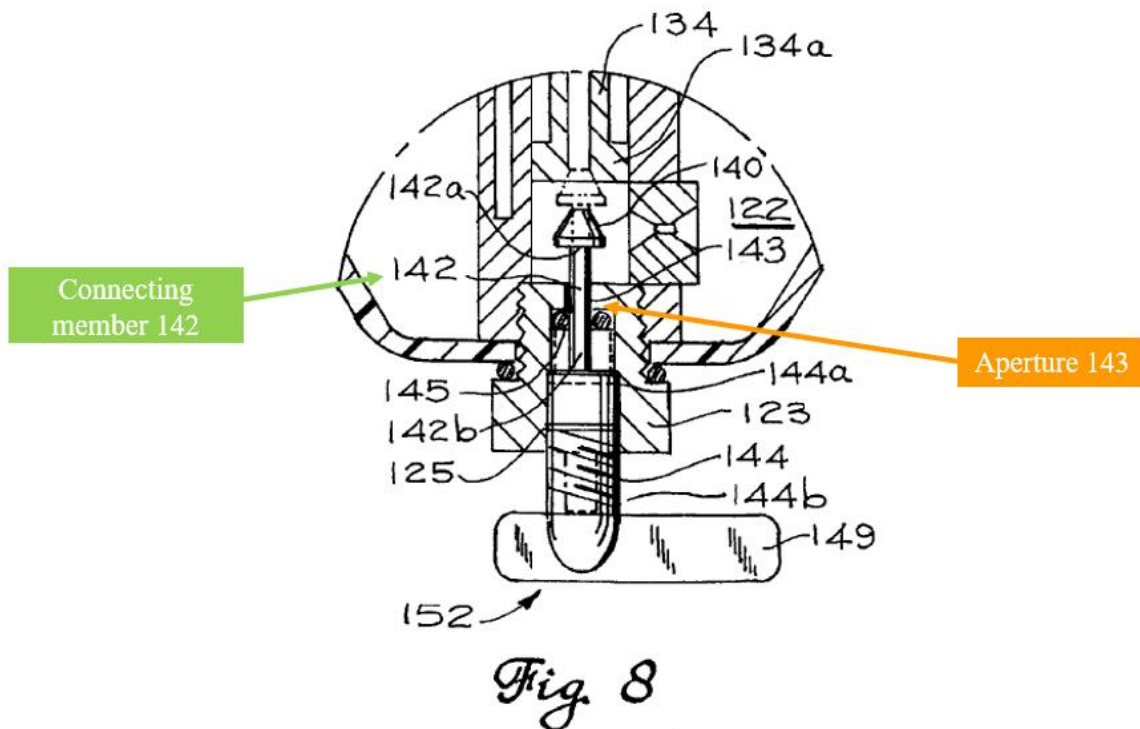
Id., FIGS. 3-3A, 4 & 8 (annotated).

- b. Element [15.2]: “wherein the manually actuated fuel shutoff comprises a shaft extending into the carburetor through an aperture in the float bowl, the shaft being coupled to a valve tip in the float bowl that rotates to open and close the fuel passage.”**

shaft extending into the carburetor through an aperture in the float bowl and

coupled to a valve tip in the float bowl that rotates to open and close the fuel passage.”

[0301]. In the Figure 8 embodiment, Winberg’s fuel shutoff comprises a shaft (connecting member 142) attached to plunger 140 that extends through aperture 143 in the carburetor. Ex.1013, 7:65-8:52, FIG. 8. Winberg’s valve tip (plunger 140) rotates to open and close the fuel passage. *Id.*



Id., FIG. 8 (annotated), 7:65-8:52.

[0302]. Winberg also discloses:

Plunger 140 in FIG. 8 is selectively movable between the Stop or blocking position, and the run or non-blocking position through the use of a connecting member 142 interconnected with a rotating actuating lever assembly 152. Connecting member 142 has one end

142a attached to plunger 140, and extends from plunger 140 through an aperture 143 drilled through the center of the carburetor bowl mounting screw 123. Connecting member 142 then extends to and has a Second end 142b interconnected with a rotating actuating lever assembly 152.

Ex.1013, 8:15-25.

When lever arm 149 is rotated such that the pitch of the thread in threaded bore 125 advances threaded member 144 further into threaded bore 125, plunger 140 is advanced towards the intake end 134a of fuel nozzle 134 via connecting member 142. When plunger 140 contacts or substantially contacts the intake end 134a of fuel nozzle 134, plunger 140 blocks or substantially blocks the flow of fuel into fuel nozzle 134, and is therefore in the Stop or blocking position. As lever 149 arm is rotated such that the pitch of the thread in threaded bore 125 moves threaded member 144 further out of threaded bore 125, plunger 140 is moved away from intake end 134a of fuel nozzle 134 via connecting member 142. When plunger 140 is not in contact or Substantial contact with intake end 134a of fuel nozzle 134, plunger 140 does not block or substantially block fuel from flowing into fuel nozzle 34, and is therefore in the run or non-blocking position.

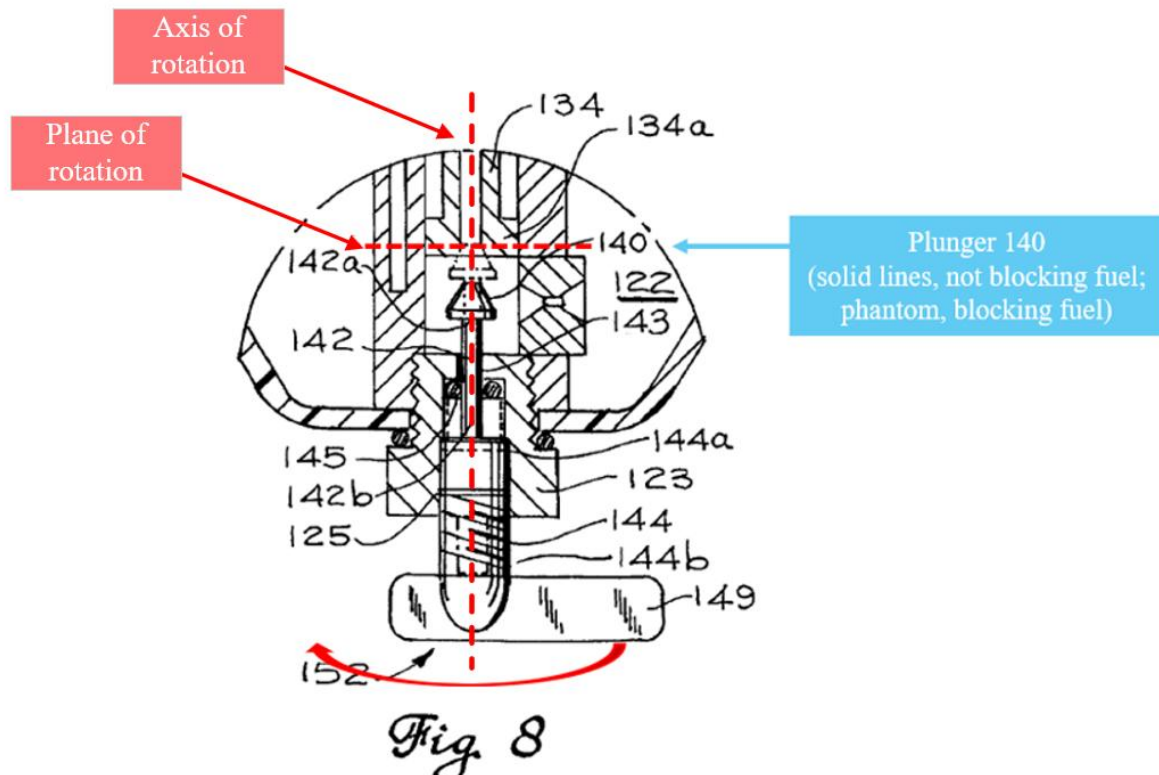
Ex.1013, 8:37-53.

[0303]. Accordingly, a POSA would have understood that the combination of Workshop Manual, Matsushima, and Winberg teaches claim 15.

6. Claim 16: “The dual fuel generator of claim 15 wherein the valve tip rotates parallel to an inlet of the fuel passage between a first position permitting fuel flow into the inlet and a second position blocking fuel flow into the inlet.”

[0304]. Claim 16 depends from claim 15, and recites “wherein the valve tip rotates parallel to an inlet of the fuel passage between a first position permitting fuel flow into the inlet and a second position blocking fuel flow into the inlet.”

[0305]. In the Figure 8 embodiment, Winberg's valve tip (plunger 140) has a plane of rotation that is parallel to the inlet (input end 134a) of the fuel passage (fuel nozzle 134):



Id., FIG. 8 (annotated), 7:65-8:52.

[0306]. Winberg's plunger 140 rotates between a position permitting fuel flow into the inlet of the fuel passage (first position) and a second position blocking fuel flow into the inlet of the passage. *Id.* Accordingly, a POSA would have understood that the combination of Workshop Manual, Matsushima, and Winberg teaches claim 16.

F. Ground 6: Claims 11-16 are Rendered Obvious by the Combination of Nakafushi, Matsushima, and Winberg.

1. Claim 11

a. Element [11.0]: “A dual fuel generator comprising:”

[0307]. Nakafushi and Matsushima disclose dual fuel engines that can be implemented in a generator. *Supra*, §VII.C.2.a.

b. Element [11.1]: “an engine operable on a gaseous fuel and a liquid fuel;”

[0308]. Nakafushi teaches an engine operable on a gaseous fuel and a liquid fuel. *Supra*, §VII.C.2.b.

c. Element [11.2]: “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; and”

[0309]. Nakafushi teaches 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. *Supra*, §VII.C.2.e.

d. Element [11.3]: “a manually actuated fuel shutoff coupled to the carburetor, the manually actuated fuel shutoff comprising: a first end in the carburetor that actuates to selectively allow or block a flow of fuel through the carburetor; and a second end external to the carburetor to actuate the first end.”

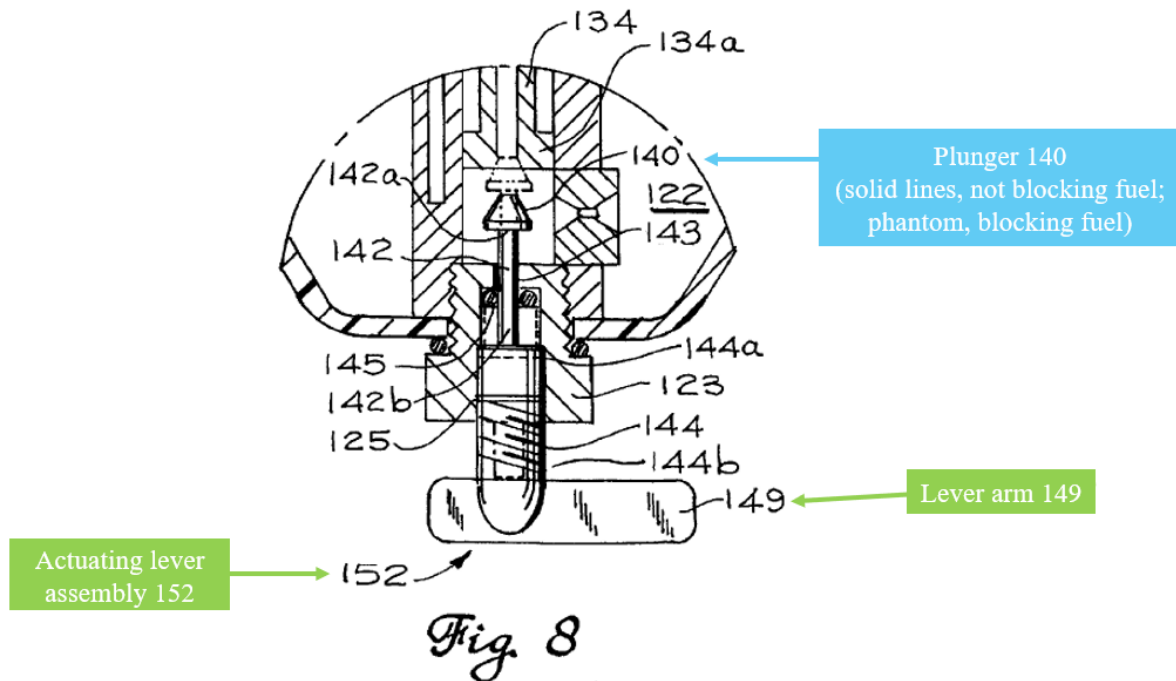
[0310]. Winberg teaches “a manually actuated fuel shutoff coupled to the carburetor, the manually actuated fuel shutoff comprising: a first end in the carburetor that actuates to selectively allow or block a flow of fuel through the

carburetor; and a second end external to the carburetor to actuate the first end.”

§VII.E.1.d, *supra*.

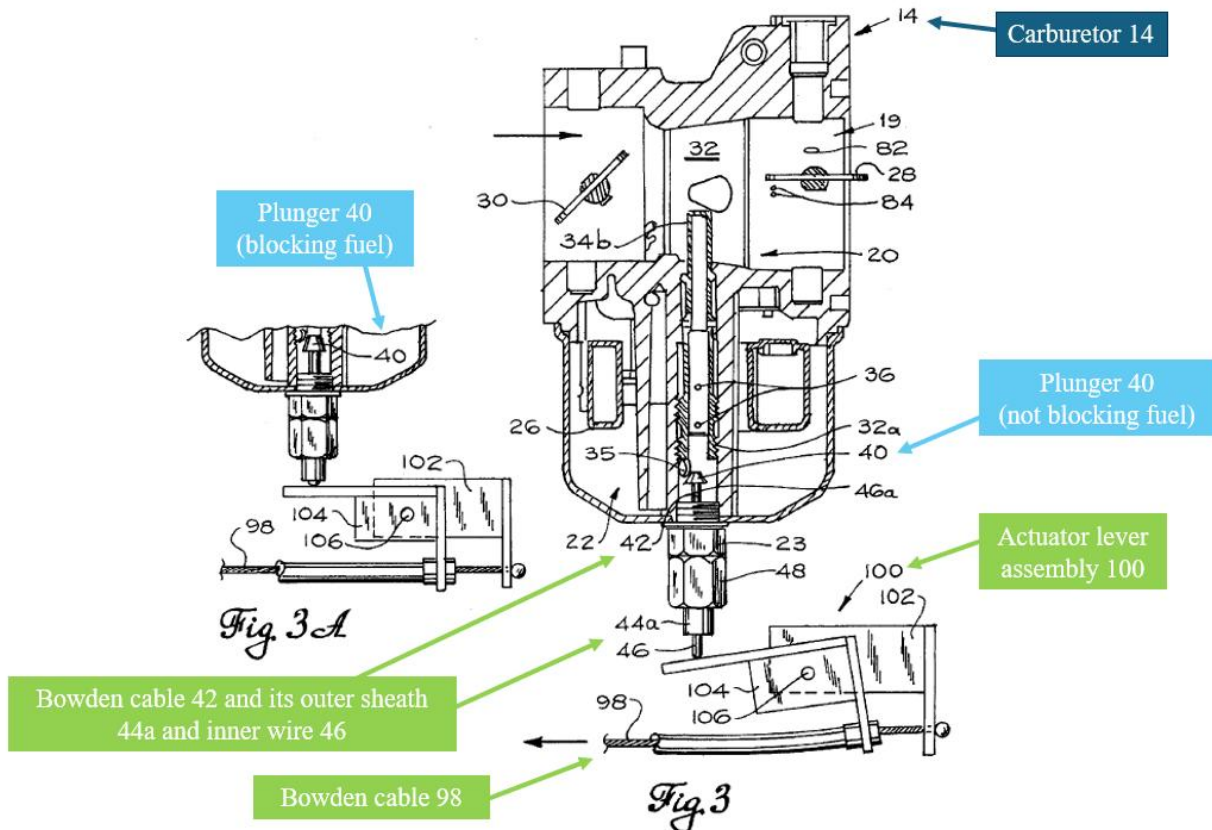
[0311]. A POSA would have understood that Winberg’s manually actuated fuel shutoff in the dual fuel engine can be incorporated into Nakafushi’s dual fuel engine. Winberg’s fuel shutoff has a plunger 40/140, which is a first end in the carburetor that actuates to close the fuel passage. Ex.1013, 5:34-46, 7:31-55, 7:65-8:52, FIGS. 3-3A & 8.

[0312]. In the Figure 8 embodiment, Winberg’s fuel shutoff has an actuating lever assembly 152, which is a second end external to the carburetor to actuate the plunger (the first end). Ex.1013, 7:65-8:52, Fig. 8. Plunger 140 moves between a blocking position (shown in phantom in Figure 8) and a non-blocking position (shown in solid lines in Figure 8) by rotating actuating lever assembly 152 using lever arm 149:



Ex.1013, Fig. 8 (annotated), 7:65-8:52.

[0313]. In the Figure 3/3A embodiment, Winberg's fuel shutoff has an actuator lever assembly 100, which is a second end external to the carburetor to actuate the plunger 40 (the first end). Id. The plunger 40 moves between a blocking position (Figure 3A) and a non-blocking position (Figure 3) through the use of Bowden cables 42 and 98 interconnected with actuator lever assembly 100. Id.



Id., FIGS. 3-3A (annotated).

[0314]. Winberg's fuel shutoff is manually actuated in the Figure 8 embodiment and the Figure 3/3A embodiment. Ex.1013, Abstract, 2:14-24, 7:31-55, 7:65-8:52, FIGS. 3-3A & 8.

[0315]. A POSA would have been motivated to combine Nakafushi and Winberg. Nakafushi and Winberg both relate to internal combustion engines. §VI.B, *supra*; §VI.F, *supra*. Nakafushi and Winberg both disclose fuel shutoff systems in carburetors. Ex.1005, [0003]-[0004]; Ex.1013, Abstract. Winberg discloses that its manually actuated fuel shutoff is applicable to internal combustion engines. Ex.1013, 1:8-10.

[0316]. A POSA also would have had a reasonable expectation of success, because Winberg's float bowl configuration was common for use with small engines, and Winberg discloses using its float bowl and fuel shutoff in different applications of small engines. In addition, a POSA would have understood that mechanical valves, such as Winberg's fuel shutoff, and solenoids, such as the line valves in Nakafushi, can be configured to operate simultaneously. Walker demonstrates such a solution in a dual fuel engine using gasoline and LPG. Ex.1015, 2:3-32.

[0317]. Accordingly, a POSA would have understood that Winberg teaches [11.3].

2. Claim 12: "The dual fuel generator of claim 11, wherein the engine is a pull start, batteryless engine."

[0318]. Claim 12 depends from claim 11 and recites: "wherein the engine is a pull start, batteryless engine."

[0319]. Matsushima discloses a pull start, batteryless engine. *Supra*, §VII.B.4. A POSA would have been motivated to combine Nakafushi and Matsushima, and would have had a reasonable expectation of success in doing so. *Id.* Accordingly, a POSA would have understood that the combination of Nakafushi, Matsushima, and Winberg teaches claim 12.

3. Claim 13: "The dual fuel generator of claim 11, wherein the gaseous fuel is LPG and the liquid fuel is gasoline."

[0320]. Claim 13 depends from claim 11 and recites: “wherein the gaseous fuel is LPG and the liquid fuel is gasoline.”

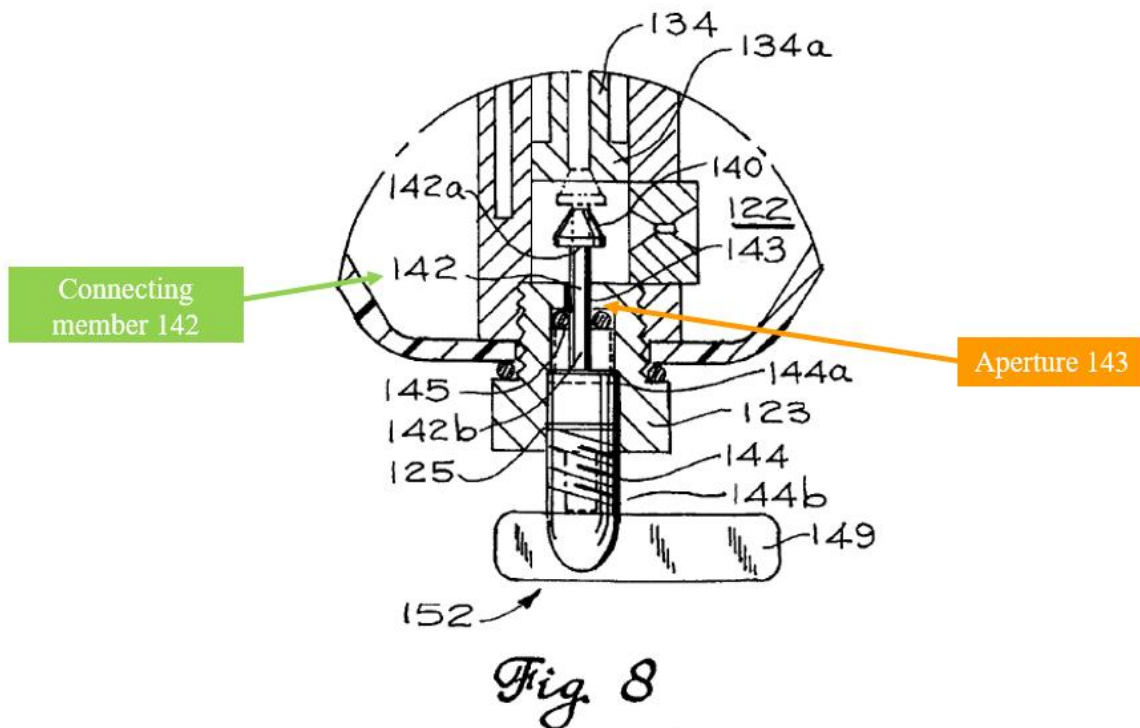
[0321]. Nakafushi discloses an engine operable on LPG and gasoline.

Supra, §VII.C.6.

4. Claim 14: “The dual fuel generator of claim 11, wherein the manually actuated fuel shutoff comprises a rotating mechanical valve.”

[0322]. Claim 14 depends from claim 11 and recites: “wherein the manually actuated fuel shutoff comprises a rotating mechanical valve.”

[0323]. In the Figure 8 embodiment, Winberg discloses a rotating shaft (connecting member 142) that extends through an aperture 143 in the carburetor:



Ex.1013, Fig. 8 (annotated), 7:65-8:52

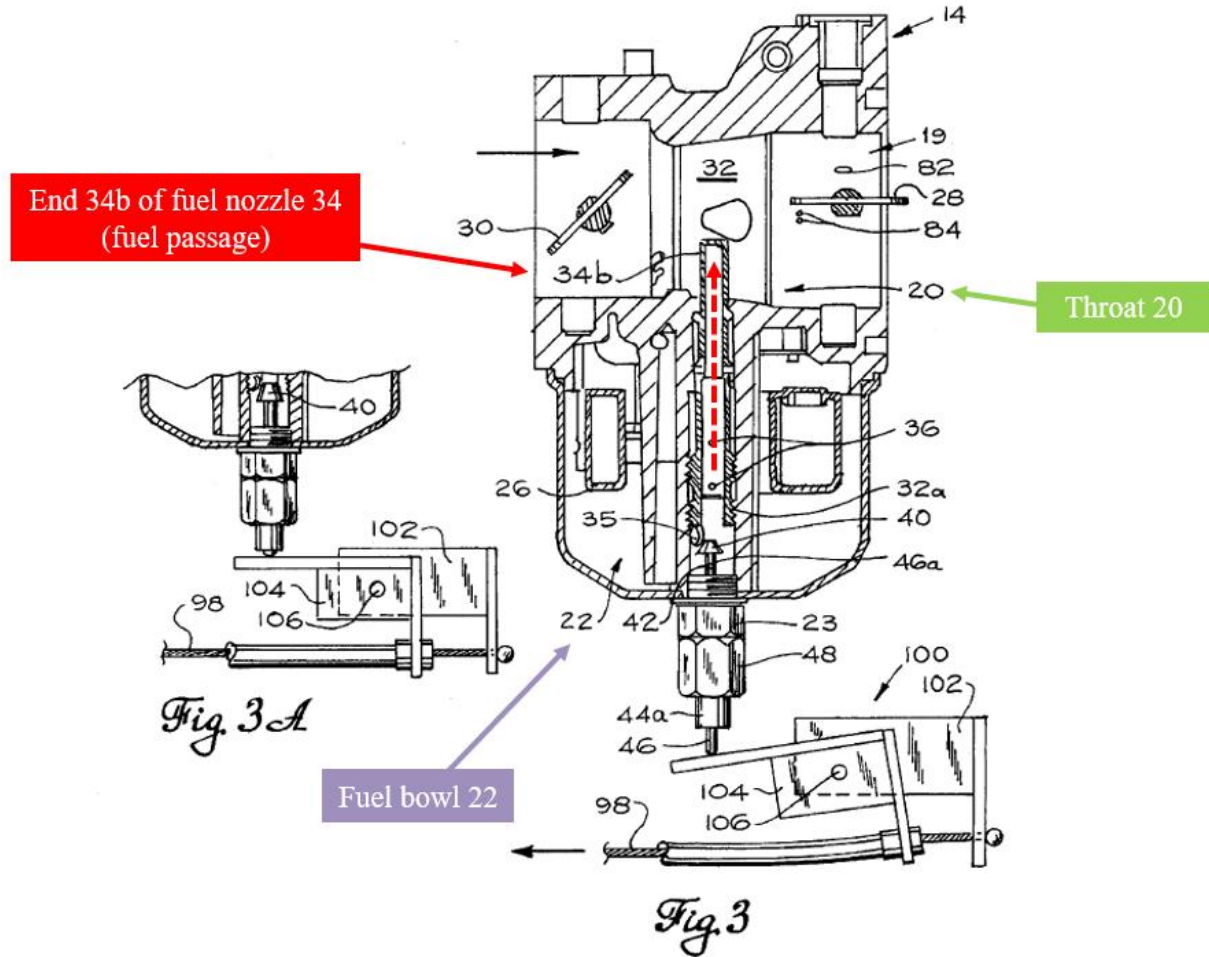
[0324]. Accordingly, a POSA would have understood that the combination of Nakafushi, Matsushima, and Winberg teaches claim 14.

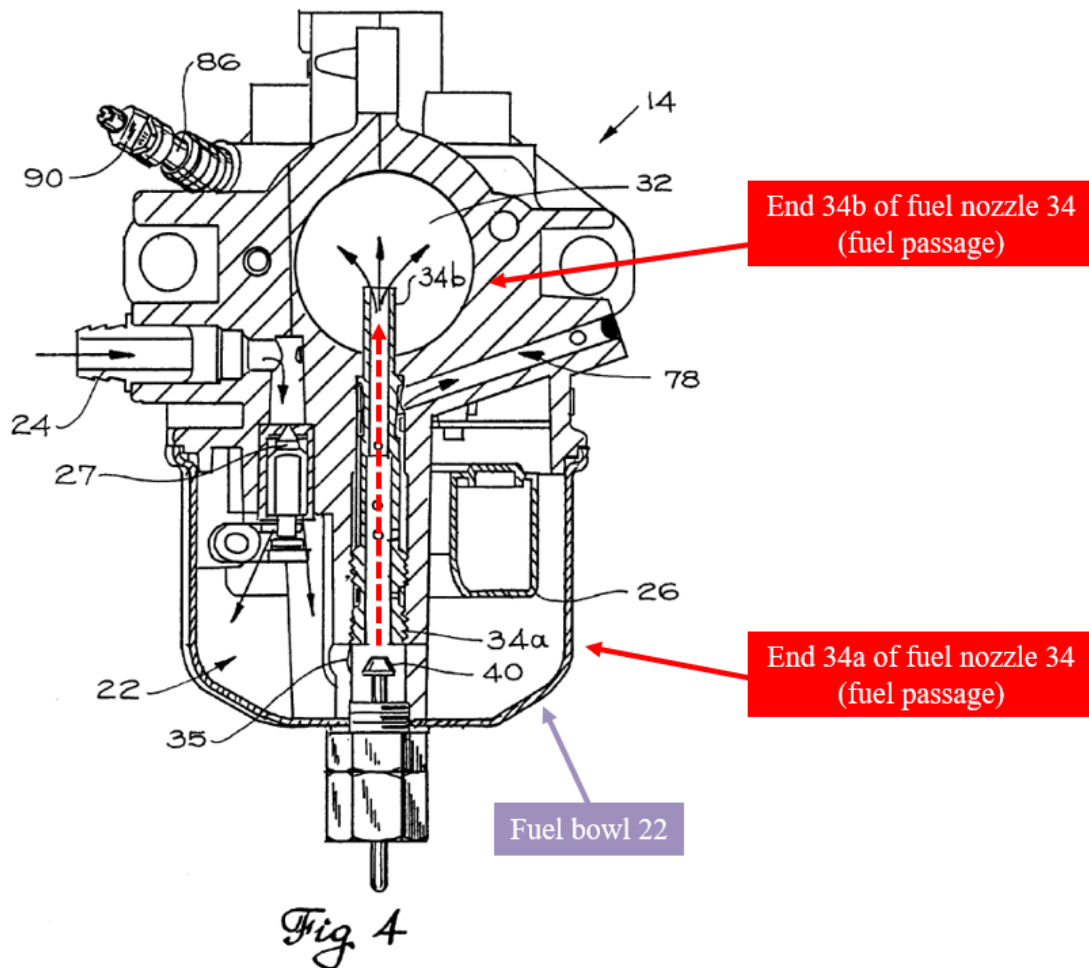
5. Claim 15

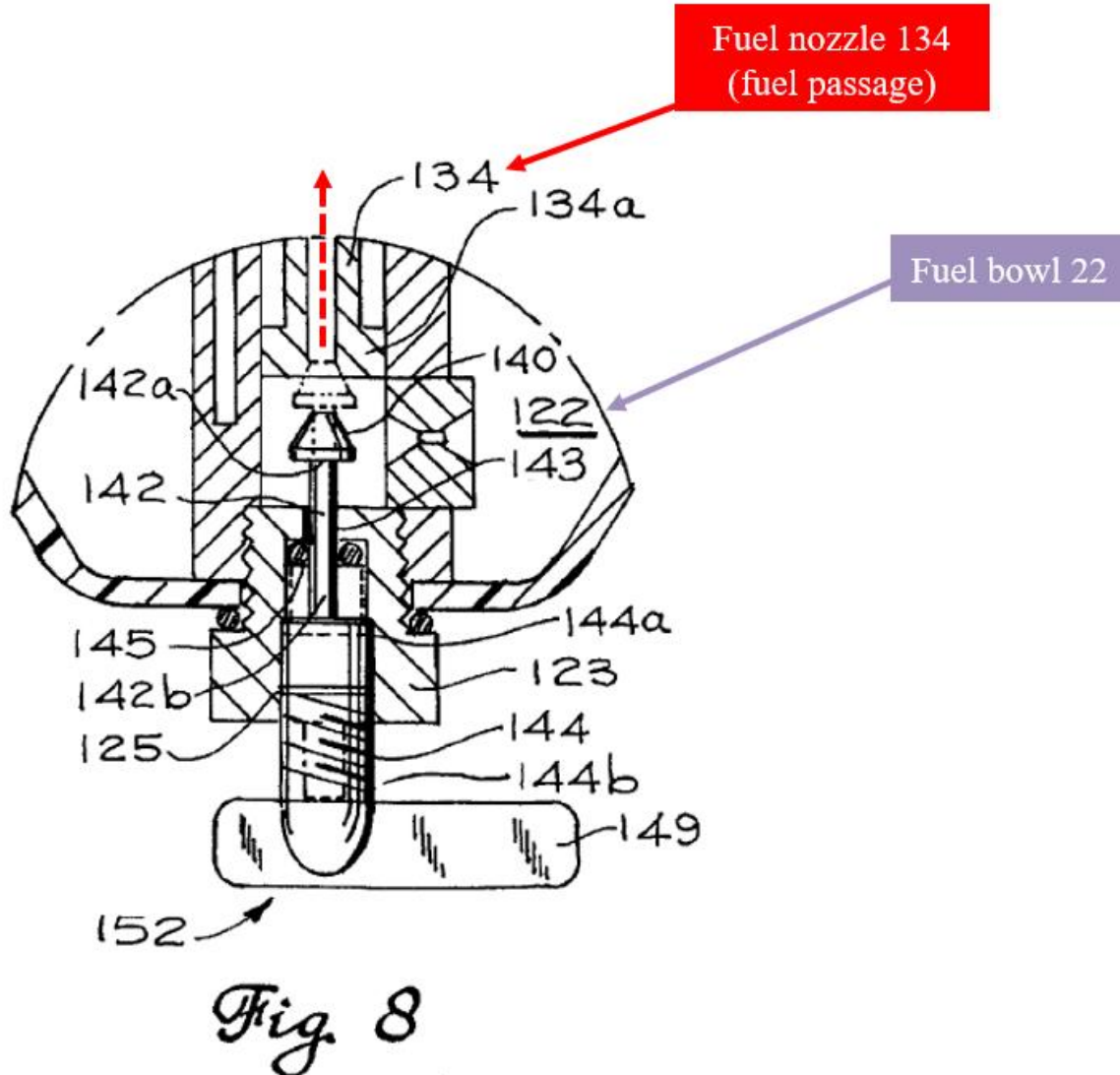
a. Element [15.1]: “The dual fuel generator of claim 14 wherein the carburetor comprises:”

[0325]. Element [15.1] recites a carburetor comprising “a float bowl, a throat, and a fuel passage extending from the float bowl to the throat.”

[0326]. Winberg discloses a carburetor 14, which has a float bowl (fuel bowl 22/122) and throat 20. Ex.1013, 3:61-4:32, 7:65-8:52; FIGS. 3A-5 & 8. The carburetor 14 has a fuel nozzle 34/134, which has a fuel passage extending from the float bowl to the throat. *Id.*, 4:12-33, 7:65-8:52, FIGS. 3A-5 & 8.







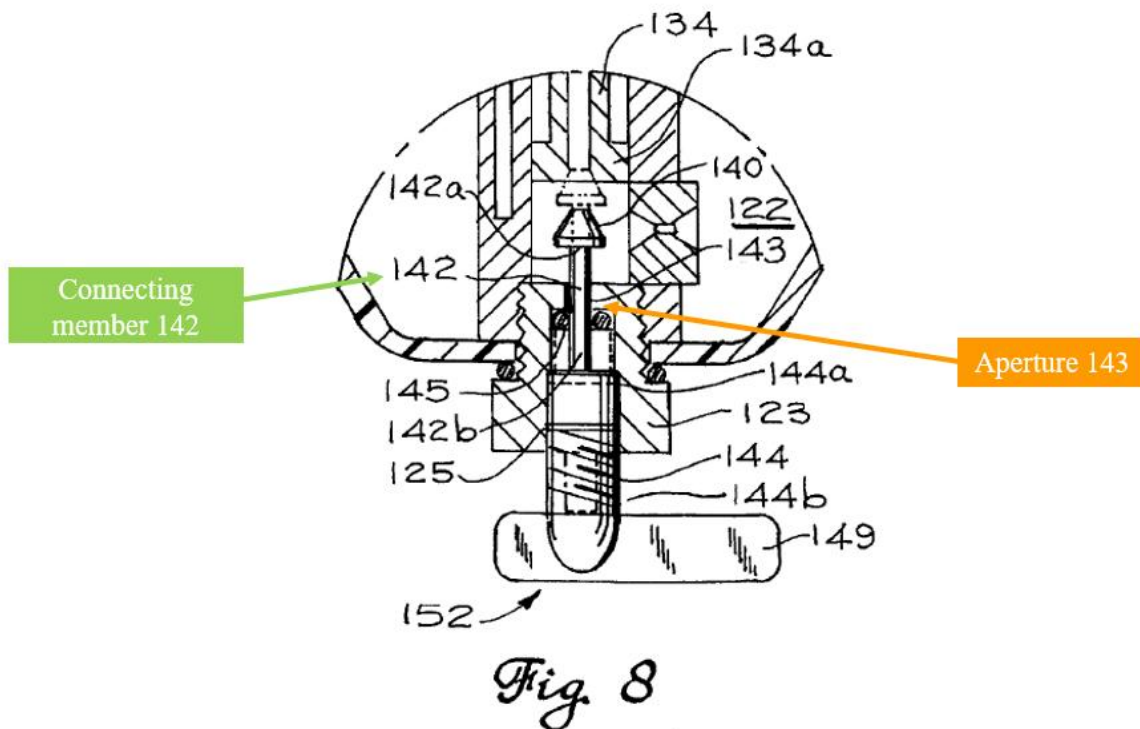
Id., FIGS. 3-3A, 4 & 8 (annotated).

- b. **Element [15.2]: “wherein the manually actuated fuel shutoff comprises a shaft extending into the carburetor through an aperture in the float bowl, the shaft being coupled to a valve tip in the float bowl that rotates to open and close the fuel passage.”**

[0327]. Element [15.1] recites “wherein the fuel shutoff comprises a shaft extending into the carburetor through an aperture in the float bowl and

coupled to a valve tip in the float bowl that rotates to open and close the fuel passage.”

[0328]. In the Figure 8 embodiment, Winberg’s fuel shutoff comprises a shaft (connecting member 142) attached to plunger 140 that extends through aperture 143 in the carburetor. Ex.1013, 7:65-8:52, Fig. 8. Winberg’s valve tip (plunger 140) rotates to open and close the fuel passage. *Id.*



Id., Fig. 8 (annotated), 7:65-8:52.

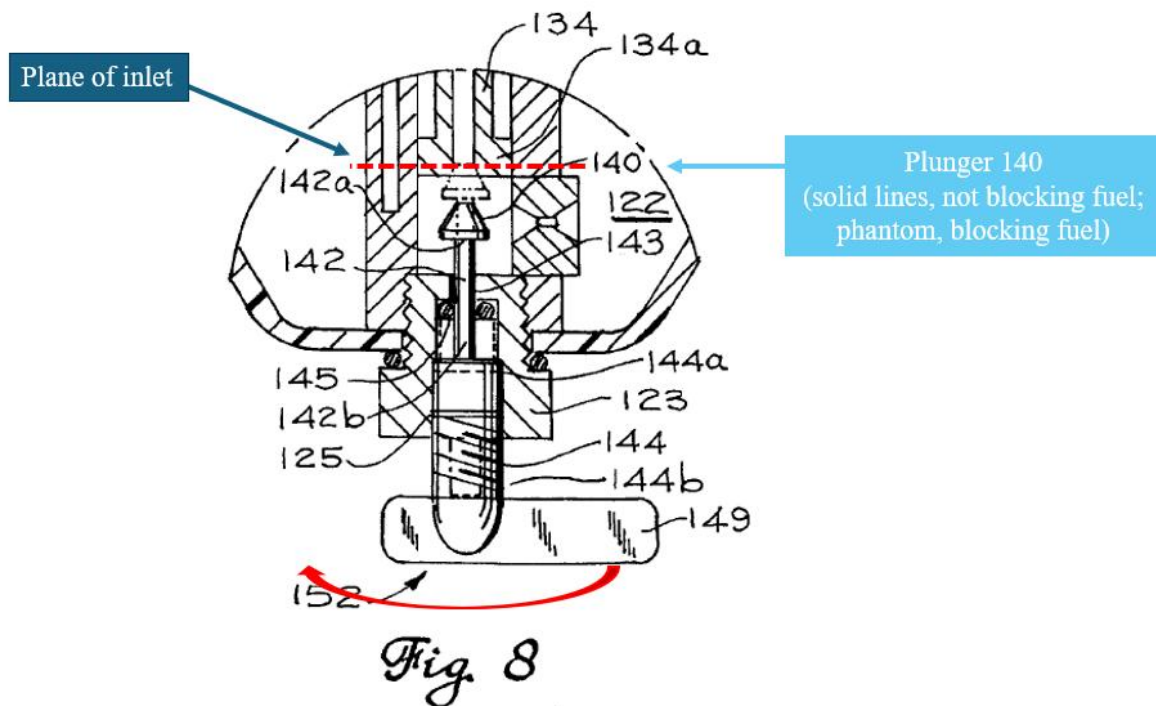
[0329]. Accordingly, a POSA would have understood that the combination of Nakafushi, Matsushima, and Winberg teaches claim 15.

6. Claim 16: “The dual fuel generator of claim 15 wherein the valve tip rotates parallel to an inlet of the fuel passage between a

first position permitting fuel flow into the inlet and a second position blocking fuel flow into the inlet.”

[0330]. Claim 16 depends from claim 15, and recites “wherein the valve tip rotates parallel to an inlet of the fuel passage between a first position permitting fuel flow into the inlet and a second position blocking fuel flow into the inlet.”

[0331]. In the Figure 8 embodiment, Winberg’s valve tip (plunger 140) has a rotational plane that is parallel to the inlet of the fuel passage:



Id., Fig. 8 (annotated), 7:65-8:52.

[0332]. Winberg’s plunger 140 rotates between a position permitting fuel flow into the inlet of the fuel passage (first position) and a second position blocking fuel flow into the inlet of the passage. *Id.* Accordingly, a POSA would

have understood that the combination of Nakafushi, Matsushima, and Winberg teaches claim 16.

G. Ground 7: Claims 11, 13, and 14 are Obvious by Holzapfel.

1. Claim 11

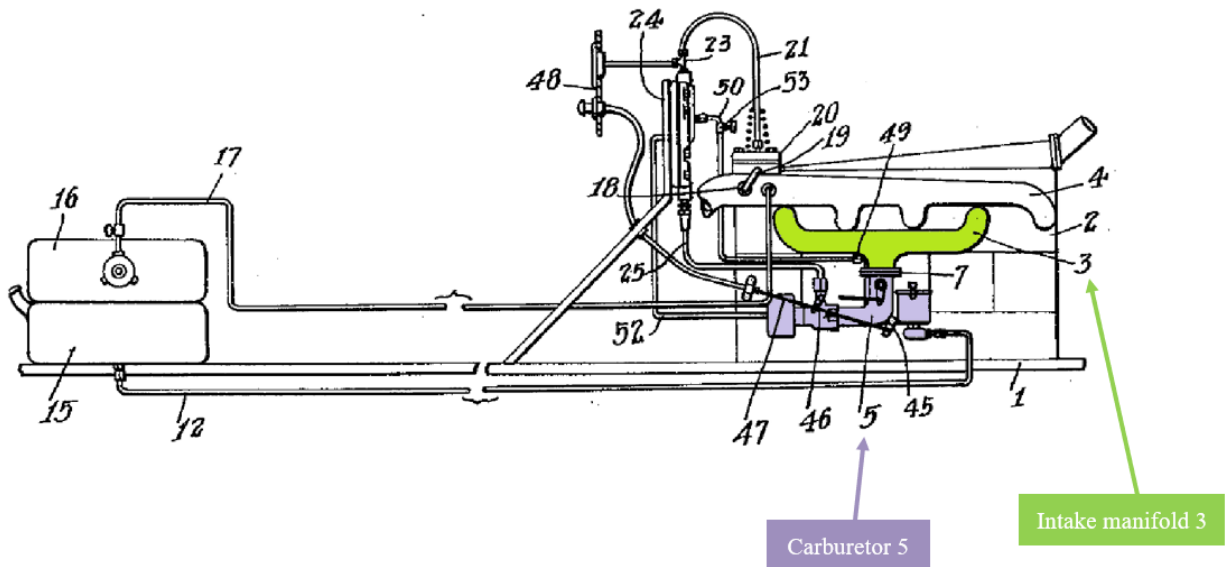
a. Element [11.1]: “an engine operable on a gaseous fuel and a liquid fuel;”

[0333]. Holzapfel teaches a dual fuel engine. Ex.1008, 1:1-5. It would have been obvious to a POSA to have implemented Holzapfel’s dual fuel engine in a generator, as dual fuel generators were well known as of the earliest priority date of the ‘145 Patent. Ex.1016, pp.1-31; Ex.1017, p.1.

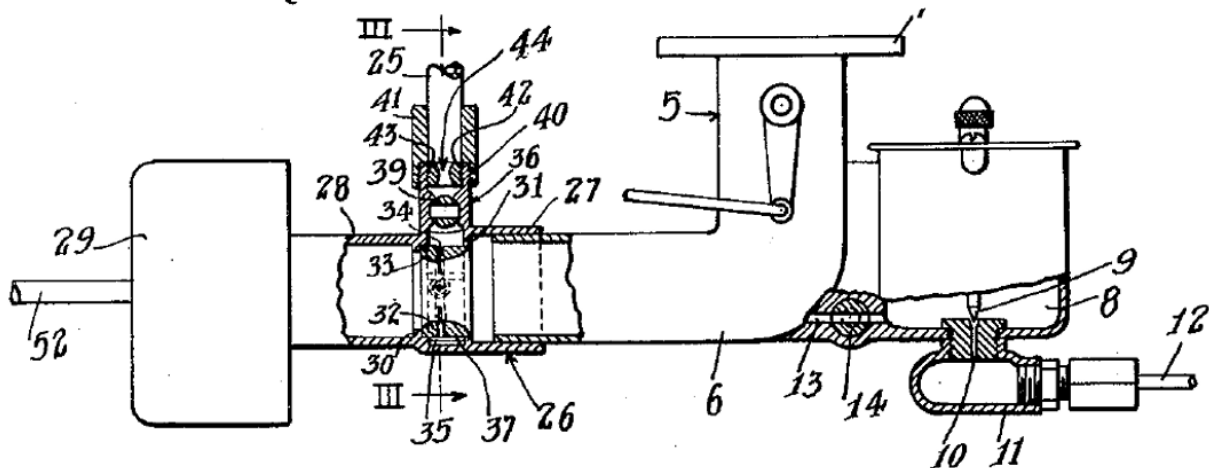
b. Element [11.2]: “a carburetor attached to an intake of the engine to mix air and fuel and connect to a gaseous fuel source and a liquid fuel source; and”

[0334]. Element [11.2] recites “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.”

[0335]. Holzapfel teaches 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. VII.D.2.e, *supra*. Holzapfel teaches a carburetor 5 that is connected to intake manifold 3, as seen in FIGS. 1-2 below:

Fig.1*Fig.2*

Carburetor



Ex.1008, FIG. 2 (annotated), 1:84-86.

[0336]. Holzapfel states the other end of the carburetor constitutes an “inlet opening through which air may be sucked for mixing with the fuel injected into the carburetor.” Ex.1008, 1:87-89. The carburetor is “equipped with a float

chamber or fuel reservoir 8 which may be of any suitable construction to provide a supply of [liquid] fuel at atmospheric pressure ready for injection into the tube 6 of the carburetor 5.” Ex.1008, 1:89-94. The float chamber 8 communicates with the carburetor by means of passage 13. Ex.1008, 1:100-04.

[0337]. Holzapfel further discloses “the gaseous fuel supply through outlet tube 25 may be mixed with air and passed into the tube 6 of the carburetor 5 so that such air and gas mixture may pass into the intake manifold 3 of the engine 2.” Ex.1008, 2:39-44.

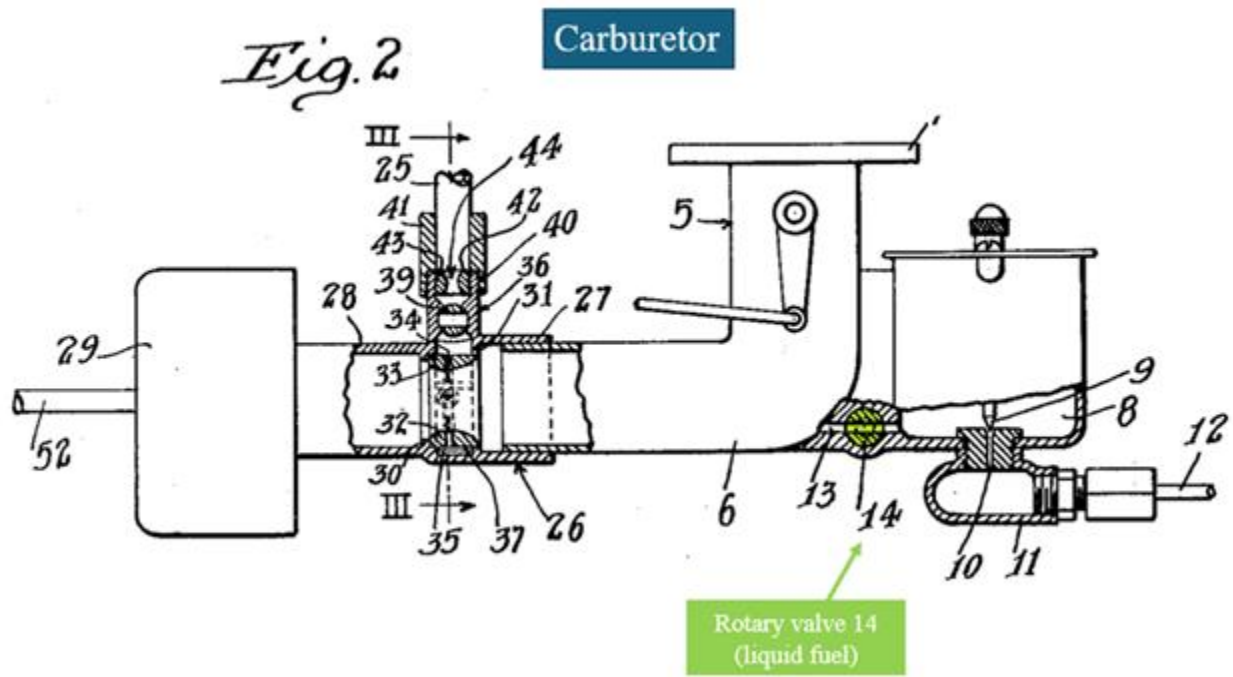
[0338]. A POSA would understand that Holzapfel teaches a carburetor attached to an engine intake that mixes air and fuel and connects to a gaseous fuel source and the liquid fuel source, as recited in [11.2].

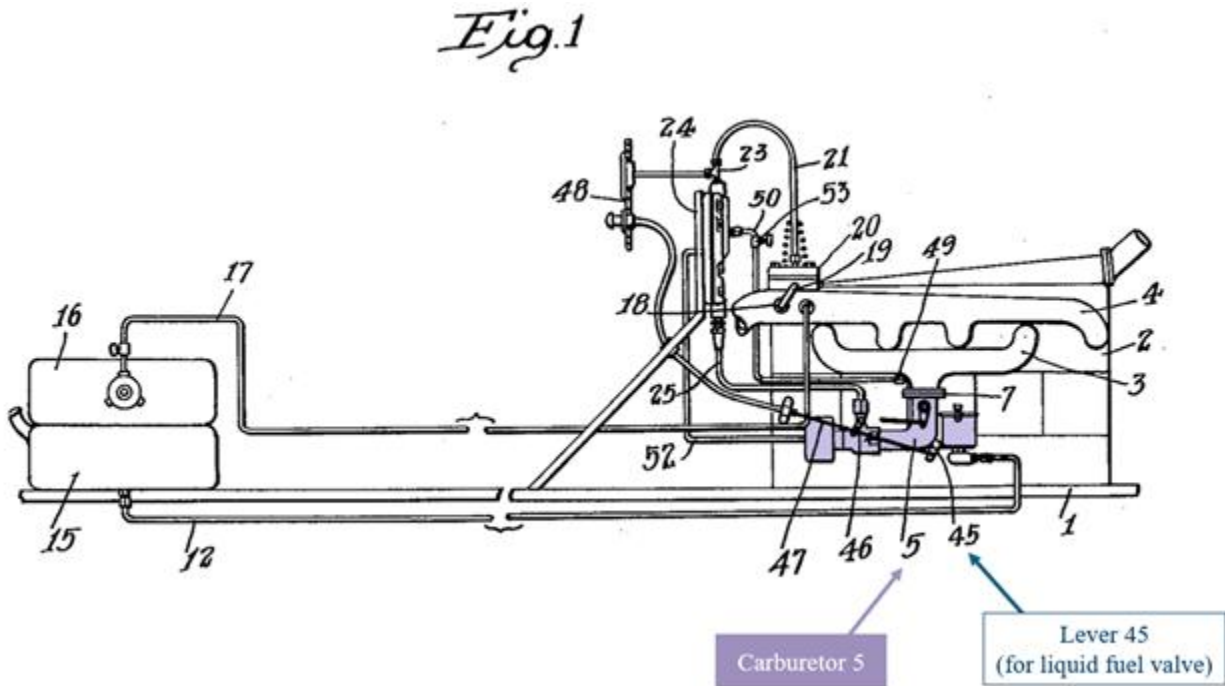
- c. **Element [11.3]: “a manually actuated fuel shutoff coupled to the carburetor, the manually actuated fuel shutoff comprising: a first end in the carburetor that actuates to selectively allow or block a flow of fuel through the carburetor; and a second end external to the carburetor to actuate the first end.”**

[0339]. Element [11.3] recites “a manually actuated fuel shutoff coupled to the carburetor...comprising: a first end in the carburetor that actuates to selectively allow or block a flow of fuel through the carburetor; and a second end external to the carburetor to actuate the first end.”

[0340]. Holzapfel discloses rotary valve 14 connected to lever 45, which together are a “manually actuated fuel shutoff.” Ex.1008, 2:100-123; FIGS. 1-2.

[0341]. As seen in FIGS. 1 and 2, rotary valve 14 and lever 45 are coupled to carburetor 5:





Ex.1008, FIGS. 1-2 (annotated).

[0342]. Rotary valve 14 defines the first end of the fuel shutoff, which operates in carburetor 5, and lever 45 defines the second end of the fuel shutoff, which operates external to carburetor 5.

[0343]. Rotary valve 14 is manually actuated to selectively allow or block a flow of fuel through the carburetor. Ex.1008, 2:100-123.

[0344]. Accordingly, a POSA would have understood that Holzapfel teaches [11.3].

2. **Claim 13: “The dual fuel generator of claim 11, wherein the gaseous fuel is LPG and the liquid fuel is gasoline.”**

[0345]. Holzapfel discloses an engine operable on LPG and gasoline.

Supra, §VII.D.6.

3. Claim 14: “The dual fuel generator of claim 11, wherein the manually actuated fuel shutoff comprises a rotating mechanical valve.”

[0346]. Claim 14 depends from Claim 11 and recites “wherein the manually actuated fuel shutoff comprises a rotating mechanical valve.” As discussed (*supra* §VII.G.1.c), Holzapfel discloses a “manually actuated fuel shutoff” comprising “a rotating mechanical valve,” i.e., rotary valve 14. Ex.1008, 1:104-107. Accordingly, a POSA would have understood that Holzapfel teaches claim 14.

H. Ground 8: Claims 12, 15, and 16 are Rendered Obvious by the Combination of Holzapfel, Matsushima, and Winberg.

1. Claim 12: “The dual fuel generator of claim 11, wherein the engine is a pull start, batteryless engine.”

[0347]. Claim 12 depends from claim 11 and recites: “wherein the engine is a pull start, batteryless engine.”

[0348]. Holzapfel teaches or renders obvious all limitations of claim 11 *Supra*, §VII.G.1. Matsushima discloses a pull start, batteryless engine. *Supra*, §VII.D.1. A POSA would have been motivated to combine Holzapfel and Matsushima, and would have had a reasonable expectation of success in doing so. *Id.* Accordingly, a POSA would have understood that the combination of Holzapfel, Matsushima, and Winberg teaches claim 12.

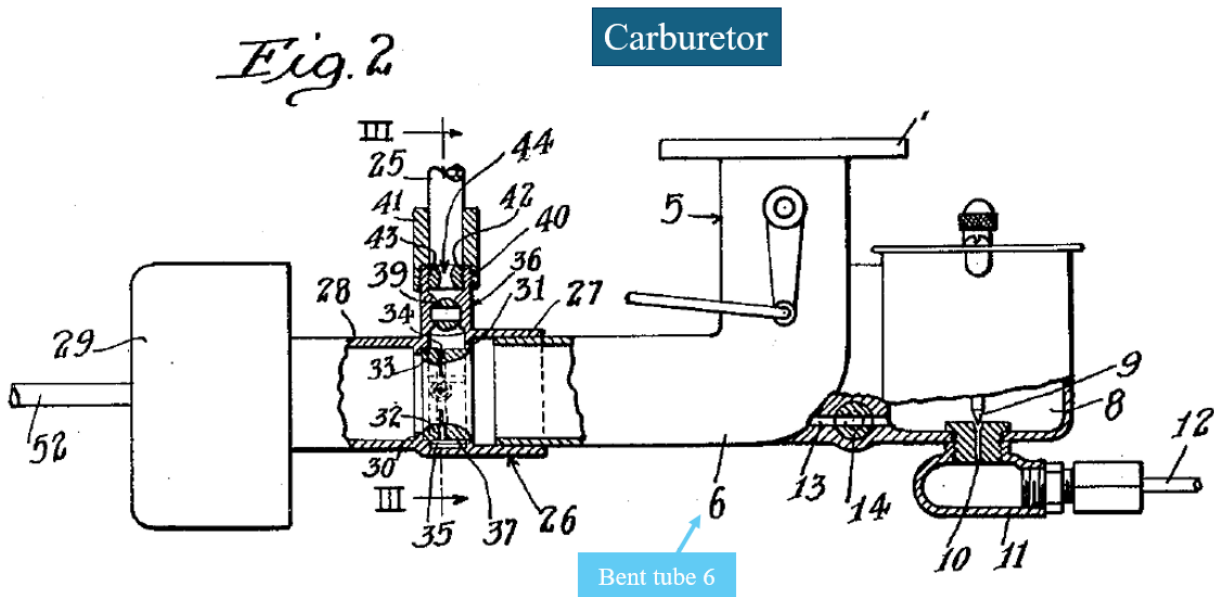
2. Claim 15

[0349]. Claim 15 depends from claims 11 and 14. Holzapfel teaches or renders obvious all limitations of claims 11 and 14. *Supra*, §§VII.G.1, VII.G.3.

a. **Element [15.1]: “a float bowl; a throat; and a fuel passage to provide fuel from the float bowl to the throat;”**

[0350]. Element [15.1] recites a carburetor comprising “a float bowl, a throat, and a fuel passage extending from the float bowl to the throat.”

[0351]. Holzapfel’s carburetor includes float chamber or fuel reservoir 8 that communicates with the carburetor by means of passage 13. As seen in Figure 2, carburetor 5 also includes a throat (which is bent tube 6):



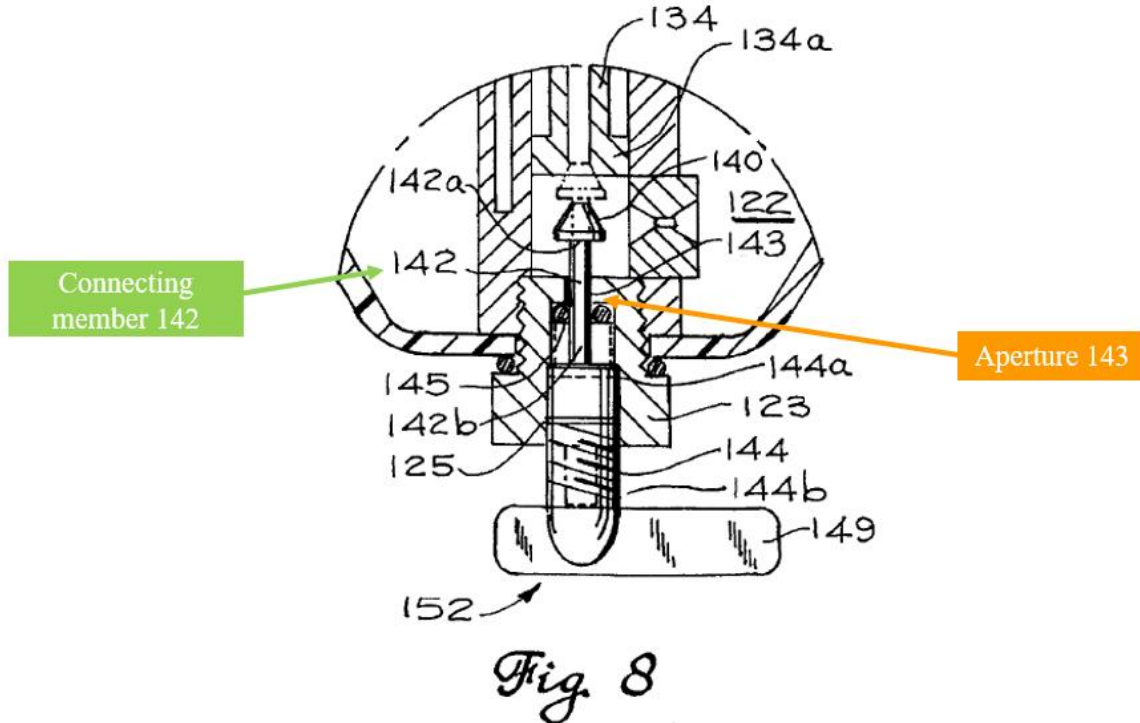
Ex.1008, FIG. 2.

b. **Element [15.2]: “wherein the manually actuated fuel shutoff comprises a shaft extending into the carburetor through an aperture in the float bowl, the shaft being**

coupled to a valve tip in the float bowl that rotates to open and close the fuel passage.”

[0352]. Winberg teaches “wherein the manually actuated fuel shutoff comprises a shaft extending into the carburetor through an aperture in the float bowl, the shaft being coupled to a valve tip in the float bowl that rotates to open and close the fuel passage.” §VII.E.5.b, *supra*.

[0353]. In the Figure 8 embodiment, Winberg’s fuel shutoff comprises a shaft (connecting member 142) attached to plunger 140 that extends through aperture 143 in the carburetor. Ex.1013, 7:65-8:52, Fig. 8. Winberg’s valve tip (plunger 140) rotates to open and close the fuel passage. *Id.*



Id., Fig. 8 (annotated), 7:65-8:52.

[0354]. It would have been obvious to a POSA that Winberg's fuel bowl 122 and plunger 140 (*Id.*, FIG. 8) could substitute for Holzapfel's float chamber 8 and needle valve 9. A POSA would have understood that Winberg's plunger structures perform the same function as Holzapfel's needle valve structure, namely, blocking and unblocking an aperture through which fuel flows. A POSA would have been motivated to combine Holzapfel and Winberg. Holzapfel and Winberg both relate to internal combustion engines. §VI.C, *supra*; §VI.F, *supra*. Holzapfel and Winberg both disclose fuel shutoff systems in carburetors. Ex.1008, 2:108-123; Ex.1013, Abstract. Winberg discloses that its manually actuated fuel shutoff is applicable to internal combustion engines. Ex.1013, 7:57-64.

[0355]. In addition, a POSA would have been motivated to use Winberg's float bowl and fuel cutoff to minimize any gasoline leaks caused by a defective horizontal valve 13 in Holzapfel's configuration or if the user forgets to close the shutoff valve, particularly for a portable generator that is transported to different locations between uses. Because Winberg's fuel nozzle 134 is vertical, any leaks caused by a defective plunger 140 would be minimal compared with Holzapfel's configuration, which has a horizontal fuel passage 13.

[0356]. A POSA also would have had a reasonable expectation of success, because Winberg's float bowl configuration was common for use with

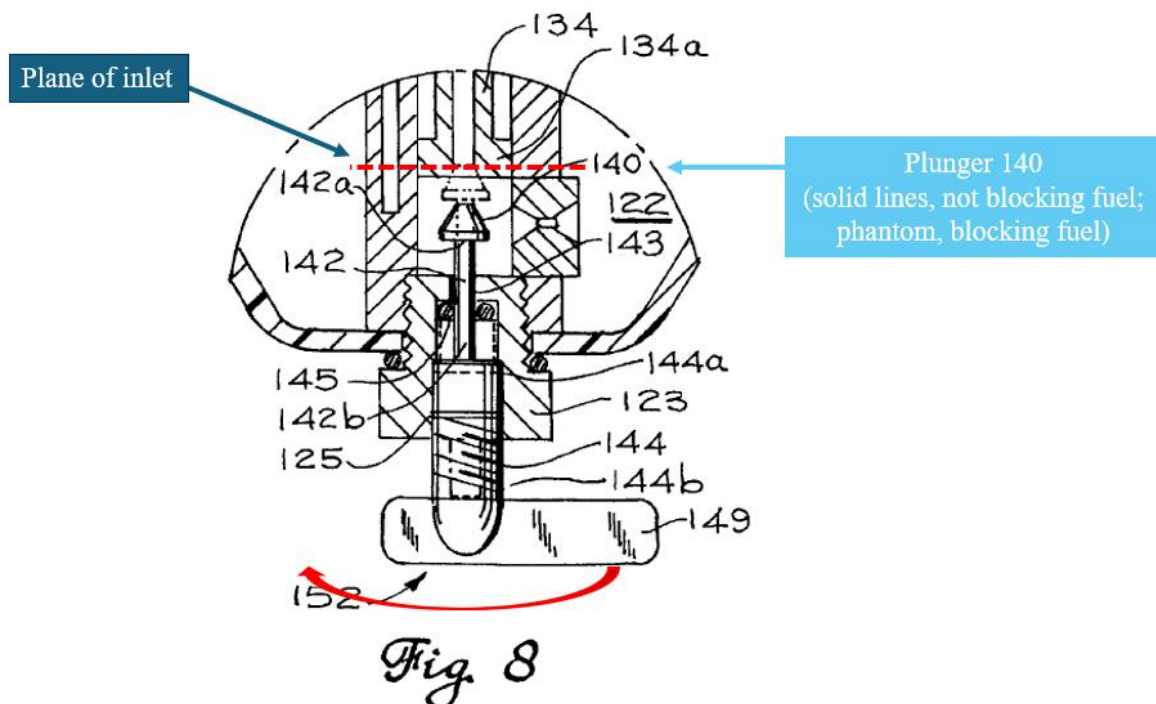
small engines, and Winberg discloses using its float bowl and fuel shutoff in different applications of small engines, including generators.

[0357]. Accordingly, a POSA would have understood that the combination of Holzapfel, Matsushima, and Winberg teaches claim 15.

3. Claim 16: “The dual fuel generator of claim 15 wherein the valve tip rotates parallel to an inlet of the fuel passage between a first position permitting fuel flow into the inlet and a second position blocking fuel flow into the inlet.”

[0358]. Claim 16 depends from claim 15 and recites “wherein the valve tip rotates parallel to an inlet of the fuel passage between a first position permitting fuel flow into the inlet and a second position blocking fuel flow into the inlet.”

[0359]. In the Figure 8 embodiment, Winberg’s valve tip (plunger 140) has a rotational plane that is parallel to the inlet of the fuel passage:



Id., Fig. 8 (annotated), 7:65-8:52.

[0360]. Winberg's plunger 140 rotates between a position permitting fuel flow into the inlet of the fuel passage (first position) and a second position blocking fuel flow into the inlet of the passage. *Id.*

[0361]. Accordingly, a POSA would have understood that the combination of Holzapfel, Matsushima, and Winberg teaches claim 16.

VIII. CONCLUSION

[0362]. In signing this Declaration, I recognize that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in this proceeding. If required, I will appear for cross-examination at the appropriate time. I reserve the right to offer opinions relevant to the invalidity of the challenged claims and/or offer testimony in support of this Declaration.

[0363]. I hereby declare that all statements made herein of my own knowledge are true and that all statements are 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 18 U.S.C. § 1001.

EXHIBIT 1001

Related U.S. Application Data

continuation-in-part of application No. 14/738,060,
filed on Jun. 12, 2015, now Pat. No. 10,221,781.

(51) **Int. Cl.**

F02D 41/00 (2006.01)
F02M 17/38 (2006.01)
F02M 13/08 (2006.01)
F02D 19/06 (2006.01)
F02B 43/00 (2006.01)
F02M 17/10 (2006.01)
F02M 21/02 (2006.01)
F02B 63/04 (2006.01)
F02D 41/06 (2006.01)
F02M 21/04 (2006.01)
F02M 19/08 (2006.01)
F02N 3/02 (2006.01)

(52) **U.S. Cl.**

CPC **F02D 19/0613** (2013.01); **F02M 13/08**
(2013.01); **F02M 17/10** (2013.01); **F02M**
21/0212 (2013.01); **F02M 43/00** (2013.01);
F02D 41/0025 (2013.01); **F02D 41/062**
(2013.01); **F02M 19/08** (2013.01); **F02M**
21/047 (2013.01); **F02N 3/02** (2013.01); **Y02T**
10/30 (2013.01)

(58) **Field of Classification Search**

CPC F02M 35/10196; F02D 19/0647; F02D
19/0613; F02D 29/06; F02D 41/0025

See application file for complete search history.

(56)

References Cited**U.S. PATENT DOCUMENTS**

4,287,908 A 9/1981 Storgard
4,323,046 A 4/1982 Barber
4,364,370 A 12/1982 Smith et al.
4,375,795 A 3/1983 Billingsley
4,416,244 A 11/1983 McDonald
4,471,805 A 9/1984 Solie et al.
4,492,207 A 1/1985 Hallberg
4,750,514 A 6/1988 Omori et al.
4,788,960 A 12/1988 Oshizawa
5,555,873 A 9/1996 Nolen
5,682,845 A * 11/1997 Woody F02B 33/04
123/73 A
5,934,320 A 8/1999 O'Reilly et al.
6,543,395 B2 4/2003 Green
6,591,817 B2 7/2003 Deutsch

7,591,257 B2 9/2009 Bayer et al.
7,802,562 B2 9/2010 Lippa et al.
7,905,469 B2 3/2011 Nickels et al.
7,954,479 B2 6/2011 Kojima et al.
8,042,569 B2 10/2011 Morris
8,616,159 B1 * 12/2013 Hawkins F02B 63/047
123/2
8,757,139 B2 6/2014 Deng
8,944,027 B2 2/2015 Montgomery
9,175,601 B2 11/2015 Markoski
9,523,497 B2 12/2016 Deng
2007/0137591 A1 6/2007 Sugimoto et al.
2007/0215223 A1 9/2007 Morris
2009/0320789 A1 * 12/2009 Lund F02D 19/0644
123/299
2015/0034025 A1 * 2/2015 Markoski F02N 3/02
123/2
2015/0308356 A1 * 10/2015 Taniguchi F02M 21/0236
123/495
2017/0009670 A1 * 1/2017 Sorge F02D 19/0615
2017/0130676 A1 * 5/2017 Markoski F02D 11/02
2018/0080392 A1 * 3/2018 Janscha F02B 69/04

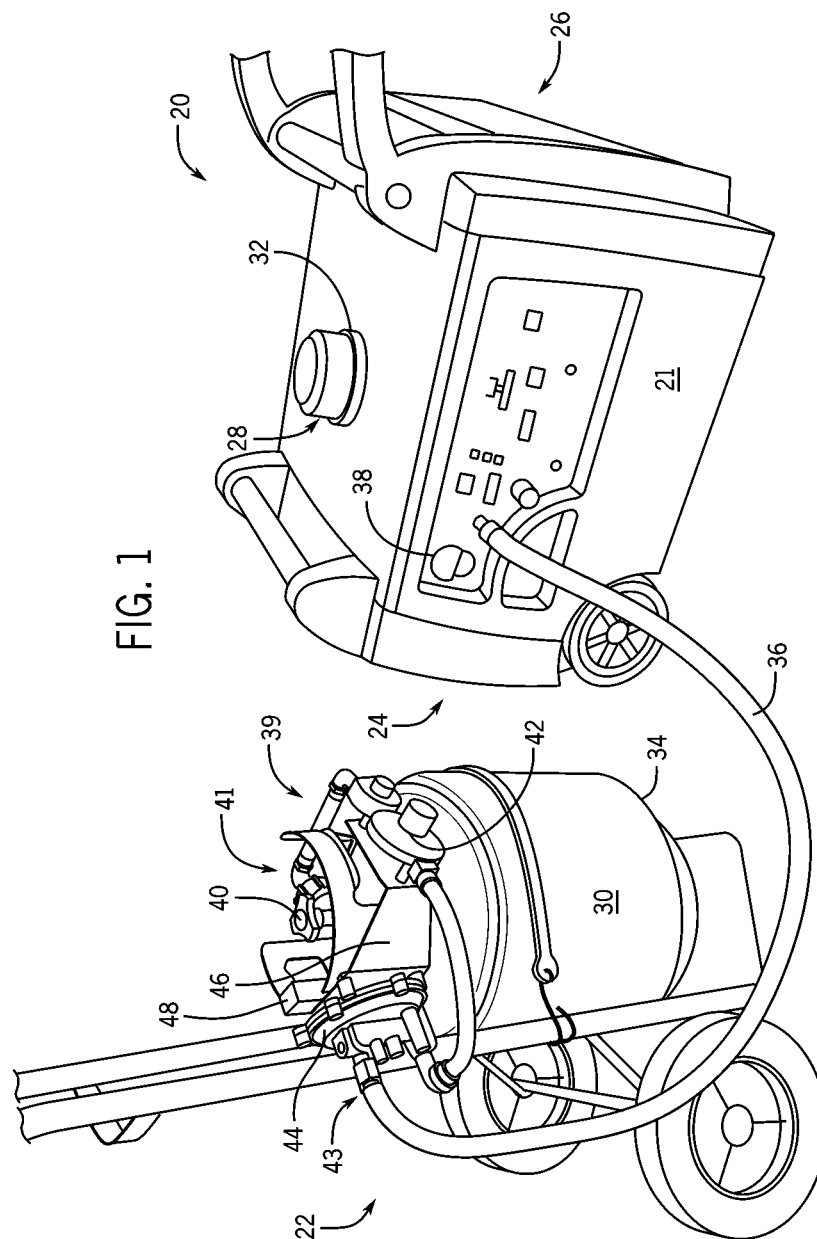
FOREIGN PATENT DOCUMENTS

EP 1826377 A2 8/2007
FR 2220679 A1 10/1974
FR 2510660 A1 2/1983
GB 189800 A 10/1923
GB 532903 A 2/1941
JP H0466743 A 3/1992
WO 1999001659 A1 1/1999
WO 2007048633 A1 5/2007

OTHER PUBLICATIONS

Winco Inc., Home Power Tri-Fuel Portable Generators Owners
Manual, Nov. 21, 2017, pp. 1-16.
Winco Inc., HPS9000VE/E and HPS9000VE-03/A Generator Instal-
lation and Operators Manual, Aug. 9, 2013, pp. 1-16.
Winco Inc., Dyna ME5000VA Installation, Operation, and Mainte-
nance Instructions, Nov. 21, 2017, pp. 1-12.
Winco Inc., Dyna DL9000E, DL5000H, and D3000 Portable Gen-
erators Installation, Operation, and Maintenance Instructions, Nov.
21, 2017, pp. 1-12.
PowerLand Industrial Tools, Powerland Tri Fuel Generator Owner's
Manual, Dec. 24, 2015, pp. 1-41.
Winco Inc., HPS6000HE/I Bi-Fuel Generator Installation and Opera-
tors Manual, Mar. 8, 2010, pp. 1-20.
Yamaha EF2000iS Tri Fuel Conversion: Overview & Installation
Tips, Jan. 3, 2014, <https://www.youtube.com/watch?v=caZawwDaRQg>.

* cited by examiner



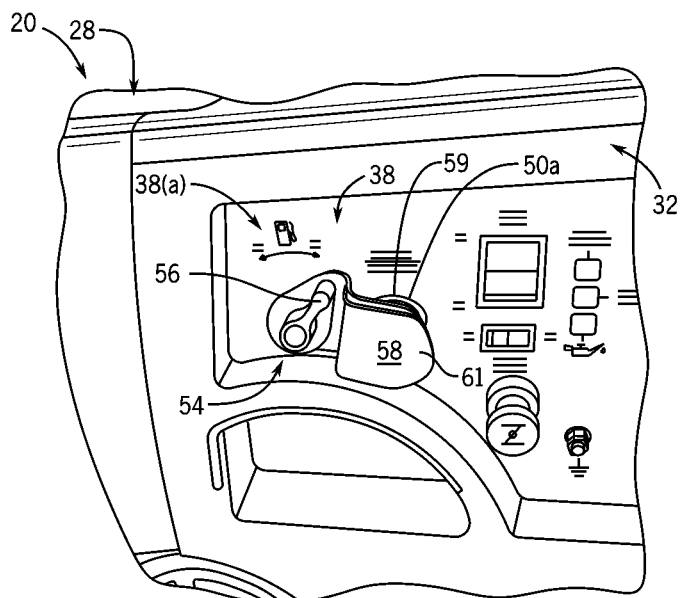


FIG. 2

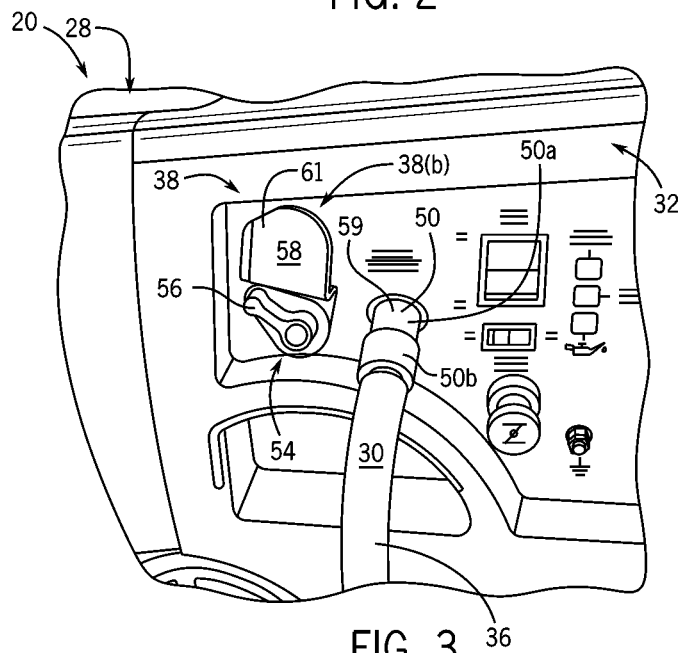


FIG. 3

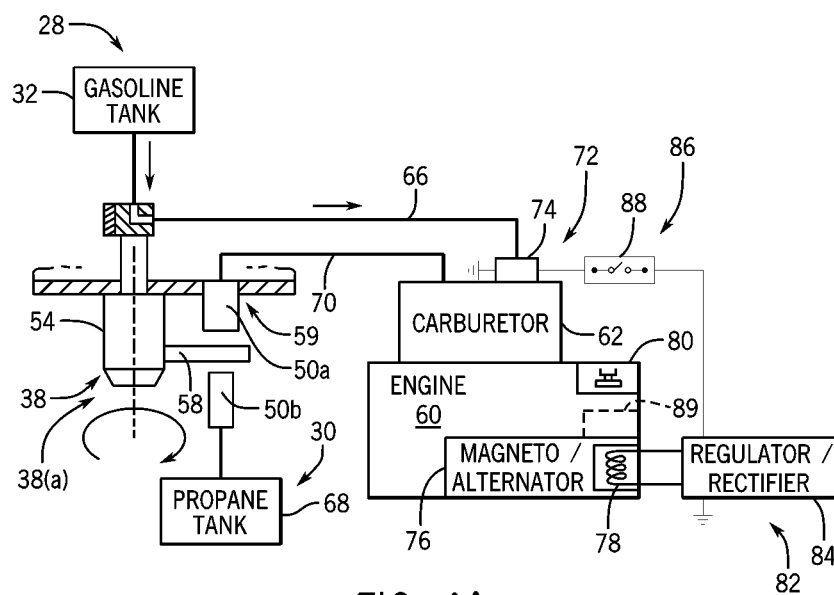


FIG. 4A

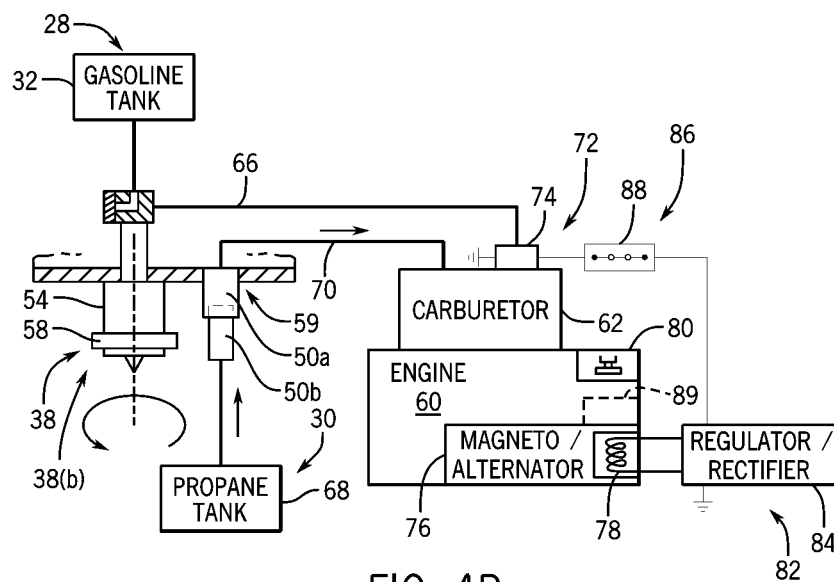
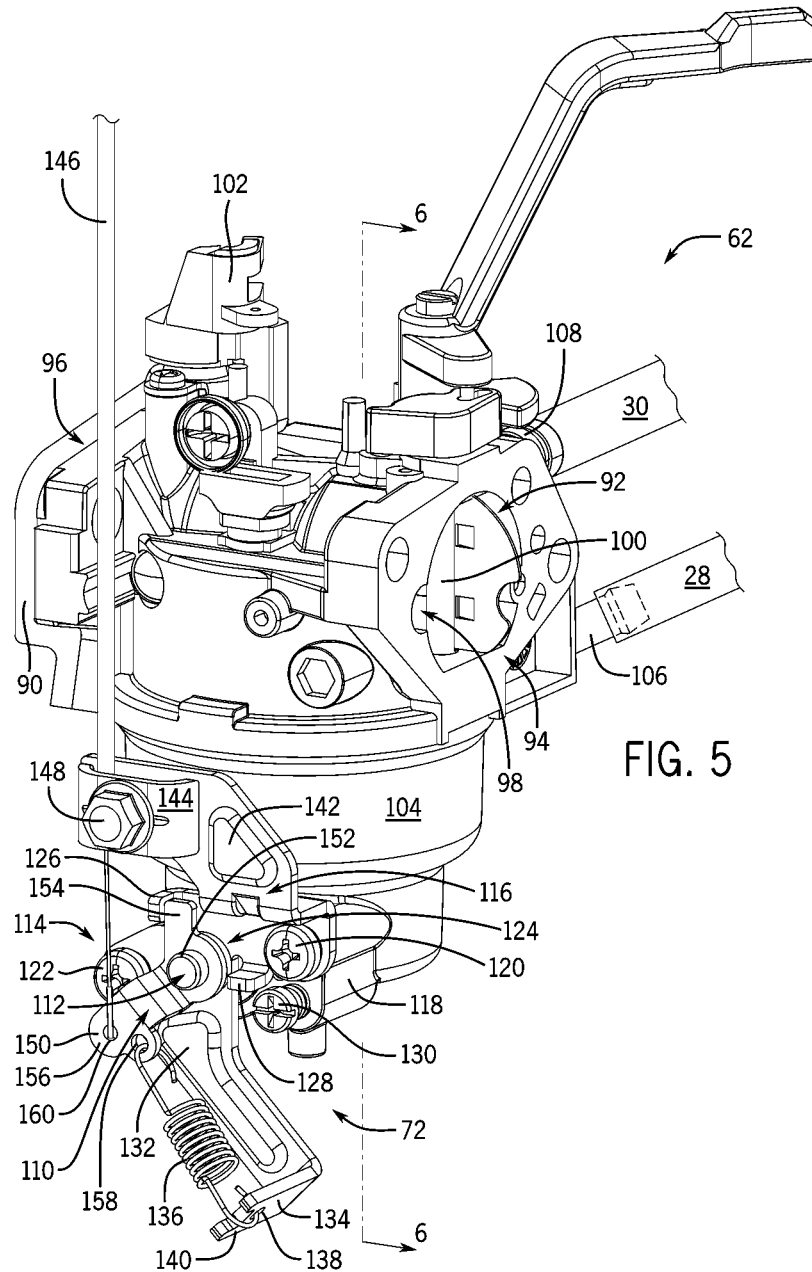
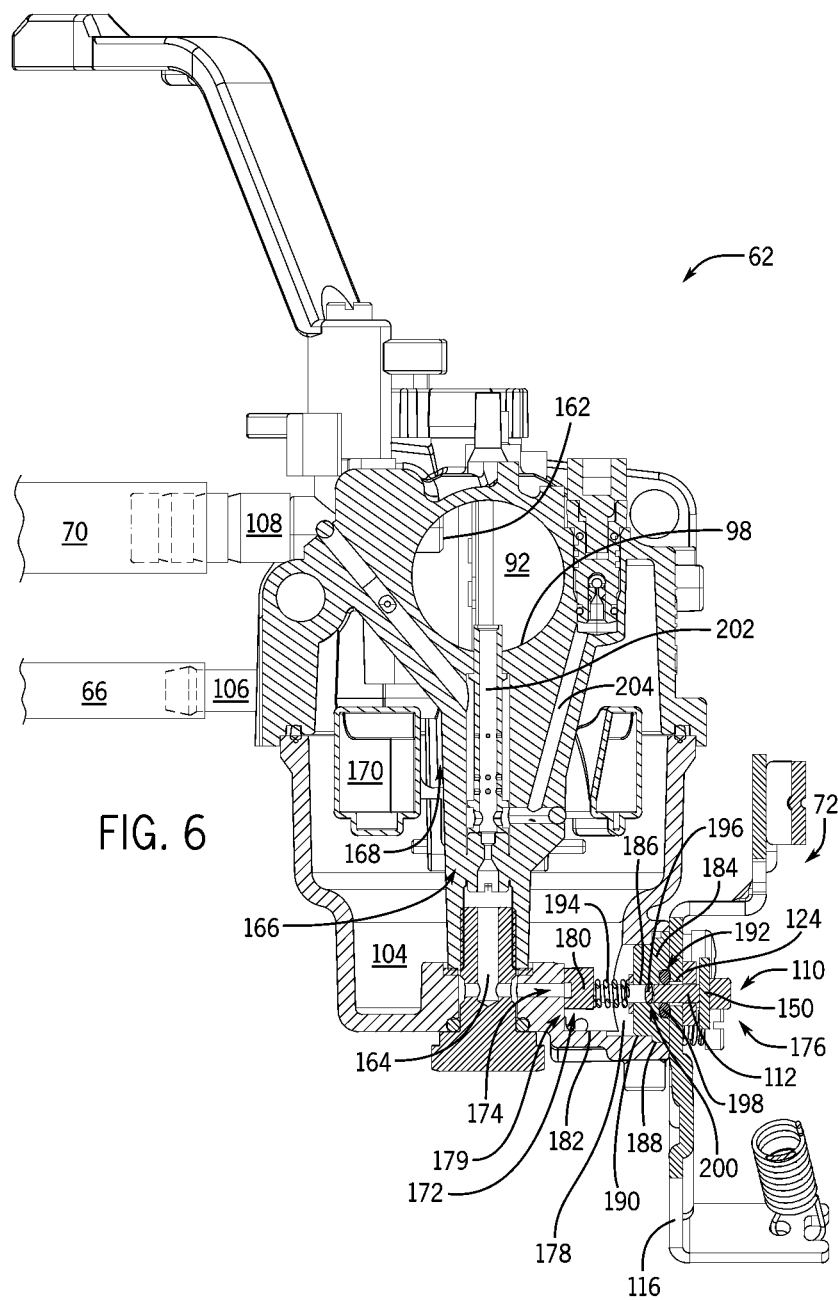
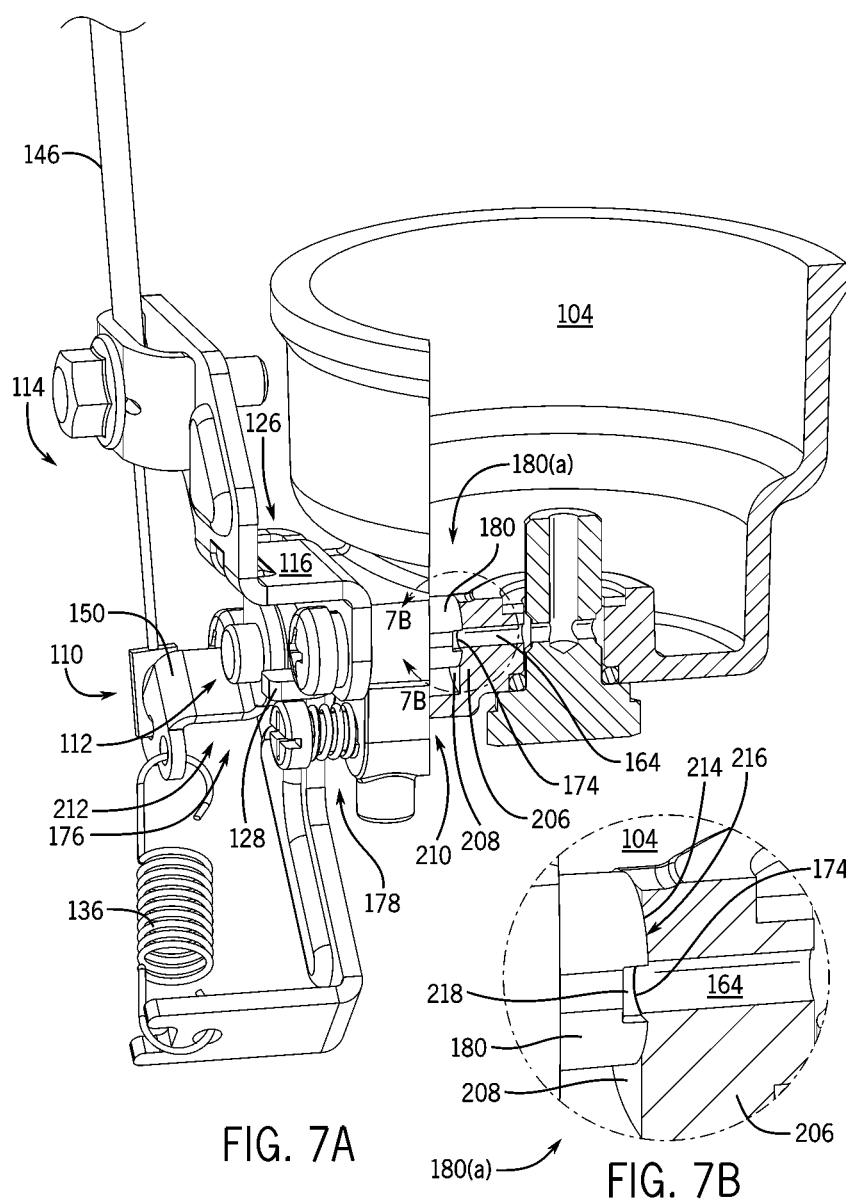


FIG. 4B







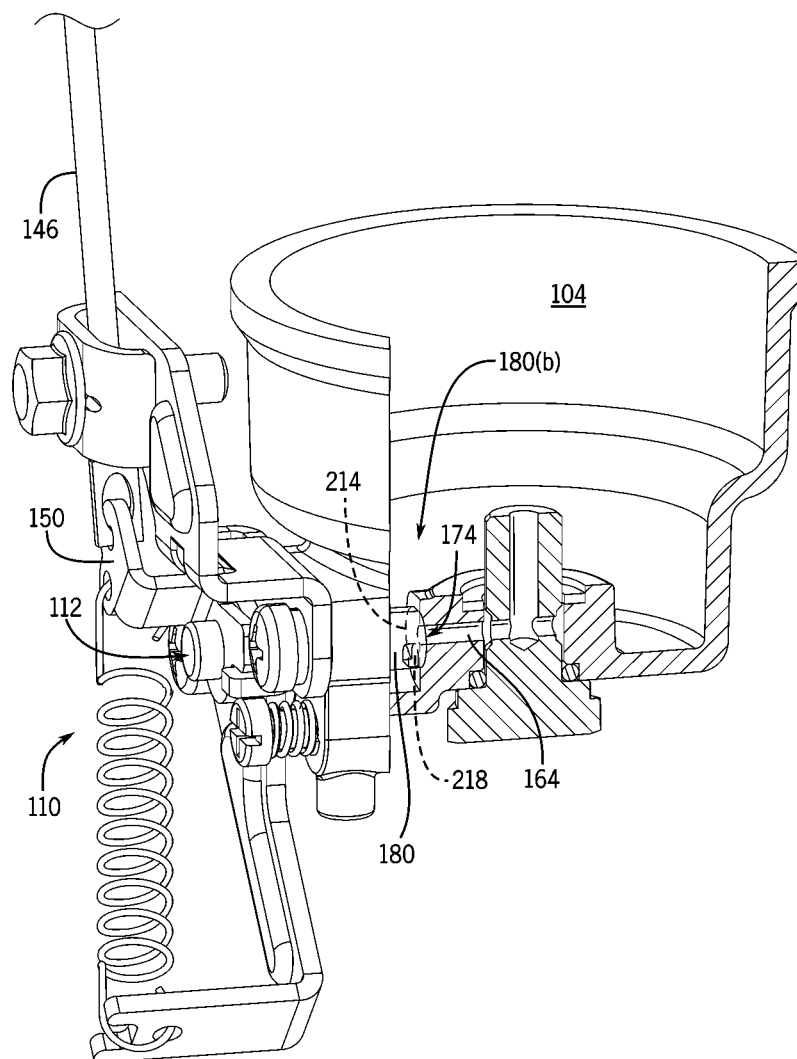
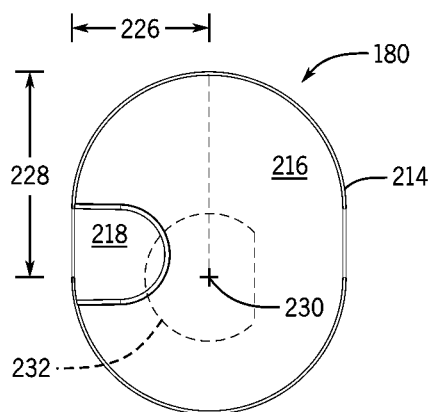
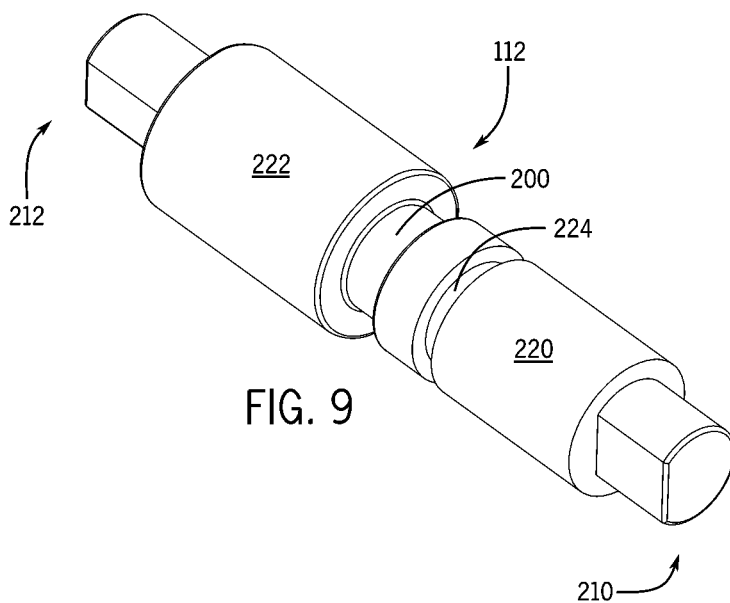


FIG. 8



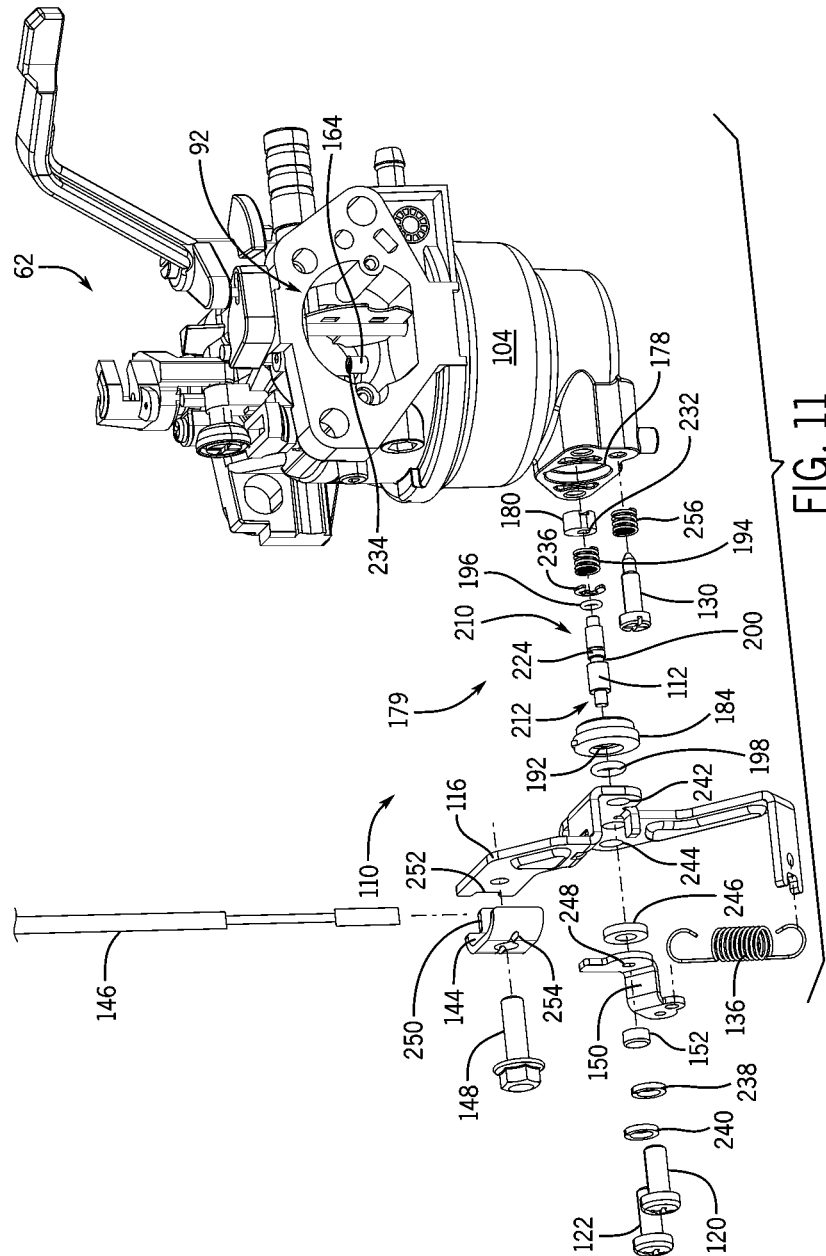


FIG. 11

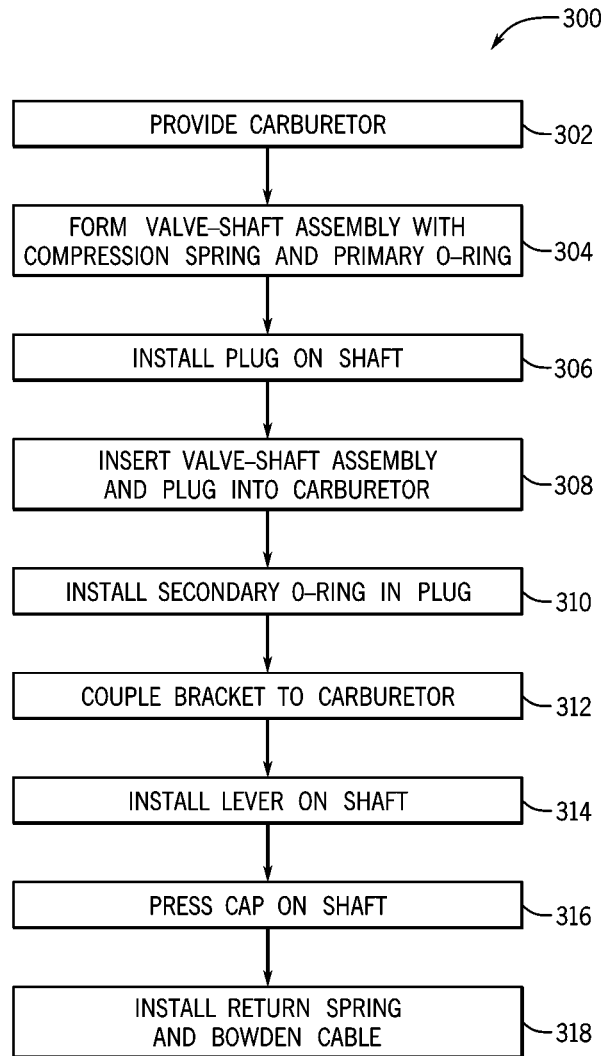
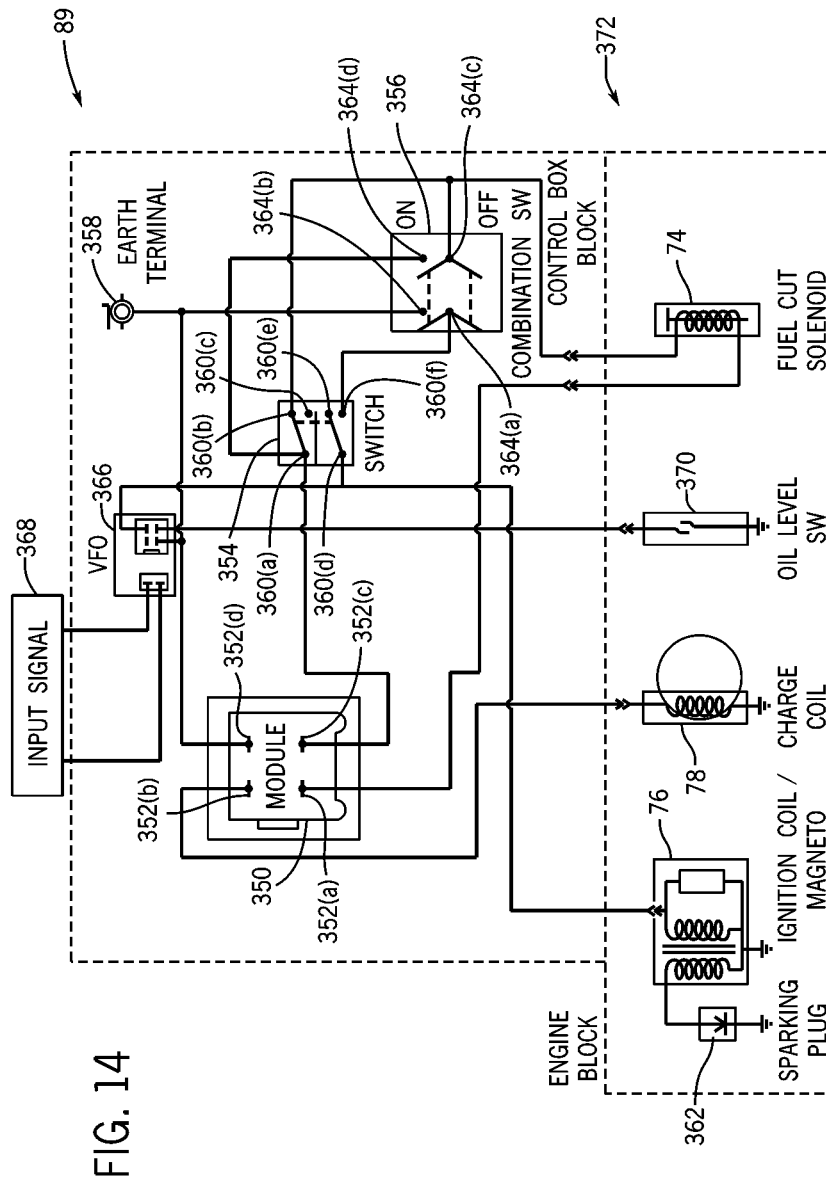


FIG. 12



1

**BATTERYLESS DUAL FUEL ENGINE WITH
LIQUID FUEL CUT-OFF****CROSS-REFERENCE TO RELATED
APPLICATION**

The present application is a continuation of, and claims priority to U.S. patent application Ser. No. 14/925,441, filed Oct. 28, 2015, which is a continuation-in-part of, and claims priority to, U.S. patent application Ser. No. 14/738,060, filed Jun. 12, 2015, now Issued U.S. Pat. No. 10,221,780, issued Mar. 5, 2019, the disclosures of which are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

Embodiments of the invention relate generally to dual fuel generators, and more particularly, to an apparatus and method for delivering liquid fuel or gaseous fuel to a dual fuel generator.

Electric generators are frequently driven by internal combustion engines that use gasoline as a fuel source. Gasoline is a common fuel source for generators in a variety of applications. However, alternative fuel sources also provide a desirable fuel source. For instance, alternative fuels may provide a clean burning fuel that limits hazardous emissions. Alternative fuels may also be stored for long periods of time without degradation, whereas gasoline can degrade over a period of months leading to hard starting, rough running, and also lead to gum and varnish deposit left in the fuel system. In addition, generators that operate on alternative fuels may generate electricity when gasoline is not readily available. For instance, generators are frequently used when power outages in the utility grid result from severe weather. Unfortunately, gas stations may also be closed as a result of the power outage. Such a circumstance presents just one example where it would be advantageous to operate electrical generators on alternative fuels.

Certain generators are configured to operate as “dual fuel” generators, otherwise known as bi-fuel generators. These generators are driven by an internal combustion engine that is configured to operate on a liquid fuel for a period of operation and an alternative fuel for another period of operation. The alternative fuel source is generally a gaseous fuel that may exist in a gaseous state at normal temperature and pressure and can be any one of liquefied petroleum gas, compressed natural gas, hydrogen, or the like. Liquefied petroleum gas (LPG), often referred to as propane, exists in a gaseous state at normal temperature and pressure but can be conveniently stored under pressure in a liquid state. LPG may be a desirable fuel source for internal combustion engines because it can be stored for longer periods of time and contains fewer impurities than gasoline, resulting in smoother and cleaner operation, and often resulting in a longer lasting engine.

In order to provide the liquid and gaseous fuel to the engine, the dual fuel engine may have a first fuel line for liquid fuel and a second fuel line for gaseous fuel. A liquid fuel source and a gaseous fuel source may be coupled to the respective lines to provide fuel to the engine. However, a common problem with such configurations that couple two fuel sources to a single engine is the engine can experience overly rich air-fuel ratio when both fuels are simultaneously engaged during cross-over switching between the fuel sources. Such simultaneous delivery of fuel from the first fuel line and the second fuel line may make the engine hard to start or lead to unstable operating conditions. Further, a

2

float bowl in the carburetor that must first fill or empty prior to changeover causes delay in cross-over switching between the fuel sources.

Therefore, it would be desirable to design a dual fuel generator having a liquid fuel and gaseous fuel delivery system that overcomes the aforementioned detriments without substantially increasing the overall cost of the system.

BRIEF DESCRIPTION OF THE INVENTION

In accordance with one aspect of the invention, a dual fuel engine includes an engine operable on a gaseous fuel and a liquid fuel. A carburetor attaches to an intake of the engine to mix air and fuel and connect to a gaseous fuel source and a liquid fuel source. The dual fuel engine also includes a switch to change operation of the engine between gaseous fuel and liquid fuel, and a liquid fuel cut-off attaches to the carburetor to interrupt liquid fuel upon actuation of the switch from liquid fuel to gaseous fuel.

In accordance with another aspect of the invention, a batteryless dual fuel generator includes a housing containing a pull start engine coupled to drive an alternator. The engine is operable on a gaseous fuel and a liquid fuel and includes a carburetor attached to an intake of the engine. The carburetor has a throat to mix fuel with air, a float bowl, and a fuel passage to provide liquid fuel from the float bowl to the throat. The generator may also include a switch to select engine operation on either the liquid fuel or the gaseous fuel and a fuel shutoff attached to the carburetor to close the fuel passage upon selection of engine operation to gaseous fuel.

In accordance with yet another aspect of the invention, a carburetor having a fuel shutoff includes a carburetor with a float bowl, a throat, and a fuel passage to provide fuel from the float bowl to the throat. A fuel shutoff couples to the carburetor which may have a first end in the carburetor that actuates to close the fuel passage and a second end external to the carburetor to actuate the first end. The fuel shutoff may operate within the carburetor such that the fuel shutoff actuates free from linear motion when opening and closing the fuel passage.

In accordance with yet another aspect of the invention, a method of assembling a dual fuel engine includes providing an engine operable on a gaseous fuel and a liquid fuel and attaching a carburetor to an intake of the engine to supply the fuels to the engine. The carburetor includes a throat to mix gaseous fuel with air and liquid fuel with air, a float bowl, and a fuel passage to provide liquid fuel from the float bowl to the throat. The fuels may be supplied to the carburetor by a gaseous fuel source coupled to the throat and a liquid fuel source coupled to the float bowl. The method also includes coupling a switch to the engine to change operation of the engine between gaseous fuel and liquid fuel, and 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.

Various other features and advantages will be made apparent from the following detailed description and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings illustrate preferred embodiments presently contemplated for carrying out the invention.

In the drawings:

FIG. 1 is a perspective view of a dual fuel generator coupled to a fuel delivery system, according to an embodiment of the invention.

3

FIG. 2 is a detail view of a portion of the generator of FIG. 1 about a mechanical fuel lockout switch with the switch in a first position, according to an embodiment of the invention.

FIG. 3 is a detail view similar to FIG. 2 and showing the mechanical fuel lockout switch in a second position, with an LPG supply line connected thereto, according to an embodiment of the invention.

FIG. 4A is a schematic diagram of a fuel system for the dual fuel generator of FIG. 1 showing a liquid fuel source in communication with a carburetor of the generator consistent with the first position of the switch as shown in FIG. 2, according to an electro-mechanical embodiment of the invention.

FIG. 4B is a schematic diagram of the fuel system of FIG. 4A showing a gaseous fuel source in communication with a carburetor of the generator of FIG. 1 consistent with the second position of the switch as shown in FIG. 3, according to an electro-mechanical embodiment of the invention.

FIG. 5 is a perspective view of a dual fuel carburetor having a manual fuel shutoff system and coupled to a first fuel line and a second fuel line, according to a mechanical embodiment of the invention.

FIG. 6 is cross-sectional view of the carburetor of FIG. 5 taken along line 6-6 of FIG. 5 through a fuel passage that provides fuel from a float bowl to a throat of the carburetor, according to an embodiment of the invention.

FIG. 7A is a partial sectional view of the float bowl of FIG. 6 with a manual fuel shutoff system in an open position, according to an embodiment of the invention.

FIG. 7B is a detailed partial sectional view of the float bowl with a manual fuel shutoff of FIG. 7A taken along line 7B-7B of FIG. 7A, according to an embodiment of the invention.

FIG. 8 is a partial sectional view similar to FIG. 7A and showing the manual fuel shutoff system in a closed position, according to an embodiment of the invention.

FIG. 9 is a perspective view of a shaft for the manual fuel shutoff system of FIG. 5, according to an embodiment of the invention.

FIG. 10 is a side view of a valve member for the manual fuel shutoff system of FIG. 5, according to an embodiment of the invention.

FIG. 11 is a perspective view of the carburetor of FIG. 5 with the manual fuel shutoff system exploded from a float bowl of the carburetor.

FIG. 12 is a flow chart showing steps in fabricating a manual fuel shutoff system for a carburetor, according to an embodiment of the invention.

FIG. 13 is a magnetic fuel shutoff system for a carburetor, according to a magnetic-mechanical embodiment of the invention.

FIG. 14 is a wiring diagram of a microcontroller receiving input signals and operating engine components, according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The operating environment of the invention is described with respect to a dual fuel generator. However, it will be appreciated by those skilled in the art that the invention is equally applicable for use with any dual fuel internal combustion engine. Moreover, the invention will be described with respect to a dual fuel generator configured to operate on a liquid fuel and a gaseous fuel. However, one skilled in the art will further appreciate that the invention is equally

4

applicable for use with other fuel combinations for dual fuel generators and internal combustion engines.

Referring to FIG. 1, a dual fuel generator 20 is coupled to a fuel delivery system 22, in accordance with an embodiment of the invention. Dual fuel generator 20 includes an internal combustion engine (not shown) within housing 21 at one end 24, operatively connected to an alternator also enclosed in housing 21 at another end 26, by conventional means. Dual fuel generator 20 is configured to operate on different fuels via either a first fuel source 28 or a second fuel source 30. In 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). Each can selectively operate the generator as desired and controlled by an operator. For instance, generator 20 may operate on gasoline for a first period of operation and then switch to LPG for a second period of operation. However, it is contemplated that dual fuel generator 20 is configured to operate on fuels other than gasoline and LPG (e.g., natural gas, biodiesel, etc.), and thus the scope of the invention is not meant to be limited strictly to a dual fuel arrangement where first fuel source 28 provides gasoline and second fuel source 30 provides LPG.

In one embodiment of the invention, dual fuel generator 20 includes a gasoline tank 32 or, generally, a liquid fuel tank, located inside cover 21 onboard generator 20 to provide gasoline to the engine as first fuel source 28. Gasoline tank 32 connects to a first fuel line to provide gasoline to the carburetor to run the engine, as will later be described with reference to FIGS. 4A and 4B. Generator 20 is also coupled to a pressurized fuel container 34, or a pressurized fuel source, located off board generator 20 to provide LPG to the engine as second fuel source 30. Pressurized fuel container 34 is coupled to generator 20 with an LPG supply hose 36. LPG supply hose 36 is coupled to a second fuel line within generator 20 to provide LPG to the carburetor to run the engine. Dual fuel generator 20 includes a mechanical fuel lockout switch 38 for selecting a desired fuel to be provided to the engine. The mechanical fuel lockout switch 38 is actuated to select first fuel source 28 when in a first position, as shown in FIG. 2, and alternately to select second fuel source 30 when in a second position, as shown in FIG. 3.

Referring back to FIG. 1, in an exemplary embodiment, fuel 30 from pressurized fuel container 34 is regulated using a fuel regulator system 39 for delivery to the engine. Fuel regulator system 39 includes one or more pressure regulators that reduce and control the pressure of the fuel from pressurized fuel container 34 and delivers fuel at a desired pressure for operation of the engine. Fuel regulator system 39 has an inlet 41 operatively coupled to a service valve 40 of pressurized fuel container 34 and an outlet 43 coupled to LPG supply hose 36. Fuel regulator system 39 includes a primary pressure regulator 42 coupled to pressurized fuel container 34 and a secondary pressure regulator 44. Primary pressure regulator 42 protects downstream components from high pressure of pressurized fuel container 34. Primary pressure regulator 42 receives LPG through service valve 40 of pressurized fuel container 34 and reduces the pressure of the LPG to a first stage. In one embodiment of the invention, the first stage may be delivered directly to generator 20 at a pressure required for operation of the engine.

In an exemplary embodiment of the invention, fuel regulator system 39 includes secondary pressure regulator 44 coupled to the outlet of primary pressure regulator 42 in order to use standard "off-the-shelf" components. Typically,

5

the primary pressure regulator is mounted on the LPG tank, while the secondary pressure regulator is mounted on the component using the fuel, such as an engine or grill. Here, since generator 20 can be used as a gasoline only generator, secondary pressure regulator 44 is mounted off-board the generator to reduce size and cost of the generator. Secondary pressure regulator 44 receives LPG from primary pressure regulator 42 and further reduces the pressure of LPG to a second stage to be delivered to generator 20. In a system with two regulators, primary pressure regulator 42 regulates fuel received from pressurized fuel container 34 and reduces the pressure of the fuel to a level required for operation of secondary pressure regulator 44. Secondary pressure regulator 44 regulates fuel received from primary pressure regulator 42 and further reduces the pressure of the fuel to a level required for operation of generator 20. In addition, primary pressure regulator 42 may compensate for varying tank pressure as fuel is depleted while secondary pressure regulator 44 may compensate for varying demand from generator 20.

In accordance with an exemplary embodiment of the invention, fuel regulator system 39 includes both the primary and secondary regulators, or a custom single regulator, but in any case is located remotely, or off-board, from dual fuel generator 20. Fuel regulator system 39 may be directly mounted to pressurized fuel container 34 using a regulator mounting bracket 46. Regulator mounting bracket 46 has mounting locations for primary pressure regulator 42 and secondary pressure regulator 44. Regulator mounting bracket 46 also has a securing mechanism 48 to secure regulator mounting bracket 46 to pressurized fuel container 34.

In another embodiment of the invention, primary pressure regulator 42 is mounted on regulator mounting bracket 46 while secondary pressure regulator 44 could be mounted on or near generator 20. In yet another embodiment of the invention, a dual stage regulator may regulate the fuel received from pressurized fuel container 34 and deliver fuel at a pressure required for operation of generator 20. Such a dual stage regulator may regulate the fuel to the second stage within a single structure. The dual stage regulator may be mounted directly on fuel container 34.

Referring to FIG. 2, a detail view of a portion of generator 20 of FIG. 1 depicts mechanical fuel lockout switch 38 in a first position 38(a), in accordance with an embodiment of the invention. In this position, 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, as will later be discussed in detail with reference to FIGS. 4A and 4B. Still referring to FIG. 2, mechanical fuel lockout switch 38 provides a combination liquid fuel shutoff valve and a gaseous fuel supply lockout that prevents simultaneous delivery of fuel to the engine from gasoline tank 32 and pressurized fuel container 34, FIG. 1. As such, mechanical fuel lockout switch 38 provides a fuel selector to ensure only the selected fuel is provided to dual fuel generator 20.

Mechanical fuel lockout switch 38, FIG. 2, includes mechanical fuel valve 54 actuatable between first position 38(a) as shown in FIG. 2 and second position 38(b) as shown in FIG. 3 to selectively control fuel flow to the dual fuel engine from first fuel source 28 through a first fuel line and second fuel source 30 through a second fuel line 36. Mechanical fuel lockout switch 38 may also include fuel lockout apparatus 58 coupled to mechanical fuel valve 54 to communicate fuel sources individually to generator 20. In one embodiment of the invention, fuel lockout apparatus 58

6

communicates first fuel source 28 to the engine by actuating mechanical fuel valve 54 to first position 38(a) to open the first fuel line as shown in FIG. 2, and communicates second fuel source 30 to the engine by actuating mechanical fuel valve 54 to second position 38(b) to open communication of the second fuel source 30 to the engine as shown in FIG. 3. Referring back to FIG. 2, when mechanical fuel valve 54 is in first position 38(a), fuel lockout apparatus 58 communicates first fuel source 28 to the dual fuel engine and prevents communication between the second fuel source and the dual fuel engine.

In an exemplary embodiment of the invention, mechanical fuel valve 54 controls the flow of LPG to the engine by actuating fuel lockout apparatus 58 to block or unblock fuel inlet 59 for the second fuel source. Mechanical fuel valve 54 is coupled to the first fuel line as a liquid fuel valve, as shown in FIGS. 4A and 4B, and therefore can control the flow of gasoline to the engine by opening and closing the first fuel line. When the mechanical fuel valve 54, FIG. 2, is in the first position 38(a), gasoline flows from the gasoline tank to the engine and the fuel lockout apparatus 58 blocks the fuel inlet 59. Accordingly, fuel lockout apparatus 58 prevents LPG flow to generator 20 when the mechanical fuel valve 54 is in first position 38(a) wherein the engine is operated on gasoline.

Mechanical fuel valve 54 includes a fuel valve handle 56 to control the opening and closing of the valve. Fuel valve handle 56 is movable between first position 38(a) as shown in FIG. 2 and second position 38(b) as shown in FIG. 3. Mechanical fuel valve 54 opens the first fuel line (to enable liquid fuel flow to the engine) when fuel valve handle 56 is in the first position, and mechanical fuel valve 54 closes the first fuel line (to prevent liquid fuel flow to the engine) when fuel valve handle 56 is in the second position. Thus, when fuel valve handle 56 is in first position 38(a) as shown in FIG. 2, mechanical fuel valve 54 opens the first fuel line and allows gasoline from gasoline tank 32 to flow to the engine.

Fuel valve handle 56 is coupled to fuel lockout apparatus 58. Fuel valve handle 56 actuates with fuel lockout apparatus 58 to prevent LPG flow to generator 20 when gasoline flow to the generator is enabled. Fuel lockout apparatus 58 is controlled by fuel valve handle 56 so that moving fuel valve handle 56 to the first position causes fuel lockout apparatus 58 to block fuel inlet 59 for LPG, and moving fuel valve handle 56 to the second position causes fuel lockout apparatus 58 to unblock fuel inlet 59 for LPG.

In an exemplary embodiment of the invention, fuel valve handle 56 rotates between the first position and the second position and fuel lockout apparatus 58 is rigidly coupled to the rotating handle. Fuel lockout apparatus 58 may include a fuel inlet cover 61, which may be a flange, coupled to fuel valve handle 56 so that fuel inlet cover 61 rotates with the handle. Fuel inlet cover 61 extends radially outward from fuel valve handle 56 and sweeps over fuel inlet 59 for LPG as fuel valve handle 56 rotates. That is, fuel inlet cover 61 rotates transversely across fuel inlet 59 and blocks access thereto. Accordingly, fuel inlet cover 61 prevents LPG flow to generator 20 when fuel valve handle 56 is in first position 38(a) to allow gasoline to run the engine.

Referring to FIG. 3, a detail view of a portion of generator 20 of FIG. 1 depicts mechanical fuel lockout switch 38 in a second position 38(b), in accordance with an embodiment of the invention. In this position, mechanical fuel lockout switch 38 provides a disconnect to stop gasoline flow from gasoline tank 32 to the engine while allowing connection of LPG supply hose 36 to fuel inlet 59 of the second fuel line.

7

FIG. 3 further shows LPG supply hose 36 coupling second fuel source 30 to generator 20 to deliver LPG to run the generator.

Mechanical fuel lockout switch 38 includes mechanical fuel valve 54 coupled to fuel lockout apparatus 58 to prevent gasoline flow to generator 20 when LPG from the LPG supply hose 36 is supplied to the engine. In one embodiment of the invention, actuation of mechanical fuel valve 54 to second position 38(b) causes fuel lockout apparatus 58 to allow communication of second fuel source 30 to the dual fuel engine, and interrupts the first fuel source 28 communication with the dual fuel engine. The position of fuel lockout apparatus 58 prevents the fuel valve handle 56 from moving to first position 38(a) (FIG. 2) while LPG supply hose 36 is connected to generator 20.

A quick-disconnect hose coupling 50, also referred to as a quick-connect hose coupling, connects LPG supply hose 36 to generator 20 so that LPG supply hose 36 may be quickly attached and detached from generator 20. Hose coupling 50 has a first end 50a mounted on the external surface of generator 20 and coupled to supply the second fuel to the engine. Hose coupling 50 has a second end 50b coupled to the outlet of LPG supply hose 36. Each end 50a, 50b has a gaseous fuel valve that opens when the couplings are engaged and closes when the couplings are disengaged. As such, quick-disconnect hose coupling 50 automatically opens when connected to enable fuel flow from LPG supply hose 36 to the engine. Hose coupling 50 automatically disconnects fluid communication when disconnected. Accordingly, when the supply hose is detached from generator 20, the coupling 50 is automatically closed so that fuel does not escape and unwanted air does not enter the fuel system.

In one embodiment, fuel inlet cover 61 is coupled to fuel valve handle 56 so that it is spaced apart from the surface of generator 20 to provide clearance for first end 50a of the quick-disconnect hose coupling 50 that protrudes from the surface of generator 20. As shown in FIG. 2, fuel inlet cover 61 blocks off first end 50a of the quick-disconnect hose coupling when fuel valve handle 56 is rotated to first position 38(a) to enable gasoline flow so that fuel inlet cover 61 prevents connection of LPG supply hose 36 (FIG. 3) to generator 20. As shown in FIG. 3, fuel inlet cover 61 uncovers first end 50a of the quick-disconnect hose coupling 50 when fuel valve handle 56 is rotated to second position 38(b) to disable gasoline flow so that fuel inlet cover 61 permits connection of LPG supply hose 36 to generator 20.

To operate generator 20 on LPG, fuel valve handle 56 is turned to second position 38(b) to disable the flow of gasoline to the engine and to expose first end 50a of hose coupling 50 on generator 20. LPG supply hose 36 is then connected to generator 20 via hose coupling 50 to enable the flow of LPG to the engine. To operate generator 20 on gasoline, LPG supply hose 36 is disconnected from generator 20 via hose coupling 50 to disable the flow of LPG to the engine and to unblock fuel valve handle 56 from rotating to the first position. As shown in FIG. 2, fuel valve handle 56 is then turned to first position 38(a) to enable the flow of gasoline to generator 20.

Referring to FIG. 4A, a schematic diagram of a fuel system for a dual fuel engine 60 shows mechanical fuel lockout switch 38 in first position 38(a) to provide communication between the first fuel source 28 and dual fuel carburetor 62, according to an embodiment of the invention. Mechanical fuel lockout switch 38 prevents communication between second fuel source 30 and dual fuel carburetor 62 when the switch is in first position 38(a). In one embodiment

8

of the invention, first fuel source 28 includes a gasoline tank 32 to provide gasoline to carburetor 62 through a first fuel line 66, and second fuel source 30 can include a propane or LPG tank 68 to provide propane or LPG to carburetor 62 through a second fuel line 70. Accordingly, first fuel line 66 may be a liquid fuel line and second fuel line 70 may be a gaseous fuel line.

Mechanical fuel lockout switch 38 changes the fuel source for engine 60 between liquid fuel and gaseous fuel. Mechanical fuel lockout switch 38 includes a mechanical fuel valve 54 actuatable between first position 38(a) as shown in FIG. 4A and second position 38(b) as shown in FIG. 4B to selectively control fuel flow to the dual fuel engine 60 from first fuel source 28 through first fuel line 66 and second fuel source 30 through second fuel line 70. Referring back to FIG. 4A, mechanical fuel valve 54 selectively controls fuel flow through first fuel line 66 by opening the line when the mechanical fuel lockout switch 38 actuates to first position 38(a). Mechanical fuel valve 54 may be coupled to fuel lockout apparatus 58 that actuates with mechanical fuel valve 54 to block and unblock fuel inlet 59 of second fuel line 70. First end 50a of the quick-disconnect hose coupling is located at fuel inlet 59 and a mating end 50b of the quick-disconnect hose coupling is coupled to the propane or LPG tank 68. Actuation of mechanical fuel valve 54 to first position 38(a) causes fuel lockout apparatus 58 to block fuel inlet 59 to prevent coupling the first end 50a and second end 50b of the quick-disconnect hose coupling together, and actuation of mechanical fuel valve 54 to another position causes fuel lockout apparatus 58 to unblock fuel inlet 59 to permit attaching first end 50a and second end 50b together.

A liquid fuel cut-off 72 couples to carburetor 62 to regulate liquid fuel flow through the carburetor. Liquid fuel cut-off 72 can stop liquid fuel flow to engine 60 to prevent an overly rich air-fuel ratio when operating engine 60 on gaseous fuel. Liquid fuel cut-off 72 may attach to carburetor 62 to interrupt liquid fuel upon actuation of mechanical fuel lockout switch 38 from liquid fuel to gaseous fuel. As such, liquid fuel cut-off 72 can prevent engine flooding by stopping liquid fuel flow when starting on gaseous fuel. Liquid fuel cut-off 72 is manually operated in some embodiments of the invention and electrically operated in other embodiments of the invention.

In one embodiment of the invention, liquid fuel cut-off 72 comprises a fuel cut solenoid 74, also referred to as a carburetor cutoff solenoid, that operates within carburetor 62 as a solenoid valve to control liquid fuel flow to engine 60. Fuel cut solenoid 74 actuates between an open position to provide liquid fuel to engine 60 and a closed position to stop liquid fuel to the engine. Fuel cut solenoid 74 can operate as a normally open solenoid valve so that power is not required to open the solenoid during liquid fuel operation. As such, fuel cut solenoid 74 is powered and moved to a closed position to stop liquid fuel flow to engine 60 during gaseous fuel operation. Alternatively, fuel cut solenoid 74 may be operated as a normally closed valve that is powered to open for liquid fuel operation.

Fuel cut solenoid 74 is preferably powered by a magneto 76, alternator, engine flywheel with a charge winding, or other electrical power generator having a charge winding or coil 78. Charging coil 78 allows operation of fuel cut solenoid 74 in a batteryless engine. In a batteryless dual fuel generator, the charging coil 78 may be integral to an alternator driven by the batteryless engine. Engine 60 may be a pull-start engine having a recoil starter 80. During engine startup, recoil starter 80 cranks the engine with a

manual pull by a user that causes magneto 76 to supply electrical power to fuel cut solenoid 74. While a fuel cut solenoid 74 in a normally open mode does not require any initial electrical power for starting engine 60 on liquid fuel, charging coil 78 powers the solenoid to stop liquid fuel flow during startup on gaseous fuel. Alternatively, charging coil 78 can power a fuel cut solenoid 74 operating in a normally closed mode to open and provide liquid fuel to engine 60 during startup on liquid fuel.

Charging coil 78 has an output voltage generally proportional to engine speed and therefore charge coil 78 will produce a range of voltages over the range of engine operating speeds. For example, if charging coil 78 produces 12 VAC at 3600 rpm, it may only produce 1 VAC at 300 rpm which would be insufficient voltage during startup to power a solenoid that requires 12 volts. An alternator typically used to power 12 volt accessories, such as a battery, at engine speeds will need increased output voltage to provide sufficient voltage for operation of fuel cut solenoid 74 at low recoil start speeds. In addition, the output voltage of a charging coil may vary if the alternator or magneto 76 also powers accessories. Accordingly, the output voltage of a charging coil should be verified by running engine 60 through the full range of operating speeds before increasing the output voltage.

Additional turns can be added to a charging coil in the alternator or magneto 76 to increase the output voltage and provide sufficient voltage to activate fuel cut solenoid 74 at manual start speeds. Typical alternators or magnetos may have limited room within stator laminations for additional turns, but low current requirements of fuel cut solenoid 74 allows substitution of smaller gage wire. Alternatively, solenoid windings on fuel cut solenoid 74 can be modified to operate at lower voltages for recoil starting. However, adding coil turns to a charge winding provides an inexpensive modification and allows use of standard 12 volt solenoids.

To protect electrical systems, a voltage regulator 82 couples to charging coil 78 to provide a fixed output voltage for a varying input voltage. If charge winding 78 is wound to supply 12 VAC at 300 rpm, it could supply 144 VAC at 3600 rpm. Applying 144 volts could quickly destroy a solenoid designed to operate at 12 volts. Accordingly, voltage regulator 82 may comprise a switching power supply circuit 84 that regulates a rectified DC power output from magneto 76 and provides a fixed voltage to fuel cut solenoid 74. Switching circuits are very efficient, dissipate very little power, and can be made small and inexpensive. Switching power supply circuit 84 allows for low rpm, recoil starter electrical power generation with charge coil 78 voltage control over engine speed range.

In the embodiment shown in FIGS. 4A and 4B, fuel cut solenoid 74 is operated by an electro-mechanical switch 86. Electro-mechanical switch 86 connects one fuel source to carburetor 62 and is connected to magneto 76 for a power source. Electro-mechanical switch 86 may comprise an electrical switch 88 that provides electrical connection between fuel cut solenoid 74 and magneto 76. Electro-mechanical switch 86 may also comprise mechanical fuel lockout switch 38, and electrical switch 88 can be mechanically actuated and controlled by mechanical fuel lockout switch 38. Fuel cut solenoid 74 connects to open and close a fuel path to pull-start engine 60 in response to reception of electrical power from electro-mechanical switch 86.

Fuel cut solenoid 74 can operate as a normally open valve that closes when powered by alternator or magneto 76. The normally open valve is activated to close and prevent

gasoline flow to engine 60 for LPG mode, and deactivated to open and allow gasoline flow to engine 60 for gasoline mode. As such, actuation of mechanical fuel lockout switch 38 to first position 38(a) opens electrical switch 88 to interrupt power and open fuel cut solenoid 74 as represented in FIG. 4A, and actuation of mechanical fuel lockout switch 38 to second position 38(b) closes electrical switch 88 to power and close fuel cut solenoid 74 as represented in FIG. 4B. Alternatively, fuel cut solenoid 74 can operate as a normally closed valve where actuation of mechanical fuel lockout switch 38 to first position 38(a) closes electrical switch 88 to power and open fuel cut solenoid 74, and actuation of mechanical fuel lockout switch 38 to second position 38(b) opens electrical switch 88 to interrupt power and close fuel cut solenoid 74.

In an alternative embodiment of the invention, a microcontroller 89 operates fuel cut solenoid 74 so that fuel cut solenoid 74 opens to operate engine 60 on gasoline and is closed when the engine operates on LPG. While engine 60 is running, charging coil 78 provides power available to microcontroller 89 for operation of fuel cut solenoid 74. Fuel cut solenoid 74 may operate in a normally open mode to allow gasoline flow to engine 60 without power from microcontroller 89, and microcontroller 89 may operate fuel cut solenoid 74 to operate as an after-fire solenoid when shutting down engine 60 from gasoline operation. That is, microcontroller 89 powers fuel cut solenoid 74 to a closed position preventing fuel being drawn into engine 60 and muffler during engine shutdown from operation on gasoline. When engine 60 runs on LPG, microcontroller 89 switches on power to close fuel cut solenoid 74 to prevent engine 60 from drawing in gasoline from the float bowl of carburetor 62 and first fuel line 66. Microcontroller 89 may also operate fuel cut solenoid 74 configured to be normally closed. Implementation of microcontroller 89 is further described with respect to FIG. 14.

Referring to FIG. 4B, a schematic diagram of a fuel system for a dual fuel engine shows mechanical fuel lockout switch 38 in second position 38(b) to provide communication between second fuel source 30 and dual fuel carburetor 62, according to an embodiment of the invention. Mechanical fuel lockout switch 38 prevents communication between first fuel source 28 and dual fuel carburetor 62 when the switch is in second position 38(b). The dual fuel engine has a first fuel line 66 to provide fuel from first fuel source 28 to carburetor 62 and a second fuel line 70 to provide fuel from second fuel source 30 to carburetor 62.

Mechanical fuel lockout switch 38 includes mechanical fuel valve 54 that selectively controls fuel flow through first fuel line 66 by closing the line when mechanical fuel lockout switch 38 actuates to second position 38(b). Mechanical fuel lockout switch 38 may also include a mechanical lockout apparatus 58 to block and unblock fuel inlet 59 of the second fuel line 70. Fuel inlet 59 may include first end 50a of the quick-connect hose coupling mounted on the generator and coupled to second fuel line 70. Second end 50b of the quick-connect hose coupling is coupled to the outlet of second fuel source 30, and the first end 50a mates with second end 50b to quickly attach propane or LPG tank 68 to second fuel line 70. Fuel lockout apparatus 58 may also hold mechanical fuel lockout switch 38 in second position 38(b) when the propane or LPG tank 68 is coupled to the engine via the ends 50a, 50b of the quick-connect hose coupling.

Liquid fuel cut-off 72 couples to carburetor 62 to regulate liquid fuel flow through the carburetor as described with respect to FIG. 4A. Liquid fuel cut-off 72 may comprise a fuel cut solenoid 74 powered by magneto 76. Engine 60 has

11

recoil starter **80** that cranks the engine and drives magneto **76** to power fuel cut solenoid **74** when starting the engine. Voltage regulator **82** reduces the voltage delivered to fuel cut solenoid **74** at higher engine operating speeds. Fuel cut solenoid **74** is activated by electro-mechanical switch **86** providing electrical connection to magneto **76** via electrical switch **88**. Electrical switch **88** can be manually actuated and controlled by mechanical fuel lockout switch **38**. FIG. 4B shows electrical switch **88** closed to power a normally open configured fuel cut solenoid **74** to a closed position for LPG mode when mechanical fuel lockout switch **38** is in second position **38(b)**.

FIG. 4A and FIG. 4B depict an embodiment where mechanical fuel valve **54** operates along first fuel line **66** to provide a flow path for first fuel source **28** to carburetor **62** when the valve is in first position **38(a)**. That is, mechanical fuel valve **54** may control a single fuel line that runs through the valve while operating fuel lockout apparatus **58** to control fuel flow through second fuel line **70**. Embodiments of the invention also contemplate mechanical fuel valve **54** configured to operate along second fuel line **70** to provide a flow path for second fuel source **30** to carburetor **62** when the valve is in second position **38(b)**. Mechanical fuel valve **54** may be configured to control multiple fuel lines that run through the valve according to embodiments of the invention. In another embodiment of the invention, a manual fuel petcock is coupled along second fuel line **70** to provide an independent shut-off from second fuel source **30** to the engine.

Referring to FIG. 5, a dual fuel carburetor having a manual fuel shutoff system is shown, in accordance with a mechanical embodiment of the invention. Carburetor **62** attaches to an intake **90** of the engine to mix air and fuel and connect to a liquid fuel source and a gaseous fuel source. Carburetor **62** has a mixing passage or throat **92** having an inlet **94** for air and an outlet **96** for an air-fuel mixture. A venturi **98** is located in throat **92** with a choke valve **100** located upstream from the venturi and a throttle valve **102** located downstream from the venturi. Carburetor **62** has a float bowl **104** that provides fuel through a fuel passage into a narrow portion of venturi **98**. Float bowl **104** has a liquid fuel inlet **106** to receive liquid fuel from first fuel source **28**. Throat **92** has a gaseous fuel inlet **108** to receive gaseous fuel from second fuel source **30**. Dual fuel carburetor **62** mixes air with fuel from first fuel source **28** and second fuel source **30** and provides the respective air-fuel mixtures for operation of the dual fuel generator.

Liquid fuel cut-off **72** couples to carburetor **62** to control liquid fuel flow downstream of float bowl **104** in the carburetor. Liquid fuel cut-off **72** can close off float bowl **104** to stop liquid fuel flow to the engine and prevent an overly rich air-fuel ratio during gaseous fuel operation. As such, liquid fuel cut-off **72** prevents engine flooding when starting on gaseous fuel. Liquid fuel cut-off **72** also traps fuel in float bowl **104** to eliminate delay in filling the bowl when starting the engine on liquid fuel, and can stop liquid fuel flow to the engine immediately after ignition shutdown. As such, liquid fuel cut-off **72** reduces emissions and prevents afterfire by stopping the engine from continuing to draw in fuel from float bowl **104** during shutdown.

In the embodiment of FIG. 5, liquid fuel cut-off **72** comprises a manually operated fuel shutoff **110** coupled to carburetor **62** to control liquid fuel flow downstream of float bowl **104**. Manual fuel shutoff **110** can be cable actuated for use on engines without battery power, for instance engines with recoil starters. Manual fuel shutoff **110** actuates between a first position to allow gasoline flow to the engine,

12

as shown in FIG. 7A, and a second position to prevent gasoline flow to the engine, as shown in FIG. 8. Referring back to FIG. 5, manual fuel shutoff **110** may comprise a shaft **112** extending into carburetor **62** that actuates between the first position and second position. A manually operated control system **114** couples to shaft **112** external to carburetor **62** to control manual fuel shutoff **110**.

A bracket **116** couples to the outer surface of carburetor **62** to support manual control system **114**. Bracket **116** mounts to a boss **118** extending outwards from float bowl **104**. Boss **118** has a flat vertical surface with a pair of tapped holes for mounting bracket **116** to float bowl **104**. Screws **120**, **122** extend through respective holes in bracket **116** and into the tapped holes to mount the bracket to carburetor **62**. Manual fuel shutoff **110** extends out of carburetor **62** and through an opening **124** in bracket **116**. Bracket **116** has a first stopping tab **126** and a second stopping tab **128** extending away from float bowl **104** to hold manual fuel shutoff **110** in a respective open or closed position. A fuel drain screw **130** extends into an opening in carburetor **62** adjacent bracket **116**.

Bracket **116** has a lower arm **132** extending downward and to the air inlet side of carburetor **62**. Lower arm **132** has a bottom portion **134** bent outward from carburetor **62** to couple to a control system spring **136**. Bottom portion **134** has a hole **138** for control system spring **136** adjacent a positioning groove **140** for the spring. Control system spring **136** is held in position by groove **140** as it hooks through hole **138**. Bracket **116** also has an upper arm **142** extending first outward from carburetor **62** and then vertically and to the outlet side of the carburetor. Upper arm **142** has a cable clamp **144** for holding a Bowden cable **146**. Cable clamp **144** has a flat midsection and two curved ends contacting bracket **116** to hold the midsection slightly apart from the bracket. Cable clamp **144** is coupled to bracket **116** by a bolt **148** extending through a hole in the midsection and through upper arm **142** of the bracket.

A lever **150** couples to shaft **112** to actuate manual fuel shutoff **110**. A cap **152** holds lever **150** on shaft **112**. Alternatively, lever **150** may be coupled to the shaft **112** by welding or staking. Lever **150** has a first lever arm **154** to contact and hold lever **150** against first and second stopping tabs **126**, **128** of the bracket. Lever **150** has a second lever arm **156** to actuate shaft **112**. First lever arm **154** is in plane with an opening in the lever for shaft **112** and second lever arm **156** extends first outward from carburetor **62** and then parallel to first lever arm **154**. Second lever arm **156** extends outward from carburetor **62** to provide clearance between bracket **116** and the second lever arm for control system spring **136** and screw **122**. Second lever arm **156** has two holes **158**, **160** for coupling control system spring **136** and Bowden cable **146** to lever **150**.

Manual fuel shutoff **110** operates as a valve within carburetor **62** to selectively interrupt liquid fuel flow to the engine. Control system spring **136** preferably pulls on lever **150** to hold manual fuel shutoff **110** in an open valve position, and Bowden cable **146** pulls lever **150** against control system spring **136** to rotate manual fuel shutoff **110** to a closed valve position. As such, control system spring **136** holds manual fuel shutoff **110** open for gasoline mode until Bowden cable **146** is pulled to close the valve for LPG mode. Alternatively, control system spring **136** can hold manual fuel shutoff **110** in a closed valve position until Bowden cable **146** is pulled to open the valve. Therefore, actuation of the Bowden cable **146** acts as a switch to assist in changeover between the dual fuels. Manual fuel shutoff **110** may rotate 90 degrees between the open and closed positions with stopping tabs **126**, **128** positioned about

13

bracket 116 accordingly. Lever 150 can be positioned on shaft 112 so that second lever arm 156 is pulled upward by a generally vertical Bowden cable 146. Second lever arm 156 may actuate between a position 45 degrees below horizontal for an open valve and a position 45 degrees above horizontal for a closed valve. When holding the valve open, control system spring 136 may be oriented at a right angle to second lever arm 156 for increased leverage.

Referring to FIG. 6, a cross-sectional view of the carburetor taken generally about line 6-6 of FIG. 5 is shown, in accordance with an embodiment of the invention. Carburetor 62 includes a throat 92 to mix gaseous fuel with air and liquid fuel with air. Throat 92 includes a gaseous fuel inlet port 162 in communication with gaseous fuel inlet 108 coupled to a second fuel line 70. Carburetor 62 also includes float bowl 104 and a fuel passage 164 to provide a liquid fuel path from float bowl 104 through a main nozzle 166 into venturi 98. Float bowl 104 has a liquid fuel inlet port 168 and a float valve 170 to regulate liquid fuel flow through liquid fuel inlet port 168. Liquid fuel inlet port 168 is in communication with the liquid fuel inlet 106 coupled to first fuel line 66.

Manual fuel shutoff 110 couples to carburetor 62 to regulate liquid fuel flow downstream of float bowl 104. Manual fuel shutoff 110 attaches to carburetor 62 to close fuel passage 164 upon selection of engine operation to gaseous fuel. Manual fuel shutoff 110 may have a first end 172 positioned in carburetor 62 adjacent an inlet port 174 to fuel passage 164, and the first end 172 actuates to close fuel passage 164. That is, first end 172 actuates between a first position to permit fuel flow into fuel passage 164, as shown in FIG. 7A, and a second position to prevent fuel flow into fuel passage 164, as shown in FIG. 8.

Referring back to FIG. 6, manual fuel shutoff 110 has a second end 176 positioned external to carburetor 62 that is manually actuated to operate manual fuel shutoff 110. Manual fuel shutoff 110 may have a rotating shaft 112 that extends through an opening 178 in carburetor 62. A blocking member or valve tip 180 couples to shaft 112 in carburetor 62 to create a valve-shaft assembly 179. Valve tip 180 rotates parallel to inlet 174 of fuel passage 164 between a blocking position and non-blocking position to selectively block fuel flow into fuel passage 164. Lever 150 couples to shaft 112 external to carburetor 62 and actuates to rotate shaft 112 and valve tip 180.

Shaft 112 may be horizontal or substantially horizontal to allow valve tip 180 to be positioned directly in float bowl 104 adjacent inlet port 174 of fuel passage 164. That is, manual fuel shutoff 110 may be coupled to carburetor 62 such that second end 176 is horizontal from first end 172. Inlet 174 of fuel passage 164 can face horizontal or substantially horizontal to accommodate valve tip 180 in float bowl 104. As such, fuel passage 164 may have a horizontal component that receives fuel from float bowl 104 leading to a vertical component to provide fuel to venturi 98. The interior surface of the float bowl 104 may also have a recess or cavity 182 to provide room for valve member 180 in the bowl.

Opening 178 in carburetor 62 has a plug 184 to hold shaft 112 and prevent fuel flow out of the carburetor. Shaft 112 extends through a hole 186 in plug 184 and hole 186 is positioned to align valve tip 180 with fuel passage 164. Plug 184 has a larger outer diameter 188 toward the external side of carburetor 62 and a smaller outer diameter 190 toward the internal side. Larger outer diameter 188 and smaller outer diameter 190 mate with corresponding diameters of opening 178. Plug 184 has a counterbore 192 to hole 186 on the

14

external side of the plug. A compression spring 194 is positioned around shaft 112 in float bowl 104 to push valve tip 180 against plug 184. Compression spring 194 holds valve tip 180 against inlet 174 of fuel passage 164 in order to seal the fuel passage.

A primary o-ring 196 and a secondary o-ring 198 are positioned around shaft 112 to provide a respective first and second fuel seal between the shaft and plug 184 and to seal first end 172 of manual fuel shutoff 110 in carburetor 62. Primary o-ring 196 may be positioned in an o-ring groove 200 in shaft 112 and secondary o-ring 198 may be positioned in counterbore 192 of plug 184. A bracket 116 or other support member mounts over counterbore 192 and around shaft 112 to hold secondary o-ring 198 in counterbore 192. Bracket 116 has an opening 124 large enough for shaft 112 but small enough to hold secondary o-ring 198 in counterbore 192. Manual fuel shutoff 110 actuates in a rotative motion free from linear motion in part to ensure fuel will not leak through primary o-ring 196 or secondary o-ring 198. Compared to a sliding valve, a rotating valve, such as manual fuel shutoff 110, reduces the likelihood that fuel will leak from carburetor 62.

Liquid fuel cut-off 72 may regulate fuel flow through multiple fuel passages in carburetor 62 that provide fuel from float bowl 104 to the engine. For instance, carburetor 62 may have a main fuel circuit 202 and an idle fuel circuit 204. Main fuel circuit 202 provides fuel through main nozzle 166 into a narrow portion of venturi 98. Idle fuel circuit 204 provides fuel to throat 92 downstream from the throttle valve. Liquid fuel cut-off 72 may regulate fuel flow through some or all of the fuel circuits that provide fuel from float bowl 104 to the engine. FIG. 6 shows an embodiment where idle fuel circuit 204 branches off from main fuel circuit 202 and liquid fuel cut-off 72 actuates to block fuel flow into both main fuel circuit 202 and idle fuel circuit 204. In other embodiments, liquid fuel cut-off 72 closes main fuel circuit 202 while small amounts of liquid fuel pass through idle fuel circuit 204. Fuel passing through idle fuel circuit 204 may not negatively affect engine performance during LPG operation but will eventually drain the gasoline tank.

Referring to FIG. 7A, a partial sectional view of a float bowl shows a manual fuel shutoff system in an open position for gasoline mode, in accordance with an embodiment of the invention. The partial sectional view is taken through a portion of float bowl 104 along fuel passage 164 while showing another portion of float bowl 104 in front of fuel passage 164 and coupled to manual fuel shutoff 110. Inlet 174 to fuel passage 164 is in a boss 206 extending outward from a central region of float bowl 104. Boss 206 has an oval top with sides that extend to the floor of float bowl 104. Inlet 174 to fuel passage 164 extends through boss 206 and has a substantially flat perimeter edge 208 around inlet port 174 on the surface of the boss. Manual fuel shutoff 110 presses against substantially flat perimeter edge 208 surrounding fuel passage 164 to block fuel flow into fuel passage 164.

Manual fuel shutoff 110 may have a rotating shaft 112 extending through an aperture 178 in float bowl 104. Shaft 112 has a first end 210 coupled to valve tip 180 and located in float bowl 104 that is held against inlet port 174 to fuel passage 164. Shaft 112 rotates valve tip 180 against inlet port 174 between a first position 180(a) allowing fuel flow through the inlet port 174, as shown in FIG. 7A, and a second position 180(b) blocking fuel flow through the inlet port 174, as shown in FIG. 8. That is, valve tip 180 uncovers the inlet 174 of fuel passage 164 to permit fuel flow into the inlet 174 when rotated to first position 180(a), FIG. 7A, and

15

covers inlet 174 of fuel passage 164 to prevent fuel flow into inlet 174 when rotated to second position 180(b), FIG. 8.

Referring back to FIG. 7A, the manual fuel shutoff system further includes bracket 116 to support shaft 112 in float bowl 104 and provide mounting locations for manually operated control system 114. Bracket 116 also has a pair of stopping tabs 126, 128 to hold the manual fuel shutoff 110 in an open or closed position. Shaft 112 extends through bracket 116 and lever 150 couples to a second end 212 of shaft 112 located outside of float bowl 104. Control system spring 136 couples lever 150 to bracket 116 to hold lever 150 against stopping tab 126 and hold manual fuel shutoff 110 in the open position for gasoline mode. Bowden cable 146 couples to lever 150 to pull against control system spring 136 and rotate manual fuel shutoff 110 to the closed position for LPG mode. As such, second end 176 of manual fuel shutoff 110 is positioned external to float bowl 104 and coupled to manually operated control system 114 to operate manual fuel shutoff 110.

Referring to FIG. 7B, a detailed partial sectional view of the float bowl of FIG. 7A taken along line 7B-7B shows a manual fuel shutoff in an open position for gasoline mode, in accordance with an embodiment of the invention. Float bowl 104 includes boss 206 through which fuel passage 164 extends and having a substantially flat perimeter edge 208 surrounding inlet 174 to fuel passage 164. Substantially flat perimeter edge 208 preferably has a flat finished surface for improved sealing against valve tip 180. Valve tip 180 maintains planar contact with substantially flat perimeter edge 208 while rotating between an open position permitting fuel flow into inlet 174 and a closed position blocking fuel flow into inlet 174. As such, valve tip 180 rotates parallel to inlet 174 of fuel passage 164 between the open or first position 180(a) and closed or second position 180(b), FIG. 8.

Referring again to FIG. 7B, valve tip 180 may comprise an oval or stadium 214 having a flat surface 216 that contacts perimeter edge 208 around inlet 174 of fuel passage 164. Valve tip 180 may have a recessed portion or cutout 218 in the flat surface 216 to provide a flow passage through the valve tip. Fuel flows through the cutout 218 into the inlet 174 of fuel passage 164 when cutout 218 is aligned with inlet 174. That is, cutout 218 in valve tip 180 aligns with inlet port 174 when valve tip 180 is rotated to the open position such that fuel can pass from float bowl 104 through cutout 218 into fuel passage 164. Cutout 218 in valve tip 180 is strategically positioned in a narrow portion of stadium 214 so a long portion of stadium 214 can be rotated to cover and block inlet 174. Valve tip 180 may comprise one of many shapes including a stadium, an oval, a disk, a rectangle, an irregular shape, among others.

Referring to FIG. 8, a partial sectional view of a float bowl shows a manual fuel shutoff system in a closed position for LPG mode, in accordance with an embodiment of the invention. Valve tip 180 pushes against inlet 174 to fuel passage 164 to seal the inlet when in second position 180(b). Valve tip 180 may have a stadium shape 214 with a cutout 218 in the narrow portion of the stadium to provide a flow passage. Valve tip 180 blocks fuel flow into fuel passage 164 when the cutout 218 in valve tip 180 is rotated away from inlet 174 of fuel passage 164. Cutout 218 may face downward when in the closed position and horizontal when in the open position. Lever 150 couples to shaft 112 outside of float bowl 104 and is actuated by Bowden cable 146 to operate manual fuel shutoff 110.

Bowden cable 146 may be coupled to mechanical fuel lockout switch 38, FIG. 1, to automatically open and close

16

manual fuel shutoff 110 upon selection of a corresponding fuel source. Mechanical fuel lockout switch 38 may have a lever arm inside of the generator housing for actuating Bowden cable 146, FIG. 8. Alternatively, Bowden cable 146 may have a push-pull knob located on an external surface of the generator housing to independently actuate manual fuel shutoff 110. In either case, manual fuel shutoff 110 can attach to the carburetor to close fuel passage 164 downstream from float bowl 104 upon actuation of the mechanical fuel lockout switch 38, FIG. 1, from liquid fuel to gaseous fuel.

Referring to FIG. 9, a perspective view of a shaft for the manual fuel shutoff system of FIGS. 5-8 is shown, in accordance with an embodiment of the invention. Shaft 112 has two "D" shaped ends each located at a respective first end 210 and second end 212 of the shaft. Shaft 112 also has a first diameter 220 and a larger second diameter 222 each extending radially from shaft 112 outward beyond the two "D" shaped ends. First diameter 220 and second diameter 222 are separated by o-ring groove 200 with first diameter 220 toward first end 210 of shaft 112 and second diameter 222 toward second end 212 of shaft 112. First diameter 220 also has a groove 224 for a retaining ring. Lever 150, FIG. 8, has a "D" shaped opening to fit on the second end 212 of shaft 112 and held against the second diameter 222.

Referring to FIG. 10, a side view of a valve member for the manual fuel shutoff system of FIG. 5-8 is shown, in accordance with an embodiment of the invention. Valve tip 180 has a flat surface 216 to seal and rotate against a mating surface in the carburetor. Valve tip 180 is preferably made from polyoxymethylene (POM) or other thermoplastic material to provide a surface suitable for sealing. Valve tip 180 may be shaped as a stadium 214 with a short direction 226 and a long direction 228 extending from a center of rotation 230. The long direction 228 rotates over inlet 174, FIG. 8, to selectively block fuel passage 164. As such, valve tip 180 may rotate less than 360 degrees between the open and closed positions, and valve tip 180 rotates substantially 90 degrees between the positions in an exemplary embodiment of the invention.

Referring back to FIG. 10, cutout 218 may be located along a straight side of stadium 214 to create a flow passage through valve tip 180. Cutout 218 may have a depth less than the thickness of stadium 214 or may extend through the thickness of the stadium. Cutout 218 may be a half circle with tangent side components extending perpendicular to a straight edge of stadium 214, through a side of valve tip 180. Cutout 218 may extend into valve tip 180 short of the center of stadium 214 and positioned slightly offset along the length of the stadium from the stadium center.

Valve tip 180 may have a "D" shaped opening 232 to press onto shaft 112 of FIG. 9, defining center of rotation 230, FIG. 10. Center of rotation 230 may be equal distance from straight edges of stadium 214 and positioned between cutout 218 and a rounded end of the stadium that is the closest rounded end to the cutout. Cutout 218 is askew from center of rotation 230 along the length of stadium 214 in part to cover more distance when rotated away from inlet port 174, FIG. 8. In addition, valve tip 180 is positioned off center on shaft 112 to increase the length of long direction 228 from center of rotation 230 that is rotated to cover inlet port 174.

Referring to FIG. 11, a perspective view of the carburetor of FIG. 5 with the manual fuel shutoff system exploded from a float bowl of the carburetor is shown, in accordance with an embodiment of the invention. Carburetor 62 has a throat 92, a float bowl 104, and a fuel passage 164 from float bowl

17

104 to an outlet port 234 in throat 92. Manual fuel shutoff 110 includes shaft 112 having first end 210 to be positioned in float bowl 104 and a second end 212 to be positioned external to float bowl 104. A primary o-ring 196 installs on shaft 112 and positioned in an o-ring groove 200 in shaft 112. A retaining ring 236 installs on shaft 112 in a groove 224 toward first end 210 from o-ring groove 200. Compression spring 194 installs on shaft 112 followed by valve tip 180 pressed onto first end 210 of shaft 112 creating a valve-shaft assembly 179. Orientation of valve tip 180 is controlled by a "D" shaped hole 232 in valve tip 180 mating with a "D" shaped end of shaft 112.

Plug 184 installs on shaft 112 pushing compression spring 194 against valve tip 180. Primary o-ring 196 seals between shaft 112 and plug 184. Valve-shaft assembly 179 inserts through opening 178 in float bowl 104 and plug 184 presses into the opening. Plug 184 anchors in opening 178 so that compression spring 194 holds valve tip 180 against fuel passage 164. Secondary o-ring 198 installs around shaft 112 to seal between the shaft and plug 184. Secondary o-ring 198 may be positioned in a counterbore 192 in plug 184. Bracket 116 couples to float bowl 104 and holds secondary o-ring 198 positioned in counterbore 192. Bracket 116 may be 2.0 mm thick and stamped from Q235 grade steel. A pair of screws 120, 122 each having a spring lock washer 238, 240 extend through a respective hole 242, 244 in bracket 116 to mount bracket 116 to carburetor 62. Screws 120, 122 may be M5 screws. A spacer 246 installs on shaft 112 and against bracket 116.

Lever 150 couples to shaft 112 and held apart from bracket 116 by spacer 246. Shaft 112 has a "D" shape at second end 212 that is inserted into a corresponding "D" shaped opening 248 in lever 150. The orientation of lever 150 is controlled by "D" shape hole 248 in lever 150 mating with a "D" shape end of shaft 112. Lever 150 may be 1.5 mm thick and stamped from Q235 grade steel. Cap 152 presses onto shaft 112 to hold lever 150 on shaft 112. Control system spring 136 attaches to lever 150 and bracket 116 to hold manual fuel shutoff 110 open. Cable clamp 144 couples to bracket 116 by bolt 148. Cable clamp 144 has a tab 250 at one or both ends that fits into a corresponding slot or recess 252 in bracket 116. Cable clamp 144 also has a midsection with a notch 254 to pinch and hold Bowden cable 146 to bracket 116. Bowden cable 146 is held by cable clamp 144 and attaches to lever 150 to actuate manual fuel shutoff 110 to the closed position. Fuel drain screw 130 and drain screw spring 256 insert into carburetor 62. In one embodiment, drain screw spring 256 is the same type of spring used for compression spring 194.

Referring to FIG. 12, and with continued reference back to FIG. 11, a method of fabricating a manual fuel shutoff system for a carburetor is shown, in accordance with an embodiment of the invention. Process 300 begins by providing carburetor 62 at STEP 302. Process 300 continues with making a valve-shaft assembly 179 at STEP 304, with valve tip 180 pressed onto shaft 112. Also in STEP 304, a compression spring 194 is stalled on shaft 112 and primary o-ring 196 is installed around shaft 112. Process 300 continues by installing plug 184 on valve-shaft assembly 179 at STEP 306. Next, valve-shaft assembly 179 is inserted through opening 178 in float bowl 104 and plug 184 is pressed into the opening at STEP 308. Process 300 continues at STEP 310 by installing secondary o-ring 198 in a groove on plug 184. Next, bracket 116 is coupled to float bowl 104 of carburetor 62 in STEP 312. Process 300 continues at STEP 314 by installing lever 150 on shaft 112. Next, cap 152 is pressed onto shaft 112 to hold lever 150 to shaft 112 in

18

STEP 316. In STEP 318, control system spring 136 is installed on lever 150 and bracket 116. Also, in STEP 318, Bowden cable 146 is attached to lever 150 to actuate shaft 112.

Referring to FIG. 13, a magnetic fuel shutoff system for a carburetor is shown, in accordance with an embodiment of the invention. Magnetic fuel shutoff system 320 couples to the carburetor to provide a magnetically actuated liquid fuel cut-off for the internal combustion engine. Magnetic fuel shutoff system 320 controls liquid fuel flow through a fuel passage leading from the float bowl to the throat in the carburetor. Magnetic fuel shutoff system 320 can be manually actuated between an open position to allow gasoline flow to the engine for gasoline operation and a closed position to prevent gasoline flow to the engine for LPG operation.

Magnetic fuel shutoff system 320 includes a housing at least partially enclosing the liquid fuel cut-off. That is, magnetic fuel shutoff system 320 has a first section 322 housing magnetic fuel shutoff 324 and a second section 326 housing a manually actuated magnet 328 to operate the magnetic fuel shutoff. First section 322 has a forward wall 330 and a back wall 332 with the forward wall facing internal to the carburetor. Forward wall 330 has a flange 334 around an outer perimeter for coupling to the carburetor. Forward wall 330 also has an opening 336 through which a plunger 342 of the magnetic fuel shutoff 324 extends into the carburetor. A lip 338 extends forward from forward wall 330 around opening 336 and an o-ring 340 is installed around lip 338. Flange 334 may be mounted to a plug in an opening of the carburetor with magnetic fuel shutoff 324 entering the carburetor through a hole in the plug.

First section 322 provides a sealing member enclosing plunger 342 of magnetic fuel shutoff 324 to the carburetor and holding fuel in the carburetor. The plunger 342 extends through opening 336 in forward wall 330 with a pointed end that is selectively inserted into a fuel supply path in the carburetor to block fuel flow downstream from the float bowl. Magnetic fuel shutoff 324 has a back plate 344 coupled to plunger 342 in first section 322. Plunger 342 extends perpendicular from a forward face of back plate 344. A spring 346 pushes a back face of back plate 344 against back wall 332 to push plunger 342 through opening 336 in forward wall 330 to block the fuel supply path in the carburetor. Accordingly, the first section 322 holds the spring 346 against the plunger 342. Magnetic fuel shutoff 324 is guided through its actuation by back plate 344 sliding through first section 322 and plunger 342 through opening 336 in forward wall 330.

Second section 326 couples to first section 322 and is located behind back wall 332. Second section 326 encloses an actuating magnet 328 to selectively pull magnetic fuel shutoff 324 against spring 346. Second section 326 preferably guides actuating magnet 328 along a path perpendicular to that of magnetic fuel shutoff 324. As such, the magnetic force to pull magnetic fuel shutoff 324 to an open valve position is the strongest when actuating magnet 328 is aligned with the path of magnetic fuel shutoff 324. Actuating magnet 328 pulls magnetic fuel shutoff 324 against spring 346 when actuating magnet 328 approaches magnetic fuel shutoff 324 and releases magnetic fuel shutoff 324 while traveling away from magnetic fuel shutoff 324. Actuating magnet 328 may comprise a rare-earth or other permanent magnet.

In an exemplary embodiment of the invention, magnetic fuel shutoff 324 actuates horizontally between an open position to permit fuel flow into a fuel passage in the

19

carburetor and a closed positioned to prevent fuel flow into the fuel passage. Actuating magnet 328 preferably follows a vertical path and a spring 348 couples to a top of second section 326 pushing downward on actuating magnet 328. Bowden cable 146 couples to the top of second section 326 and to actuating magnet 328 to pull the magnet vertically against spring 348 and operate magnetic fuel shutoff system 320.

Referring now to FIG. 14, a wiring diagram of a microcontroller 89 receiving input signals and operating engine components is shown, according to an embodiment of the invention. Microcontroller 89 closes fuel cut solenoid 74 when the engine operates on LPG and opens the fuel cut solenoid to operate the engine on gasoline. For LPG mode, microcontroller 89 switches on power to fuel cut solenoid 74 to close the solenoid preventing the engine from drawing in gasoline from the float bowl of the carburetor. During shutdown from gasoline operation, microcontroller 89 can also power fuel cut solenoid 74 to a closed position preventing additional gasoline being drawn into the engine. While microcontroller 89 can operate fuel cut solenoid 74 operating in a normally open configuration, microcontroller 89 can also operate a fuel cut solenoid operating in a normally closed configuration.

Microcontroller 89 may include a module 350 to connect fuel cut solenoid 74, charging coil 78, switches and a ground terminal. Module 350 has a first connection 352(a) to couple fuel cut solenoid 74 and a second connection 352(b) to couple charging coil 78 to power the fuel cut solenoid. Fuel cut solenoid 74 may be coupled to a fuel switch 354 and a combination switch 356 that are also connected to module 350 via a third connection 352(c). Fuel switch 354 changes operation of the engine between LPG and gasoline, and combination switch 356 can operate to kill the engine. A ground terminal 358 connects to module 350 via a fourth connection 352(d) in order to ground fuel cut solenoid 74 via fuel switch 354 or combination switch 356.

In LPG mode, fuel switch 354 connects a first contact 360(a) to a second contact 360(b), instead of third contact 360(c), to complete an electrical circuit for fuel cut solenoid 74 by connecting the fuel cut solenoid to ground terminal 358. A fuel cut solenoid 74 operating in a normally open configuration is therefore powered and closed to prevent gasoline flow from the fuel bowl of the carburetor to the engine. Fuel switch 354 also connects a fourth contact 360(d) to a fifth contact 360(e), instead of sixth contact 360(f), to prevent combination switch 356 from grounding magneto 76 thereby maintaining power to spark plug 362.

In gasoline mode, fuel switch 354 connects first contact 360(a) to third contact 360(c) to interrupt an electrical circuit for fuel cut solenoid 74 by disconnecting the fuel cut solenoid from ground terminal 358. A fuel cut solenoid 74 operating in a normally open configuration is therefore unpowered and opened to allow gasoline flow from the fuel bowl of the carburetor to the engine. Fuel switch 354 also connects fourth contact 360(d) to sixth contact 360(f) to allow combination switch 356 to ground magneto 76 upon shutdown thereby interrupting power to spark plug 362.

Combination switch 356 can actuate fuel cut solenoid 74 upon engine shutdown from gasoline operation to prevent after-fire. That is, combination switch 356 connects a first point 364(a) to a second point 364(b) to kill the engine by connecting magneto 76 to ground terminal 358. At the same time, combination switch 356 connects a third point 364(c) to a fourth point 364(d) completing an electrical circuit for fuel cut solenoid 74 by connecting the solenoid to ground terminal 358. Fuel cut solenoid 74 is then powered and

20

closed to prevent continued gasoline flow to the engine after combination switch 356 stops power supply to spark plug 362.

In one embodiment of the invention, combination switch 356 can operate as a kill switch only for gasoline operation. That is, combination switch 356 can be decoupled from magneto 76 by fuel switch 354 so that combination switch 356 cannot be actuated to shut down the engine during LPG operation. In another embodiment of the invention, combination switch 356 can operate as a kill switch for both gasoline operation and LPG operation. During LPG operation, combination switch 356 may actuate fuel switch 354 with actuation of combination switch 356 to ground magneto 76 and kill the engine. That is, combination switch 356 connects first point 364(a) to second point 364(b) and also actuates fuel switch 354 to connect fourth contact 360(d) to sixth contact 360(f) so that magneto 76 is coupled to ground terminal 358 killing the engine. At the same time, combination switch 356 connects third point 364(c) to fourth point 364(d) so that fuel cut solenoid 74 maintains connection to ground terminal 358 to remain closed even though fuel switch 354 interrupts connection between first contact 360(a) and second contact 360(b).

Microcontroller 89 may also include a Voltage Frequency and Low Oil Shutdown (VFO) module 366. VFO module 366 can measure parameters of an alternator driven by an engine in a generator. VFO module 366 monitors alternator voltage and frequency by receiving an input signal 368 from the alternator. Input signal 368 is 120 VAC and 60 Hz from the alternator as a monitoring point for VFO module 366. VFO module 366 allows the engine to run if alternator parameters are within preset limits and shuts down the engine if the parameters are outside the limits. VFO module 366 can also monitor oil volume within the engine by receiving an input signal from an oil level switch 370 shown in the wiring diagram engine block 372. VFO module 366 may allow the engine to operate only if the oil volume is greater than a preset lower limit and can shutdown the engine by initiating connection between the ignition coil or magneto 76 and ground terminal 358.

Beneficially, embodiments of the invention provide for a fuel lockout switch to ensure that two fuels are not simultaneously delivered to a dual fuel internal combustion engine and to efficiently convert operation of the engine between the fuel sources. Embodiments of the invention also provide for a dual fuel generator with a remotely mounted gaseous fuel regulator system. Embodiments of the invention also provide for a batteryless dual fuel internal combustion engine having a liquid fuel cut-off coupled to a carburetor to selectively interrupt liquid fuel.

Therefore, according to one embodiment of the invention, 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. The dual fuel engine also includes 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. A liquid fuel cut-off attaches to the carburetor to interrupt liquid fuel upon actuation of the switch from liquid fuel to gaseous fuel.

According to another embodiment of the invention, a batteryless dual fuel generator includes a housing containing a pull start engine coupled to drive an alternator, the engine operable on a gaseous fuel and a liquid fuel. A carburetor attaches to an intake of the engine and includes a throat to mix fuel with air, a float bowl, and a fuel passage to provide liquid fuel from the float bowl to the throat. The generator

21

also includes a fuel shutoff attached to the carburetor to close the fuel passage upon selection of engine operation to gaseous fuel.

According to yet another embodiment of the invention, a carburetor having a fuel shutoff includes a carburetor with a float bowl, a throat, and a fuel passage to provide fuel from the float bowl to the throat. The carburetor further includes a fuel shutoff coupled to the carburetor having a first end in the carburetor that actuates to close the fuel passage and a second end external to the carburetor to actuate the first end, and the fuel shutoff can actuate free from linear motion.

According to yet another embodiment of the invention, a method of assembling a dual fuel engine includes providing an engine operable on a gaseous fuel and a liquid fuel. The method also includes attaching a carburetor to an intake of the engine, the carburetor includes a throat to mix gaseous fuel with air and liquid fuel with air, a float bowl, and a fuel passage to provide liquid fuel from the float bowl to the throat. The method also includes coupling a switch to the engine to change operation of the engine between gaseous fuel and liquid fuel and 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.

This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A dual fuel generator comprising:
an engine operable on a gaseous fuel and a liquid fuel;
an electrical power generator driven by the engine and comprising a charging coil;
a switch to change operation of the engine between gaseous fuel and liquid fuel;
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;
a liquid fuel cut-off solenoid to interrupt liquid fuel flow to the engine upon actuation of the switch from liquid fuel to gaseous fuel; and
a voltage regulator coupled to the charging coil to receive power therefrom and that operates to provide a regulated voltage to the liquid fuel cut-off solenoid.
2. The dual fuel generator of claim 1 further comprising:
a liquid fuel valve along a liquid fuel line coupling the liquid fuel source to the carburetor; and
a gaseous fuel valve along a gaseous fuel line coupling the gaseous fuel source to the carburetor.
3. The dual fuel generator of claim 2, wherein each of the liquid fuel valve and the gaseous fuel valve comprises a mechanical valve.
4. The dual fuel generator of claim 2, wherein the liquid fuel cut-off solenoid is attached to the carburetor.
5. The dual fuel generator of claim 1, wherein the gaseous fuel is LPG and the liquid fuel is gasoline.
6. The dual fuel generator of claim 1, wherein the switch is an electro-mechanical switch connecting one fuel source to the carburetor and connected to the electrical power generator, and wherein the liquid fuel cut-off solenoid is

22

connected to open and close a fuel path to the engine in response to reception of electrical power from the switch.

7. The dual fuel generator of claim 6, wherein the switch selectively powers the solenoid valve by controlling electrical connection between the solenoid valve and the electrical power generator.

8. The dual fuel generator of claim 1, wherein the liquid fuel cut-off solenoid is normally open to provide liquid fuel to the engine when the liquid fuel cut-off solenoid is unpowered.

9. The dual fuel generator of claim 8, wherein the dual fuel generator is a batteryless dual fuel generator and the engine is a pull-start engine, the batteryless dual fuel generator further comprising a pull-starter that drives the electrical power generator to power and close the liquid fuel cut-off solenoid while starting the engine on gaseous fuel.

10. The dual fuel generator of claim 1, wherein the electrical power generator comprises a magneto or an alternator.

11. A dual fuel generator comprising:

- an engine operable on a gaseous fuel and a liquid fuel;
- 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; and
- a manually actuated fuel shutoff coupled to the carburetor, the manually actuated fuel shutoff comprising:
a first end in the carburetor that actuates to selectively allow or block a flow of fuel through the carburetor; and
and a second end external to the carburetor to actuate the first end.

12. The dual fuel generator of claim 11, wherein the engine is a pull start, batteryless engine.

13. The dual fuel generator of claim 11, wherein the gaseous fuel is LPG and the liquid fuel is gasoline.

14. The dual fuel generator of claim 11 wherein the manually actuated fuel shutoff comprises a rotating mechanical valve.

15. The dual fuel generator of claim 14 wherein the carburetor comprises:

- a float bowl;
 - a throat; and
 - a fuel passage to provide fuel from the float bowl to the throat;
- wherein the manually actuated fuel shutoff comprises a shaft extending into the carburetor through an aperture in the float bowl, the shaft being coupled to a valve tip in the float bowl that rotates to open and close the fuel passage.

16. The dual fuel generator of claim 15 wherein the valve tip rotates parallel to an inlet of the fuel passage between a first position permitting fuel flow into the inlet and a second position blocking fuel flow into the inlet.

17. The dual fuel generator of claim 15, wherein the fuel passage has an inlet with a substantially flat perimeter edge and the valve tip maintains planar contact with the perimeter edge while rotating to open and close the fuel passage.

18. The dual fuel generator of claim 17 further comprising:

- a plug in the aperture around the shaft; and
- a compression spring around the shaft in the float bowl pushing against the plug to hold the valve tip against the perimeter edge of the inlet.

19. The dual fuel generator of claim 15 further comprising:

- a lever coupled to the shaft outside of the carburetor;

23

a spring coupled to the lever to hold the fuel shutoff
opening the fuel passage; and
a cable coupled to the lever to move the lever against the
spring and rotate the fuel shutoff to close the fuel
passage.

5

* * * * *

24

EXHIBIT 1002

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 11,143,145 B2
APPLICATION NO. : 16/946438
DATED : October 12, 2021
INVENTOR(S) : Collie et al.

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

Page 2 item (63) Related U.S. Application Data: delete "10,221,781" and substitute therefore
--10,221,780--.

Signed and Sealed this
Twenty-eighth Day of December, 2021



Drew Hirshfeld
*Performing the Functions and Duties of the
Under Secretary of Commerce for Intellectual Property and
Director of the United States Patent and Trademark Office*



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/946,438	06/22/2020	Kendall J. Collie	CET1090.076	5786
26629	7590	12/08/2021	EXAMINER	
ZIOLKOWSKI PATENT SOLUTIONS GROUP, SC (ZPS)			TRAN, LONG T	
136 S WISCONSIN ST				
PORT WASHINGTON, WI 53074				
			ART UNIT	PAPER NUMBER
			3747	
			NOTIFICATION DATE	DELIVERY MODE
			12/08/2021	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

info@zpspatents.com
jmf@zpspatents.com
lje@zpspatents.com



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Patent No.: 11143145
Issue Date: 10/12/2021
Appl. No.: 16/946,438
Filed: 06/22/2020

PART (A) RESPONSE FOR CERTIFICATES OF CORRECTION

This is a decision on the Certificate of Correction request filed 05 November 2021.

The request for issuance of Certificate of Correction for the above-identified correction(s) under the provisions of 37 CFR 1.322 and/or 1.323 is hereby:

(Check one)

☒ Approved ☐ Approved in Part ☐ Denied

Comments: _____

PART (B) PETITION UNDER 37 CFR 1.324 OR 37 CFR 1.48

☐ This is a decision on the petition filed _____ to correct inventorship under 37 CFR 1.324.

☐ This is a decision on the request under 37 CFR 1.48, petition filed _____. In view of the fact that the patent has already issued, the request under 37 CFR 1.48 has been treated as a petition to correct inventorship under 37 CFR 1.324.

The petition is hereby: ☐ Granted ☐ Dismissed

Comment: _____

The patented filed is being forwarded to Certificate of Corrections Branch for issuance of a certificate naming only the actual inventor or inventors.

/PHUTTHIWAT WONGWIAN/
Supervisory Patent Examiner, Art Unit 3747
Technology Center 3700
Phone: (571)270-5426

Certificates of Correction Branch email: CustomerServiceCoC@uspto.gov CoC Central Phone Number: (703) 756-1814



United States Patent and Trademark Office

Office of the Chief Financial Officer

Document Code:WFEE

User :65148

Sale Adjustment Accounting Date:11/17/2021

Effective Date	Sale Accounting Date	Sale Item Reference Number
11/05/2021	11/17/2021	16946438

Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method
I2021AGG47243135	2811	CERTIFICATE OF CORRECTION	\$160.00	Visa



United States Patent and Trademark Office

Office of the Chief Financial Officer

Document Code:WFEE

User :65148

Refund Accounting Date:11/17/2021

Effective Date	Sale Item Reference Number	Refund Total
11/05/2021	16946438	\$160.00

Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method	Account Number
I2021AGG47243135	2811	CERTIFICATE OF CORRECTION	\$160.00	Visa	*****4529

REQUEST FOR REFUND

Reference # <i>(Patent #, Application #, Trademark Serial #, Registration #, etc.)</i>		Title of Invention or Mark Information	
Patent # 11,143,145		BATTERYLESS DUAL FUEL ENGINE WITH LIQUID FUEL CUT-OFF	
Attorney Docket # <i>(if applicable)</i>	Payment Date <i>(mm/dd/yyyy)</i>	Refund Request Amount	
CET1090.076	11/05/2021	\$ 160.00	
Refund Option <i>(Select one)</i>			
☒ If approved, issue the refund to the account associated with the original payment.			
☐ If approved, and the original payment was a check, issue the refund to deposit account # _____.			
☐ If approved, and the original payment was a check, issue the refund as a U.S. Treasury check.			
Reason for Refund Request <i>Refund requests must generally be filed within 2 years of payment date (37 CFR 1.26 and 2.209)</i>			
☐ Duplicate Payment		☒ No Fee Due	
☐ Small Entity Later Established* (*must be filed within 3 months of payment date, 37 CFR 1.28)		☐ Office Error	
☐ Other _____			
Rationale <i>(Supporting documentation may be submitted with this form)</i>			
Applicant filed via EFS-Web a Request for Certificate of Correction of Patent for Office's Mistake (37 CFR 1.322). Therefore, no fee was due and Applicant respectfully requests a refund of the \$160 fee paid on November 5, 2021.			

Requester's Information

Company or Firm Name <i>(if applicable)</i>		
Ziolkowski Patent Solutions Group, SC		
Address Line 1	City	State/Region
136 South Wisconsin Street	Port Washington	WI
Address Line 2 <i>(if applicable)</i>	Country	Zip/Postal Code
	US	53074
Email Address <i>(You will receive an acknowledgment of receipt only if you provide a valid email address)</i>		Phone Number
info@zpspatents.com		262-268-8100
Requester's Name		Registration Number <i>(if applicable)</i>
Timothy J. Ziolkowski		38368
Signature		Date <i>(mm/dd/yyyy)</i>
/Timothy J. Ziolkowski/		11/09/2021

Submit online: [EFS-Web](#) *(registered users only; select "Request for Refund" from the document description menu)*, or

Fax to: 571-273-6500, or

Mail to: Mail Stop 16, Director of the U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450



ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
16/946,438

RECEIPT DATE / TIME
11/09/2021 04:39:39 PM ET

ATTORNEY DOCKET #
CET1090.076

Title of Invention

BATTERYLESS DUAL FUEL ENGINE WITH LIQUID FUEL CUT-OFF

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
under 35 USC 111(a)

PATENT # 11143145

CONFIRMATION # 5786

FILED BY Robyn Templin

PATENT CENTER # 60392047

FILING DATE 06/22/2020

CUSTOMER # 26629

FIRST NAMED INVENTOR Kendall J. Collie

CORRESPONDENCE ADDRESS -

AUTHORIZED BY Timothy Ziolkowski

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
2021.11.09 Request for Refund.pdf	1	Refund Request	685 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
2021.11.09 Request for Refund.pdf	D38FEE0CD689AB69CEC50DD5DD7F232B1C4A7AC5C68C939 A53B9BB4408E6680A6C681CA993C75F5C218C5846FC23A5EA F9898AE2D0501B34599819CEC466C1F0

by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Number : 11,143,145 B2
Issued : October 12, 2021
Name of Patentee : Collie et al.
Title of Invention : BATTERYLESS DUAL FUEL ENGINE WITH LIQUID
FUEL CUT-OFF

**REQUEST FOR CERTIFICATE OF CORRECTION OF PATENT FOR
OFFICE'S MISTAKE (37 CFR 1.322)**

1. It is noted that errors appear in this patent of a clerical nature or characterized as more fully described below and would not constitute new matter or would not require re-examination. A Certificate of Correction is requested.

2. Attached hereto is Form PTO-1050 which should be suitable for printing.

3. **REFERRING TO THE FILING RECEIPT DATED JULY 6, 2020** - The error to be corrected is as follows:

On the Title Page of USP 11,143,145 B2, Page 2

(63) Related U.S. Application Data: delete "10,221,781"
and substitute therefore --10,221,780 --.

4. Please send the Certificate to:

Timothy J. Ziolkowski
Ziolkowski Patent Solutions Group, SC
136 South Wisconsin Street
Port Washington, WI 53074

Date: November 5, 2021

/Timothy J. Ziolkowski/
Timothy J. Ziolkowski
Registration No. 38,368
Telephone: (262) 268-8100

UNITED STATES PATENT AND TRADEMARK OFFICE CERTIFICATE OF CORRECTION

Page 1 of 1

PATENT NO. : 11,143,145 B2
 APPLICATION NO. : 16/946,438
 ISSUE DATE : October 12, 2021
 INVENTOR(S) : Collie et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page of USP 11,143,145 B2, Page 2

(63) Related U.S. Application Data: delete "10,221,781"
 and substitute therefore --10,221,780 --.

(Also Form PTO-1050)

MAILING ADDRESS OF SENDER:

Timothy J. Ziolkowski
 Ziolkowski Patent Solutions Group, SC
 136 South Wisconsin Street
 Port Washington, WI 53074

PATENT NO: 11,143,145 034 B2

Burden Hour Statement: This form is estimated to take 1.0 hour to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450



ELECTRONIC PAYMENT RECEIPT

APPLICATION #
16/946,438

RECEIPT DATE / TIME
11/05/2021 03:29:38 PM ET

ATTORNEY DOCKET #
CET1090.076

Title of Invention

BATTERYLESS DUAL FUEL ENGINE WITH LIQUID FUEL CUT-OFF

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
under 35 USC 111(a)

PATENT # 11143145

CONFIRMATION # 5786

FILED BY Robyn Templin

PATENT CENTER # 60387336

AUTHORIZED BY Timothy Ziolkowski

CUSTOMER # 26629

FILING DATE 06/22/2020

CORRESPONDENCE
ADDRESS -

FIRST NAMED
INVENTOR Kendall J. Collie

Payment Information

PAYMENT METHOD
CARD / 4529

PAYMENT TRANSACTION ID
E2021A5F30330706

PAYMENT AUTHORIZED BY
Robyn Templin

FEE CODE	DESCRIPTION	ITEM PRICE(\$)	QUANTITY	ITEM TOTAL(\$)
2811	CERTIFICATE OF CORRECTION	160.00	1	160.00
TOTAL AMOUNT:				\$160.00

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371