

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Mercedes-Benz USA, LLC,

Petitioner,

v.

Westport Fuel Systems Canada, Inc.
Patent Owner.

Case IPR2023-00351
Patent 6,575,138

**PETITION FOR *INTER PARTES* REVIEW OF
U.S. PATENT NO. 6,575,138
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. §42.100 *et seq.***

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I. INTRODUCTION

Petitioner Mercedes-Benz USA, LLC (“**Petitioner**” or “**Petitioners**”) challenges claims 1-3, 6, 13-14, 16-22, 26-28, and 41 of US6,575,138 (“**138**”) (Ex.1001). The ’138 claims nothing more than what was well-known in the art of compression-ignition (*i.e.*, diesel) internal combustion engine and fuel injection technology at the time it was filed. The ’138 fuel injector, like prior art fuel injectors, uses an electrically-controlled actuator to drive movement of a valve needle between open and closed positions to allow fuel to move into a combustion chamber on a periodic basis. The ’138 fuel injector includes well-known elements such as a housing, valve needle, valve needle spring, and actuator assembly to actuate movement of the spring to open and close the needle. The ’138 purports to invent a so-called “passive hydraulic link assembly” which uses hydraulic fluid to transmit forces between the actuator assembly and valve needle. However, using a hydraulic fluid to transmit forces between components in a fuel injector is well-known and has been incorporated into a variety of different fuel injectors.

None of this was new at the time of the alleged invention. Injector valves as claimed in the ’138 have been used for decades, specifically with fuel injection systems. The primary reference discussed herein, U.S. Patent No. 6,530,273 (“**Gottlieb**”) (Ex.1004), together with the Declaration of expert Glenn Bower (“**Bower Decl.**”) (Ex.1002), underscores this. Gottlieb discloses a fuel injector that

includes an actuator assembly and a hydraulic link to transfer forces to a valve needle to permit or block injection of fuel into a combustion chamber. Gottlieb alone or, for certain dependent claims, in combination with German Patent Application No. DE1938862A1 (Ex. 1005) (“**Gottlieb (DE)**”), invalidate the ’138. Neither of these references was considered during prosecution of the ’138.

II. MANDATORY NOTICES

A. Real Parties-in-Interest

The real parties-in-interest are Petitioner Mercedes-Benz USA, LLC; Mercedes-Benz Intellectual Property GmbH & Co. KG; and Mercedes-Benz AG, as well as Robert Bosch LLC.

B. Related Matters

Patent Owner Westport Fuel Systems Canada, Inc. (“**Westport**”) asserted the ’138 in five lawsuits in the Eastern District of Texas filed on December 15, 2021:

- Case No. 2:21-CV-453 against Ford Motor Co.
- Case No. 2:21-CV-454 against Petitioner Mercedes-Benz USA, LLC
- Case No. 2:21-CV-455 against Nissan North America, Inc.
- Case No. 2:21-CV-456 against General Motors, LLC
- Case No. 2:21-CV-457 against FCA USA LLC

The cases against Petitioner Mercedes-Benz USA, Nissan, and FCA have been

dismissed due to improper venue. The cases against Ford and General Motors remain in their infancy, *e.g.*, the claim construction hearing is not until 2023.

Additionally, on April 4, 2022, Robert Bosch, LLC filed a declaratory judgment action in the Eastern District of Virginia against Westport, seeking rulings of noninfringement of the '138 and its parent, US6,298,829 (“’829”), assigned Case No. 1:22-cv-370. Westport has moved to dismiss that case.

Petitioner is filing another *inter partes* review petition against the '138, along with the required statement ranking the petitions. Petitioner is filing other *inter partes* review petitions against the '829 contemporaneously with this petition. The '138 is a continuation-in-part of the '829, and both claim priority to US60/159,791 (EX1007) (the “**Provisional**”).

C. Counsel and Service Information

Lead counsel is Celine Crowson (Reg. 40,357). Backup counsel are Joe Raffetto (Reg. 66,218), Scott Hughes (Reg. 68,385), and Ryan Stephenson (Reg. 76,608). Service information is as follows:

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III. NOTICE OF FEES PAID

Fees are submitted herewith. If additional fees are due during the proceeding, the undersigned authorizes the Office to charge them to Deposit Account No. 50-1349.

IV. CERTIFICATION OF GROUNDS FOR STANDING

Petitioner certifies that the '138 is available for *inter partes* review, and that it is not barred or estopped from requesting this review.

V. PRECISE RELIEF REQUESTED

The relief requested is cancellation of the challenged claims, as follows:

Ground	References	Claims ¹	Basis
1a	Gottlieb	1-3, 6, 13-14, 16-17, 19-21, 26-28, 41	102 / 103
1b	Gotlieb/Gottlieb (DE)	14, 18, 22	103

VI. BACKGROUND ON FUEL INJECTORS

A. Overview of Reciprocating Internal Combustion Engines

Almost all internal combustion engines use reciprocating engine geometry where pistons move up and down inside the cylinders and, through each piston and a connecting rod, transfer power to the crankshaft and then to whatever the engine is driving. (Bower Dec., ¶ 19.) The pistons therefore move from the bottom of the

¹ Independent claims in bold.

cylinder to the top of the cylinder and then back down again. The bottom position of the piston is called "bottom dead center" ("BDC"), or sometimes "bottom center" ("BC"). The top position of the piston is called top dead center " ("TDC") or "top center" ("TC"). Each upward or downward motion of the piston is called a "stroke." (Bower Dec., ¶ 19.)

The most common type of internal combustion engine uses a four-stroke cycle. (Bower Dec., ¶ 20.) These four strokes - a series of downward and upward motions of the piston - are called the intake stroke, compression stroke, expansion stroke and exhaust stroke. Normally, combustion occurs just before the end of the compression stroke through the start of the expansion stroke. (Bower Dec., ¶ 20.)

Internal combustion engines are used to produce power by burning hydrocarbon fuels mixed with air. (Bower Dec., ¶ 21.)

Compression-ignition (Diesel), internal combustion engines generate power at the crankshaft via reciprocating pistons that compress and ignite atomized/vaporized diesel fuel with air in the cylinders. (Bower Dec., ¶ 22.) Diesel engines activate intake and exhaust valves to pull intake air into the engine and expel combusted air out of the engine. (Bower Dec., ¶ 22.) Once the intake air is trapped in an engine's cylinder, it is compressed by pushing the piston upward in the cylinder causing the temperature and pressure of the trapped air to increase drastically. (Bower Dec., ¶ 22.) As the piston approaches its top-most position, the

engine injects diesel fuel into this hot air at pressures over 20,000 psi. This ultra-high injection pressure creates very small droplets that are subsequently vaporized by the hot air in the cylinder. (Bower Dec., ¶ 22.) Once vaporized, it mixes with this trapped air. Ultimately, this vaporized fuel reaches its self-ignition temperature and the fuel ignites. Once the fuel ignites, it creates a local 'hot spot' that subsequently ignites any additional fuel and air mixtures entering this volume. (Bower Dec., ¶ 22.)

As the combustion process progresses, high-pressure, high-temperature exhaust gases are produced in the combustion chamber and the piston is "pushed" back down toward the bottom dead center position. (Bower Dec., ¶ 23.) Work is transferred from the high-pressure, high temperature gases by the downward movement of the piston to the crankshaft. (Bower Dec., ¶ 23.) The exhaust gases resulting from the combustion of the fuel and air mixture, along with any unburnt portion of the fuel and air mixture, are expelled through the cylinder exhaust port to an exhaust system for discharge to the atmosphere. (Bower Dec., ¶ 23.)

Spark-ignited (gasoline) engines are very similar to compression ignition engines except the start of the combustion process is initiated by producing a plasma (spark) using a spark plug. (Bower Dec., ¶ 24.) Once initiated, the combustion proceeds from the spark plug to the outer regions of the combustion chamber where the flame is extinguished next to the wall. (Bower Dec., ¶ 24.)

Gasoline engines under load, inject the exact amount of fuel necessary to combust almost all the oxygen molecule trapped in its cylinder. (Bower Dec., ¶ 25.) This is necessary to optimize the engines 3-way catalyst to create ultra-low emissions. (Bower Dec., ¶ 25.)

Diesel engines operating at capacity, in contrast, only utilize 50 to 60% of the oxygen trapped in their cylinders. The fuel being sprayed into the combustion chamber cannot mix with all of the air/oxygen in the combustion chamber. (Bower Dec., ¶ 26.)

Today, most Diesel engines utilize a common rail fuel injection system which allows for pre-injections, multiple main injections and post-injections. The pre-injections and main injections are ratioed and positioned by the engine manufacturer to produce acceptable levels of in-cylinder soot and Oxides of Nitrogen (NOx) while also reducing the audible noise that the engine emits. (Bower Dec., ¶ 27.)

According to Heywood (2018, p. 546), the newest option for controlling multiple injections in common rail fuel system operating at pressures up to 200 MPa is piezo-actuated injected needles. “Injectors . . . can provide up to five injections per cylinder per cycle. Use of the piezo-injectors in diesel engines reduces engine noise and air-pollutant emissions significantly, and increases power output and efficiency.” (Bower Dec., ¶ 28.)

Either compression-Ignition (Diesel) or spark-ignited engines can also utilize a turbochargers to extract energy from the exhaust products which is then used to compress the inlet air to double or triple the density of the surrounding atmosphere; increasing the power output of the engine. (Bower Dec., ¶ 29.)

B. Fuel Injectors

A fuel injector is used to introduce a precise amount of fuel into an engine for combustion. The fuel injector is also intimate in the mixing of the fuel with air prior to/during combustion. (Bower Dec., ¶ 30.)

As emission standards have become more stringent for gasoline powered automobiles, the fuel injector was moved from the back side of the intake valve (i.e. port injection) to directly injecting into the cylinder. The change constrains the fuel to the combustion chamber which lowers evaporative emissions while eliminating transient fueling unknowns. Creating a cleaner, more responsive and more fuel efficient engine. (Bower Dec., ¶ 31.)

Gaseous fueled (normally natural gas) direct-injection engines injection engines require a means (i.e. compressor or pump) for delivering high pressure natural gas to the injector. The fuel has to be injected and allowed to mix with the combustion chamber air prior to be ignited by a glow plug, spark plug or a diesel pilot injection. (Bower Dec., ¶ 32.)

In compression ignition (Diesel) engines, the fuel is ‘broken’ into droplets while it is injected. The fuel evaporates from the surface of the droplets; for an injector producing smaller droplets, the fuel is evaporated quicker. Evolution of the compression ignition injector has led to higher injection pressures coupled with smaller nozzle holes. (Bower Dec., ¶ 33.)

C. Parts of a Fuel Injector

All direct-injection injector have similar features. The external shape is a normally a long cylinder as the injector has to be mounted through the depth of the cylinder head. The injection nozzle will protrude into the combustion chamber while the fuel will enter the injector through a fuel port on the top (fitting) or center (fuel passage integrated into cylinder head) of the injector body. (Bower Dec., ¶ 34.)

Internally, almost all fuel injectors have a spring that is responsible for sealing the injection needle against the valve seat of an injector nozzle. Internally, the injector has clearances so that the fuel can flow from the injector inlet port to the injector nozzle. (Bower Dec., ¶ 35.)

Injectors will also have a mechanism for activating the injection process by overcoming the force of the spring sealing the injector nozzle. (Bower Dec., ¶ 39.)

D. Passive vs. Active Link in Fuel Injectors

According to the '138 patent, there are two different types of hydraulic operators that can be utilized to control of the injection process. There are active and passive. (Bower Dec., ¶ 40.)

An active hydraulic operator has a high pressure hydraulic source that generates the actuation force for the injector valve. ('138:1:16-21) Piezo actuated injectors that utilize a differential piston (hydraulic amplifier) to amplify the actuators displacement is an example of an active hydraulic operator as defined by the '138. (Bower Dec., ¶ 41.)

A passive hydraulic link is defined by the '138 as being a 'sandwich' of hydraulic fluid that is axially compressed during the needle opening or closing. The hydraulic fluid transmits a force but is not the source of the force. (Bower Dec., ¶ 42.)

It is impossible to utilize a passive hydraulic link in a natural gas injector without the integration of a non-consumable hydraulic fluid. (Bower Dec., ¶ 43.)

VII. OVERVIEW OF THE '138

A. Subject Matter of the '138

The '138 patent relates to fuel “injectors for internal combustion engines” that are “directly controllable” by an actuator. (Ex. 1001, 1:16-20.) The injector also includes a “passive hydraulic link.” (*Id.*, 1:21.)

The patent begins by explaining that the prior art recognized that “[d]irect

injection,” where fuel is injected directly into an engine’s “combustion chamber” was “desirable” because it improves engine performance and reduces emissions. (*Id.*, 1:23-40.) The patent concedes that “hydraulically actuated” injectors and injectors using “piezoelectric actuator[s]” were known and available. (*E.g., id.*, 2:13-17, 2:52-55.) But, existing hydraulically actuated systems were “bulk[y],” subject to “delayed response” times, and had reduced “controllability of movement of the injection valve.” (*Id.*, 2:23-46.) Further, the known piezoelectric actuators were purportedly only used to “operate a control valve, which in turn controls the flow of a hydraulic fluid to operate an injection valve....” (*Id.*, 2:52-62.) This also introduced delay and necessitated hydraulic fluid supply. (*Id.*, 2:58-64.)

The ’138 patent proposes a “directly actuated” injector without “an intermediate active hydraulic operator generating any actuating forces.” (*Id.*, 2:64-67.) This injector does include a “passive hydraulic link.” (*Id.*, 4:10-12, 39-40; 7:23-37.) Unlike “[c]onventional active hydraulic operators,” this link “merely transmits the actuating forces” (*i.e.*, serves as a “load path”) “but is not employed to generate an actuating force for actuating the valve.” (*Id.*) The “passive hydraulic link” also provides a “further advantage” in that it “may be employed to correct for differential thermal expansion, wear and dimensional variability within permitted manufacturing and assembly tolerances.” (*Id.*, 7:57-60.) It does this by “auto-adjusting itself in response to these effects by allowing movement of hydraulic fluid

between opposite sides of [a] hydraulic piston” to “re-zero[] itself to ensure that a desired valve needle lift is maintained.” (*Id.*, 7:60-65.)

The below figures provide an example:

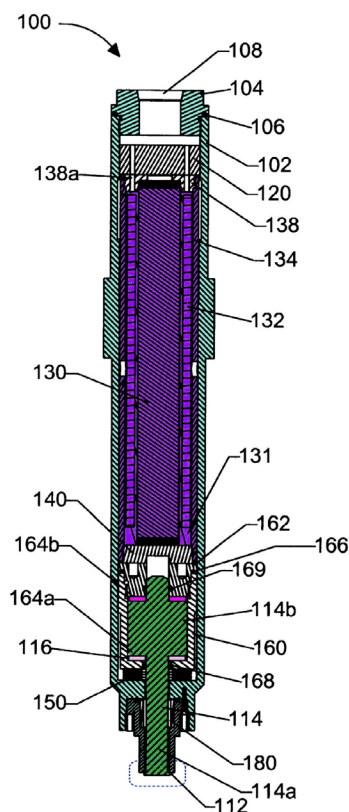


FIG. 1

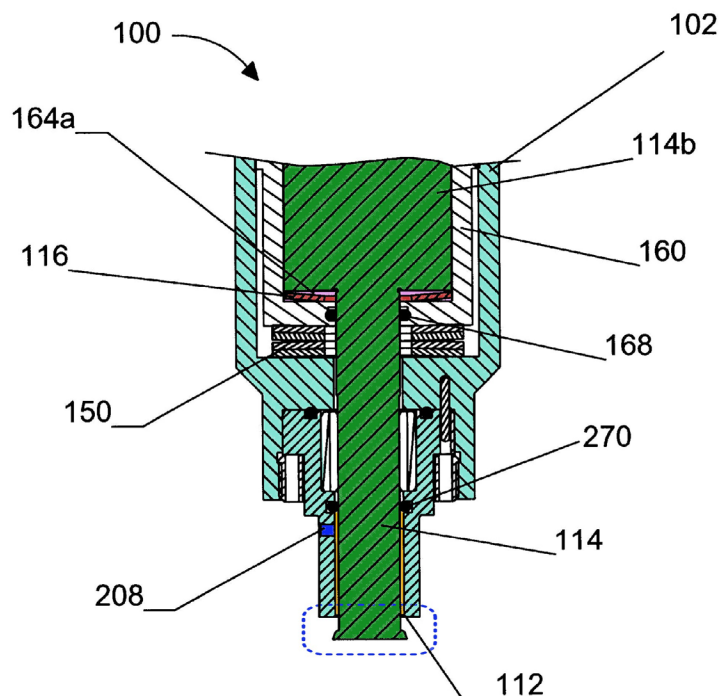


FIG. 2

(*Id.*, Figs. 1-2 (annotated).)

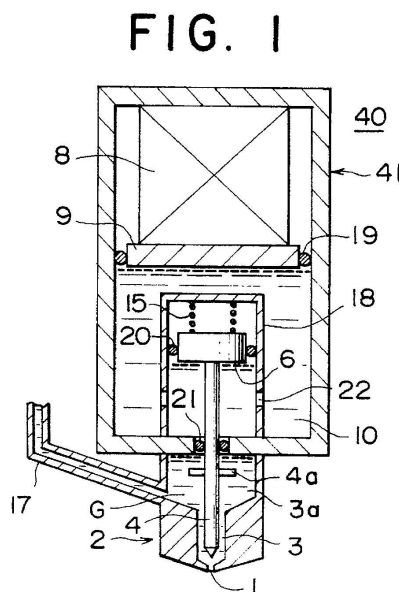
These figures depict an “outwardly opening directly actuated fuel injection valve.” (*Id.*, 8:61-63.) A “valve housing 102” and “cap 104” (teal) “provide a fluidly sealed valve body.” (*Id.*, 9:4-6.) A “fuel inlet 208” (blue) supplies fuel to the injector interior (orange). (*Id.*, 13:33-39.) A “valve member 114” (green) is located within the injector. (*Id.*, 9:23-27.) One end of this member 114 “contacts [a] valve

seat 112” (circled in blue) to close the injector. (*Id.*, 9:59-64.) A “valve spring 116” (red) in the form of a “disc or washer spring” (or “coil spring”) “biases” the member 114 “in the closed position.” (*Id.*, 10:13-19.)

A “magnetostrictive actuator” including a member 130, bobbin 131, coil 132, and flux tube 134 (purple) is located within the housing. (*Id.*, 10:41-46.) To open the valve, current is applied to the actuator causing it to “grow in length.” (*Id.*, 10:51-60.) This causes the actuator to push an intermediate “sliding pole 140” towards the “valve member 114 to provid[e] a force for opening injection valve 100.” (*Id.*, 10:59-62.) “The opening force generated by the actuator assembly is transmitted to valve member 114 through” “hydraulic fluid 164b” (small area of dark pink) of “a hydraulic link assembly.” (*Id.*, 11:65-67; 14:16-22.) During actuation, this fluid “does not have time to flow” through the “narrow clearance gap” surrounding the top of valve member 114, and instead “acts as a solid.” (*Id.*, 14:26-40.) But, when the injector is closed, “[a]uto-adjustments are accomplished by the migration of hydraulic fluid from chamber 164b on one side of the hydraulic piston 115b to chamber 164a” (small area of light pink) “on the other side” of the piston. (*Id.*, 15:14-25.) This allows the injector “to account for the effects of temperature, wear, and any small movements of valve member 114....” (*Id.*)

B. Prosecution History of the ’138

All of the originally filed claims were rejected in a November 2002 office action as obvious over U.S. 5,630,550 (“Kurishige,” Ex. 1011). (See Ex. 1012, pp. 123-125.) Fig. 1 of Kurishige is reproduced below:

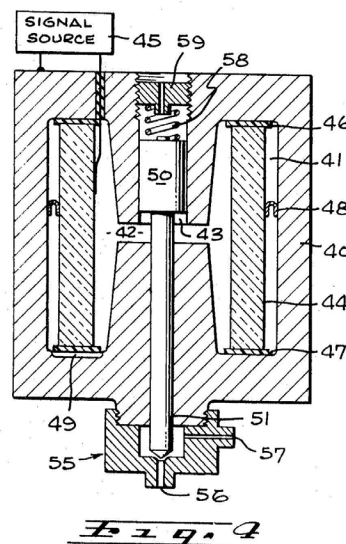


(Ex. 1011, Fig. 1.) In this injector, element 8 expands, forcing piston 9 down. This applies force to fluid 10, which flows from the outer cylinder, through holes 22, and into the narrower inner cylinder causing piston 6 to move by an amplified distance. (*Id.*, 5:45-67.)

Applicant responded in February 2003. (Ex. 1012, pp. 128-141.) The Applicant characterized Kurishige as a “conventional ‘dynamic’ hydraulic system, which relies upon the flow of hydraulic fluid” from chamber 10 to the inner cylinder “to actuate a needle valve.” (*Id.*, pp. 134, 136-37.) This is “structurally and functionally distinguished from the applicants’ ‘passive’ hydraulic link. In a

‘dynamic’ hydraulic system, the hydraulic fluid does not ‘act substantially as a solid with the thickness being substantially constant while the actuator assembly is actuated’, as recited in claim 1 ... because the hydraulic fluid must flow from one chamber to another to cause needle movement.” (*Id.*) This response led to allowance of the claims. (*Id.*, pp. 166-168.)

The ’138 is a continuation of U.S. Patent No. 6,298,829 (“the “’829”). When filed, the ’130 application underlying the ’829 included 30 claims. (*See* Ex. 1010, pp. 75-83.) Claims 1-20 were rejected in a March 2001 office action as anticipated by or obvious over U.S. 3,598,506 to O’Neill (“O’Neill,” Ex. 1009). (*See* Ex. 1010, p. 119-121.) The Examiner pointed to, among other things, Fig. 4 of O’Neill reproduced below:



(O’Neill, Fig. 4.) The Examiner explained that the combination of chambers 42 and 43 shown in this Figure correspond to the claimed “hydraulic link assembly.” (Ex.

1010, p. 120.) In operation, O’Neill’s “electroexpansive material 44” expands upon application of an electrical signal, resulting in the transmission of force through the fluid stored “chamber 41,” “passage 42,” and piston cylinder 43” to a “piston 50.” (O’Neill, 4:10-49.) This in turn opens a “valve 55.” (*Id.*) Claims 21-30, which either required a particular “magnetostrictive member” structure or were directed to a method, were allowed. (*See* Ex. 1010, pp. 79-83 121.)

The applicant responded in June 2011 by noting that “O’Neill ... rel[ies] on the dynamic flow of a hydraulic fluid to actuate/open the valve.” (*Id.*, p. 129.) More specifically, in O’Neill, the “electroexpansive material 44 is activated to displace fluid from chamber 41 through passage 42 in piston cylinder 43 to lift piston 50 and open the valve.” (*Id.*, p. 130.) Applicant went on to argue that this is different from the pending claims. Because O’Neill’s device entails fluid flow and displacement, it lacks a “‘passive’ hydraulic link.” (*Id.*, p. 129.) Moreover, because O’Neill’s “actuating fluid is displaced and flows dynamically,” it “behaves as a liquid” and not “substantially as a solid while said actuator assembly is activated” as required. (*Id.*, p. 130.) The claims were allowed immediately after this response. (*See id.*, p. 138.)

Unlike Kurishige and O’Neill, Gottlieb employs a passive hydraulic link and does not employ dynamic hydraulic fluid flow to open an injector valve.

C. Effective Filing Date of the ’138

The '138 was filed May 23, 2001 and claims priority to the '829 as well as the Provisional, which was filed October 15, 1999. ('138, Face.) The claims of the '138 are not, however entitled to the October 1999 priority date, and are instead only entitled to the March 9, 2000 date on which the '138's application was filed.

a. Legal Standard

A “reference patent is only entitled to claim the benefit of the filing date of its provisional application if the disclosure of the provisional application provides support for the claims in the reference patent in compliance with § 112, ¶ 1.” *Dynamic Drinkware, LLC v. National Graphics, Inc.*, 800 F.3d 1375, 1381 (Fed. Cir. 2015) (citation omitted); *see also* 35 U.S.C. § 119(e)(1). To satisfy the written description requirement, the prior application’s “the written description must include all of the limitations of the [claims], or the applicant must show that any absent text is necessarily comprehended in the description provided and would have been so understood at the time the patent application was filed.” *Hyatt v. Boone*, 146 F.3d 1348, 1354-55 (Fed. Cir. 1998). “To satisfy the written description requirement . . . [i]t is not enough that a claimed invention is an obvious variant of that which is disclosed in the specification.” *Novartis Pharms. Corp. v. Accord Healthcare, Inc.*, 38 F.4th 1013, 1016 (Fed. Cir. 2022) (citations and quotation marks omitted).

As explained below, the Provisional does not have the same disclosure as the '138, so the Board does not presume that the '138 entitled to the Provisional's filing

date. *See SK Hynix Inc. v. Netlist, Inc.*, IPR2020-01044 (PTAB Dec. 17, 2020) at 23-24. Thus, the patent owner bears the burden to show that identified limitations are supported by the provisional application. *Id.*

b. The '138's Challenged Claims Are Not Entitled to an Earlier Priority Date

Numerous claim elements required by all challenged claims are not supported by the Provisional under 35 U.S.C. § 112, ¶ 1. First, independent claim 41 recites that the “hydraulic fluid acts as an incompressible solid.” The Provisional does not use this language: it never describes that “the hydraulic fluid” as “act[ing] as an incompressible solid.” In contrast to this, the Provisional acknowledges that there would be some compression of the hydraulic fluid—causing displacement—during an injection when forces are applied. *See* Provisional at 14:19-21 (“[T]here is little displacement due to the compressibility of the chosen hydraulic fluid.”). Even though the Provisional acknowledges that there may be only “little” compression, it still acknowledges that there is some compression. It thus directly contradicts the language of claim 41. In short, the earliest support for this “incompressible solid” claim term is in the '829 Non-Provisional.

Second, in the same vein, independent claim 1 recites a “hydraulic fluid thickness . . . with said thickness being substantially constant while said actuator assembly is activated and wherein said thickness of said hydraulic link is adjustable while said actuator is not activated.” During prosecution of the parent application to

the '138 Patent, this term was described as supported by page 28, line 9 through 15 of the '829 Non-Provisional's specification, which state: "the hydraulic fluid preferably has a sufficiently high viscosity and bulk modulus so that it acts as an incompressible solid when activation of the actuator assembly causes a valve opening force to be quickly transmitted through the hydraulic fluid between the bottom of cylinder 160 and hydraulic piston 114b." June 20, 2011 Amendment for Patent App. No. 09/522,130 at 4 ("support [for this element] can be found in the specification, for example, on page 28, lines 9 through 15"). This allegedly supporting language was added in the '829 Non-Provisional and was not present in the Provisional. The Provisional never describes that "the hydraulic fluid . . . acts as an incompressible solid," one of the particular features in the '829 Non-Provisional specification that the Applicant pointed to as supporting the thickness being substantially constant (presumably because an incompressible solid would not change thickness even when subjected to forces). In contrast to this, the Provisional acknowledges that there would be some compression of the hydraulic fluid, and therefore a change in thickness, during an injection when forces are applied. *See* Provisional at 14:19-21 ("[T]here is little displacement due to the compressibility of the chosen hydraulic fluid."). This is inconsistent with the "thickness being substantially constant while said actuator assembly is activated," as recited in of claim 1. Even though the Provisional acknowledges that there may be only "little"

compression, it still acknowledges that there is some compression, and therefore change in thickness. As noted, the specification of the '829 Non-Provisional goes beyond this, and specifies that the fluid acts as an “incompressible solid.” Because the language the Applicant relied upon for supporting its claim amendment is found only in the '829 Non-Provisional, the claims should only be entitled to the filing date of the '829 Non-Provisional.

Further, the portion of the '829 Non-Provisional that Applicant pointed to as supporting the limitation in the claims that the fluid has a “substantially constant” thickness particularly describes the fluid as being contained “between the bottom of cylinder 160 and hydraulic piston 114b.” The Provisional’s “hydraulic link” is described only generally as being “between the needle valve 14 and the actuator 20.” Provisional 7:22-23. That is, the '829 Non-Provisional application defines that the fluid is specifically confined between two things – the bottom of the cylinder and the hydraulic piston. Being confined to this space, and being an “incompressible” solid, is the support the Applicant pointed to when amending the claim to say the thickness is “substantially constant.” The Provisional does not include these details. In short, the only support for this claim term is in the '829 Non-Provisional.

Moreover, the Provisional does not even use the terms “hydraulic fluid thickness,” “substantially constant,” or “adjustable.” (*See* Ex.1008, “Redline.”) Although, the Provisional describes hydraulic fluid within a hydraulic cavity of an

injector, *see* Ex. 1006, 12 and 13, the “thickness” of this fluid is not described. Nor does the Provisional describe or explain that any “thickness” is “substantially constant” or “adjustable” depending on if the actuator assembly is activated, as claim 1 requires.

By contrast, the ’138 expressly discloses a “fluid thickness” in its specification. (*See, e.g.*, ’829, 3:40.) It, unlike the Provisional, discloses that the thickness of the hydraulic fluid is adjustable. (*Id.*, 6:5-6 (“the **hydraulic fluid** acts as a hydraulic link and the **thickness** is automatically adjustable. . . .”).) The ’138’s specification also provides detail regarding how the hydraulic fluid thickness is adjusted, stating that, while the injection valve is closed, “[t]here is enough time between injection events for the hydraulic fluid to redistribute itself by flowing through [a] clearance gap. . . .” (*Id.*, 12:45-63.) None of this is disclosed in the Provisional.

Third, independent claim 1 recites a “passive hydraulic link,” which was explicitly defined during prosecution:

“the hydraulic link of the present invention, which may be described as a passive hydraulic link because the hydraulic fluid sealed within the hydraulic link assembly merely transmits the actuating forces but is not employed to generate an actuating force for actuating the valve. Rather, the purpose of the hydraulic link is to provide a load path for the opposing actuating forces that originate from at least one spring member and the actuator assembly.”

(Ex. 1010, June 20, 2011 Amendment for Patent App. No. 09/522,130 at 4 (“a ‘passive’ hydraulic link, as defined in the present specification (see page 17, lines 22 through 32)”).) Although the Provisional mentions the term “passive hydraulic link,” the language of this definition was added in the ’829 Non-Provisional and was not present in the Provisional. (See Ex.1008, “Redline”.) The Provisional doesn’t describe that the hydraulic link is not employed in generating an actuating force. Nor does the Provisional explain that the hydraulic link provides a load path for opposing actuating forces that originate from a spring member and the actuator assembly. In short, the only support for this claim term is in the ’829 Non-Provisional.

Fourth, independent claims 1 and 41 recite that the “hydraulic fluid acts substantially as a solid.” The Provisional does not support this at least because it does not describe the hydraulic fluid acting “substantially as a solid.” (See Redline) The Provisional only describes that the hydraulic fluid “acts as a solid,” (see Provisional, 12-13, but does not provide support for the broader limitation in the claims of the fluid acting only “substantially” as a solid. *See Rsch. Corp. Techs. v. Microsoft Corp.*, 627 F.3d 859, 871-72 (Fed. Cir. 2010) (holding that earlier applications disclosing “dot profiles” and “blue noise characteristics” did not provide priority support for later claims reciting “substantially produced dot

profiles” and “substantially blue noise characteristics” and that the later claims were broader than the disclosure in the earlier applications).

As discussed above, these elements were critical to allowance of the ’138, along with its parent the ’829. *See supra* Section VII.B. They were not present in the Provisional, but only in the allowed patent. Thus, the challenged claims of the ’138—which are independent claims 1 and 41 and claims depending therefrom—are entitled to a priority date no earlier than its parent—the ’829’s—filing date, **March 9, 2000**.

VIII. CLAIM CONSTRUCTION AND POSITA DEFINITION

A. Claim Construction

Claims in an *inter partes* review “shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b), 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.” 37 C.F.R. § 42.100(b). Unless indicated otherwise, all claim terms herein are given such ordinary and customary meaning.

B. Definition of a Person of Ordinary Skill in the Art

A person of ordinary skill in the art (“**POSITA**”) in the field of the ’138 would have had a degree in mechanical engineering or a similar discipline, along

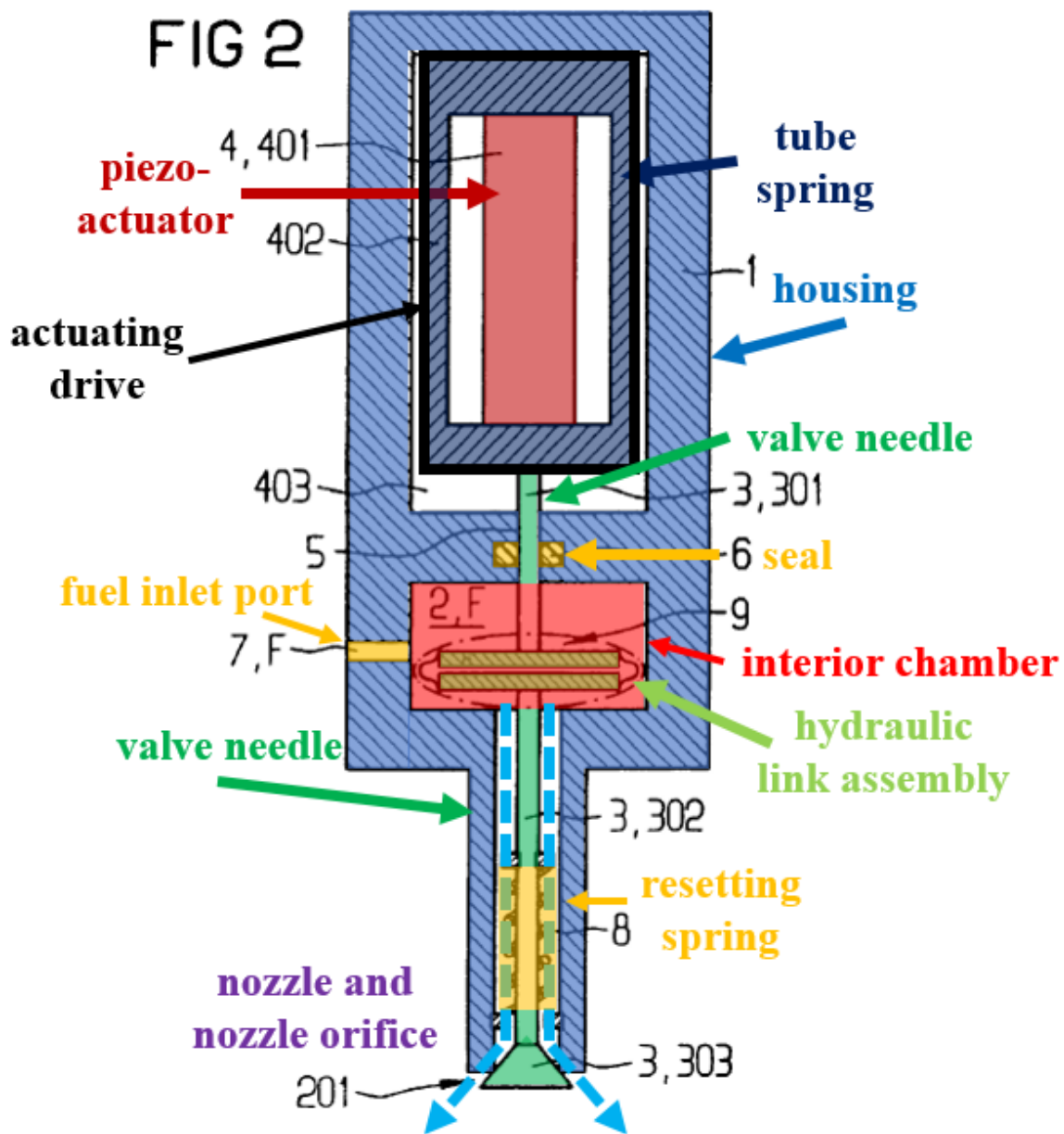
with 2 years of professional experience working with the design and development of fuel injection systems for internal combustion engines or an equivalent level of skill, knowledge, and experience. (Bower Dec., ¶ 52.) This POSITA would be aware of and generally knowledgeable about how fuel injector valves are structured and operate, and how they are used to deliver fuel to an engine's combustion chambers. (*Id.*, ¶ 52.) The more education one has, the less experience needed to attain an ordinary level of skill. (*Id.*) Similarly, more experience in the field may serve as a substitute for formal education. (*Id.*)

IX. ANALYSIS OF GROUNDS FOR UNPATENTABILITY

A. Grounds Based on Gottlieb

Gottlieb is U.S. Patent No. 6,530,273, which issued from U.S. Application No. 09/449,084. Gottlieb was filed November 24, 1999 and issued on March 11, 2003. Gottlieb claims priority to DE19854506, filed November 25, 1998. Gottlieb is prior art under at least pre-AIA 35 U.S.C. § 102(e) because it was filed before the filing date of the '138.

Gottlieb discloses “[a] metering device and method for delivering fluid that employs a compensating element” that may be “utilized for fuel injection, preferably gasoline direct injection.” (EX 1004 (“Gottlieb”), Abstract, 3:27-29; Bower Dec., ¶ 61.)



(Gottlieb, FIG. 2 (annotated).)

With reference to FIG. 2 (annotated above), Gottlieb discloses a “metering device with [a] compensating element” that may be used for fuel injection applications, such as gasoline direct injection. (Gottlieb, 3:26-29, 3:54-55, *see* Bower Dec., ¶ 62.) The metering device, or fuel injector, is made up of a housing 1

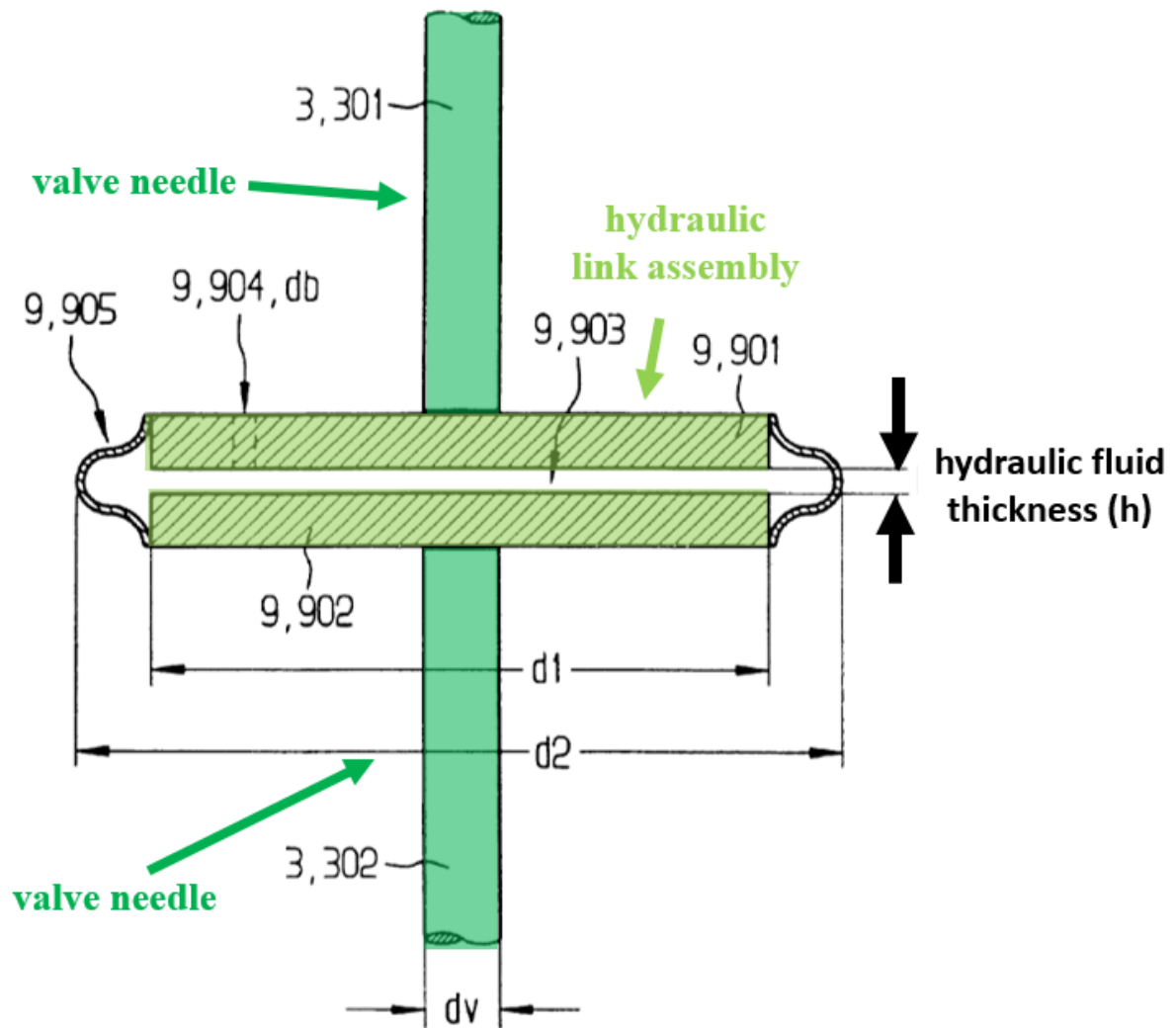
having an input fuel inlet port 7 and an output nozzle and nozzle orifice 201.

(Gottlieb, 3:61-4:24.) A resetting spring 8 applies a closing force on a valve needle 3 having a with a seal head 303 to hydraulically seal the nozzle and nozzle orifice 201. (*Id.*, 4:15-24.) An actuating drive 4—including piezo-actuator 401 held under compressive strain by tube spring 402—applies an opening force to valve needle 3 to cause the metering device to deliver fluid, such as inject fuel. (*Id.*, 3:65-4:3.)

Fuel is input at the fuel inlet port 7, passes through interior chamber 2, travels through an annular space around the valve needle 3, and is output through the nozzle and nozzle orifice. Actuating drive 4 is sealed from interior chamber 2 by a seal 6 around valve needle 3. (*See* Bower Dec., ¶ 63.)

The opening and closing forces are transmitted from the actuating drive 4 and resetting spring 8, respectively, through the valve needle 3 and a hydraulic link assembly 9 (compensating assembly comprising a hydraulic fluid) connected to the first and second parts of the valve needle 3. (Gottlieb, 4:63-5:57, 6:65-7:55, 8:14-45; *see also* Bower Dec., ¶ 64.)

FIG 1



(Gottlieb, FIG. 1 (annotated).)

With reference to FIG. 1 (annotated above), Gottlieb discloses a detailed view of the hydraulic link assembly 9, illustrating hydraulic chamber 903, first wall 901, second wall 902, and outside wall 905. (Gottlieb, Figure 1, 4:63-14.) The outside wall 905 is a flexible stainless steel bellows, so the height of the hydraulic chamber 903 can vary as fluid—such as fuel—enters or leaves the chamber 903

through at least one compensating element opening 904 in first wall 901. (*Id.*, 5:25-50.) In an exemplary embodiment, the opening 904 is shaped as a micro bore. Opening 904 “must be so small that effectively no volume exchange occurs between the hydraulic chamber 903 and the fluid chamber 2 throughout the duration of the actuation process.” (*Id.*, 6:20:22): i.e. the hydraulic chamber does not change significantly during actuation. “The compensating chamber preferably contains a fluid that exhibits a high spring constant” (*Id.*, 6:20:22): i.e. **fluid thickness being substantially constant**. The micro bore diameter is also sized such that the pressure of fluid within the hydraulic chamber can equilibrate with fluid outside the chamber when the actuating drive is not activated. Thus, the height of the hydraulic chamber 903 can increase or decrease to account for thermal expansion, tolerances, or other effects. (*See* Bower Dec., ¶ 65.)

1. **Ground 1a – Gottlieb Anticipates or Renders Obvious Claims 1-3, 6, 13-14, 16-17, 19-21, 26-28, and 41**

a. **Independent Claim 1**

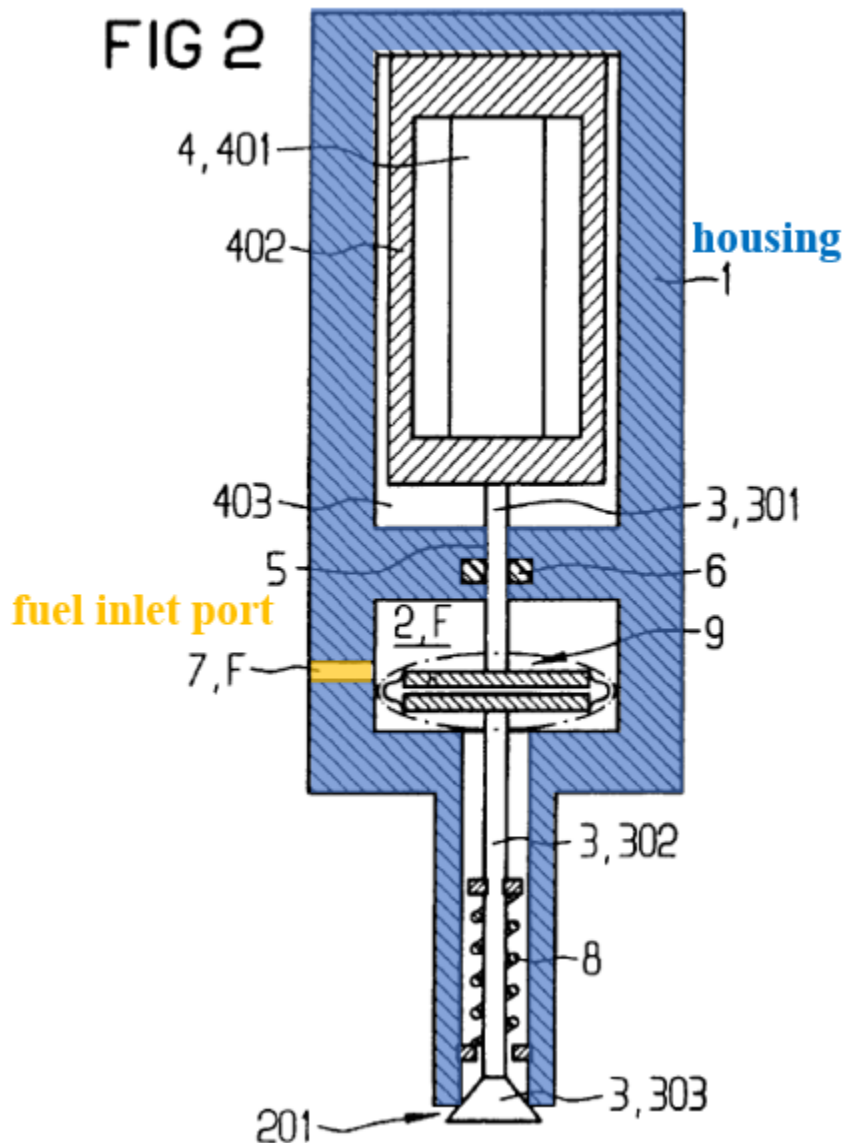
Claim 1[A]: *An injection valve for injecting fuel into a combustion chamber of an internal combustion engine, said injection valve comprising:*

To the extent the preamble is limiting, Gottlieb discloses Claim 1[A]. (Bower Dec., ¶ 66.) Gottlieb discloses an injection valve that is a metering device “utilized for fuel injection, preferably gasoline direct injection.” (*See* Gottlieb, 3:27-29, Figures 1-2; *see also id.*, claims 12-13 (indicating the metering device is

“installed within an internal combustion engine,” 20.) Gottlieb also discloses that the metering device is “utilized for injecting gasoline into a fuel engine.” (*Id.*, 6:41-44; *see also id.*, 4:48-51 (“The assumptions made in this calculation . . . are typical for fuel injectors within automobile engines.”), 7:5-6 (“The closing force is typically greater than 10 N during a gasoline or like fuel injection process.”).) Thus, Gottlieb discloses an injection valve for injecting fuel into the combustion chamber of the disclosed “internal combustion engine.” (Bower Dec., ¶ 66.)

Claim 1[B]: (a) a valve housing comprising: a fuel inlet port;

Gottlieb discloses Claim 1[B]. (Bower Dec., ¶ 67.) With reference to FIG. 2 (below), Gottlieb discloses that its fuel-injection valve includes “housing 1,” and that this housing comprises a fuel inlet port, “fluid feeder 7.” (Gottlieb, 3:62-64, Figure 2; *see also id.*, 3:67-4:7, 4:15-24, 5:36-67, claim 12.) In particular, Gottlieb explains that there is a “fluid chamber 2 . . . installed in” in the housing 1, and this “fluid chamber 2 is charged with a fluid F via a fluid feeder 7, typically under a pressure that ranges from 150 bar to 200 bar. The fluid feeder is preferably of a known type such as one that is utilized in a common-rail system.” (*Id.*, 3:60-4:3, 4:21-24.) As can be seen in Figure 2, this “fluid feeder 7” (fuel inlet port) is included in the wall of the housing 1 of Gottlieb’s fuel-injection valve:

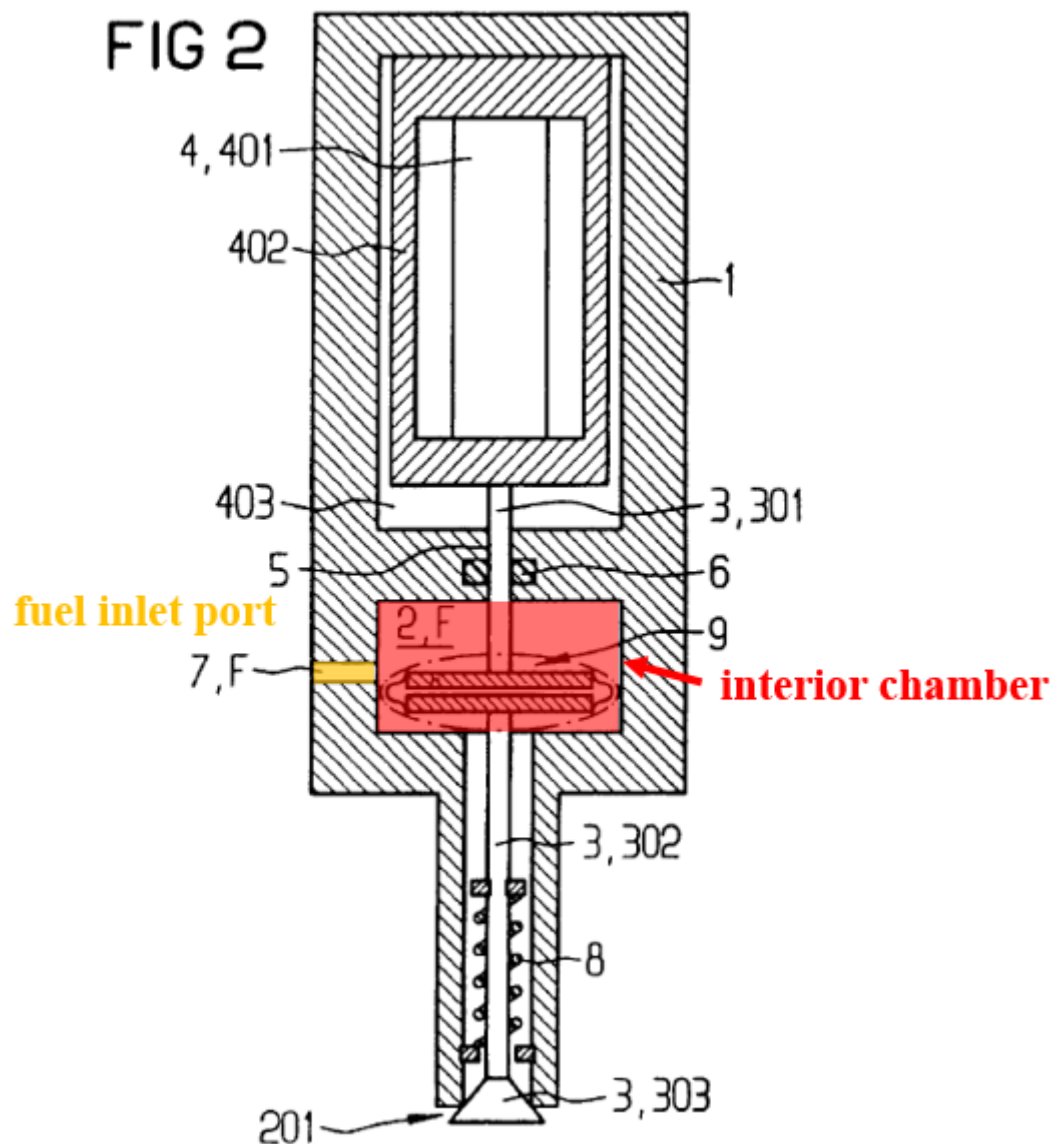


(Gottlieb, FIG. 2 (annotated).)

Claim 1[C]: *an interior chamber fluidly connected to said fuel inlet port;*

Gottlieb discloses Claim 1[C]. (Bower Dec., ¶ 68.) With reference to FIG. 2 (below), Gottlieb discloses that the housing 1 of the fuel-injection valve includes an interior chamber, “fluid chamber 2,” fluidly connected to fuel inlet port, “fluid feeder 7.” (Gottlieb, 4:20-21 (“The fluid chamber 2 is charged with fluid F via a

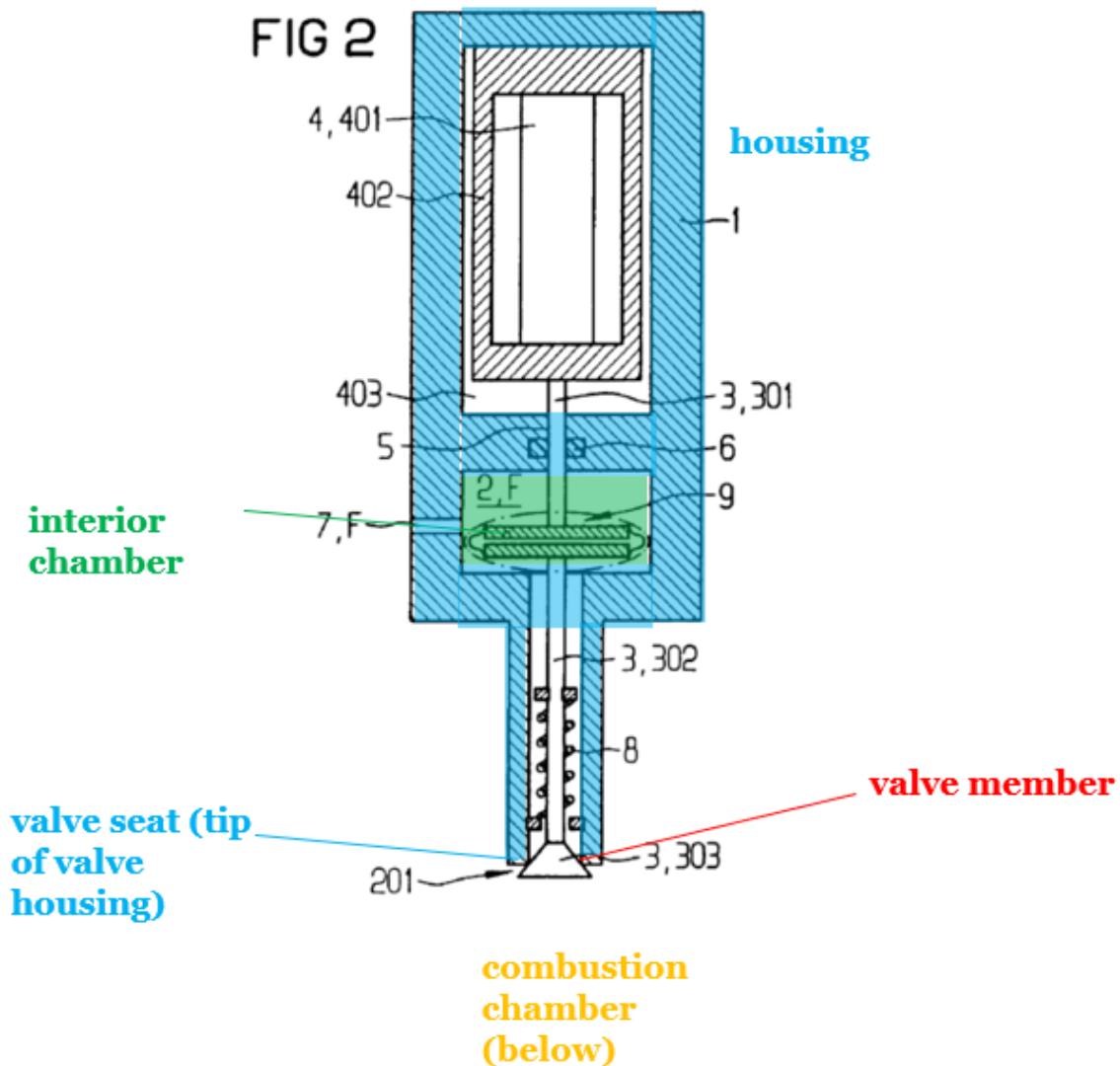
fluid feeder 7 The fluid feeder is preferably of a known type such as one that is utilized in a common-rail system.”); *see also id.*, 2:6-7, 2:24-48, 3:62-65, 4:4-13, 4:67-5:3, 5:36-40, 5:51-57; 7:28-38, 8:14-45.)



(Gottlieb, FIG. 2 (annotated).)

Claim 1[D]: and a valve seat for cooperating with a valve member to seal said interior chamber from said combustion chamber when said injection valve is closed;

Gottlieb discloses Claim 1[D]. (Bower Dec., ¶ 69.) With reference to Figure 2 below, Gottlieb discloses a valve seat (the tip of valve housing 1) for cooperating with a valve member (the valve needle 3 and seal head 303) to seal said interior chamber (fluid chamber 2) from a combustion chamber when the injection valve is closed. (Gottlieb 3:61-4:25.)

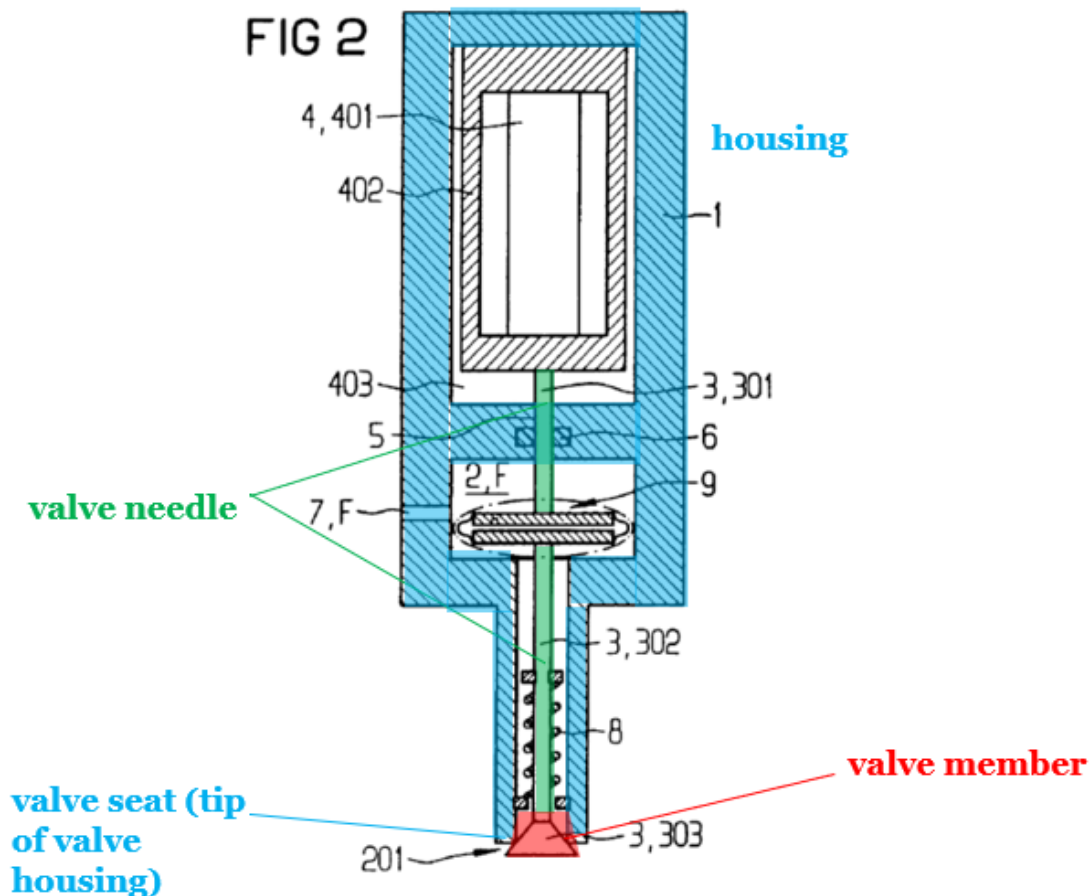


(Gottlieb, FIG. 2 (annotated).)

Claim 1[E]: *(b) said valve member having one end disposed within said valve housing and an opposite end extendable from said valve seat toward said combustion chamber, wherein said valve member comprises a sealing surface that fluidly seals against said valve seat when said injection valve is closed and that is liftable away from said valve seat when said injection valve is open;*

Gottlieb discloses Claim 1[E]. (Bower Dec., ¶¶ 70-73.) With reference to FIG. 2 (below), Gottlieb discloses a “valve member” (the valve needle 3) with an

end within the valve housing “housing 1” (i.e., the end opposite the sealing end) and an opposite “sealing” end extending toward a combustion chamber. Gottlieb teaches a valve needle “valve needle 3” disposed within said valve housing “housing 1” wherein said valve needle “valve needle 3” is movable between a closed and an open position. (Gottlieb, 2:15-18; Bower Dec., ¶ 70.)



(Gottlieb, FIG. 2 (annotated).)

Gottlieb discloses that a sealing end of the valve needle, “seal head 303” contacts a valve seat “tip of valve housing 1” to fluidly seal the interior chamber

“fluid chamber 2” from the nozzle “orifice 201” when in a closed position. (*See, e.g.,* Gottlieb, 2:15-18, 3:61-4:32, 7:28-38.) In particular, when the sealing end contacts the valve seat to fluidly seal fluid chamber 2 from the nozzle orifice 201, the valve is in a closed position. (Gottlieb, 4:11-14 (“The seal head 303 is preferably placed against the orifice or opening 201 on the outside of the fluid chamber 2. In this way, the seal head 303 hydraulically seals the orifice opening.”), 7:28-38, 8:36-45, FIG. 2.); Bower Dec., ¶ 71.)

Gottlieb further discloses an open position at which the sealing end of the valve needle 3, “seal head 303” is spaced apart from the valve seat, which is the tip of valve “housing 1,” whereby the interior “fluid chamber 2” is fluidly connected with nozzle “orifice 201.” (Gottlieb, 2:15-18, 3:61-67, 4:14-32, 6:9-11, 6:65-7:21, 8:14-45.) For example, Gottlieb discloses that the “fluid chamber 2 ... leads to the outside at an orifice or opening 201.” (*Id.*, 3:61-63.) Gottlieb explains that the orifice 201 and chamber 2 are “open” when the “seal head 303” of the needle “3” is “lifted from the orifice or opening 201 wherein the fluid is delivered through the opening 201.” (*Id.*, 8:13-35, Claim 1; Bower Dec., ¶ 72.)

Gottlieb additionally discloses the valve needle lift to open the valve equals the distance traveled by said “seal head 303” (sealing end) away from said valve seat (tip of valve housing 1). (*See* Gottlieb, 2:15-18, 3:61-67, 4:14-32, 6:9-11, 6:65-7:21, 8:14-45.) As described in Gottlieb, valve needle 3 is located within

housing 1 and “at one end at one end is fastened at an actuating drive 4 and leads through the fluid chamber 2” and “at its end opposite of the actuating drive 4[] is equipped with a seal head 303.” (*Id.*, 3:64-65, 4:10-11.) Gottlieb discloses that this actuating drive 4 includes a “piezo-actuator 401.” (*Id.*, 3:61-67, 6:65-7:1, 7:28-38, 8:13-45.) During the metering process, when the valve is opened, Gottlieb explains that “the piezo-actuator 401 moves the valve needle 3 a distance or length that ranges from 10 μm to 100 μm ,” thereby spacing the seal head 303 from the nozzle orifice 201 by that distance, which is also the lift distance. (*Id.*, 4:26-28, 8:13-45; *see also* Bower Dec., ¶ 73.) And by lifting the seal head 303 from the valve seat, the interior chamber 2 is fluidly connected with the nozzle orifice 201:

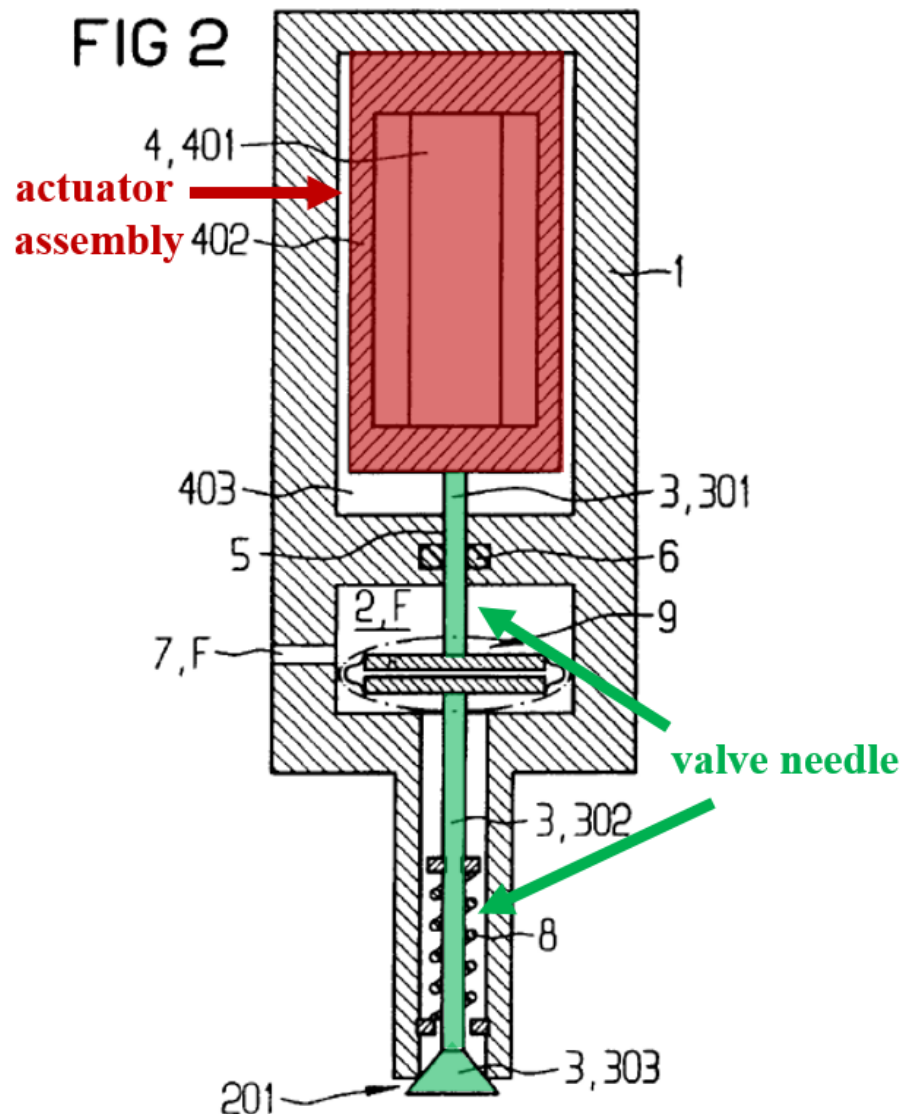
Gottlieb discloses Claim 1[F]. (Bower Dec., ¶ 74.) With reference to FIG. 2 (below), Gottlieb discloses “resetting spring 8” (biasing mechanism) that applies a closing force to the valve needle 3 (valve member for biasing the valve needle 3 in a closed position. As described in Gottlieb, “[i]n order to close the orifice or opening 201 . . . the valve needle 3 is pushed in the direction of an actuating drive 4 via a resetting spring 8 so that the seal head 303 is pressed against the housing 1.” (*Id.* at 4:15-18, 6:65-7:20 (noting that the resetting spring provides a “closing force”), 7:28-38.)



(*Id.*, FIG. 2 (annotated).)

Claim 1[G]: *(d) an actuator assembly associated with said valve member, wherein said actuator assembly may be activated to apply an opening force to said valve member stronger than said closing force, for moving said valve member to said open position;*

Gottlieb discloses Claim 1[G]. (Bower Dec., ¶¶ 75-76.) Gottlieb discloses an “actuating drive 4” (actuator assembly) that may be activated to apply an opening force to the valve needle 3 stronger than the closing force, for moving the valve needle 3 (valve member) to an open position:



(Gottlieb, FIG. 2 (annotated).)

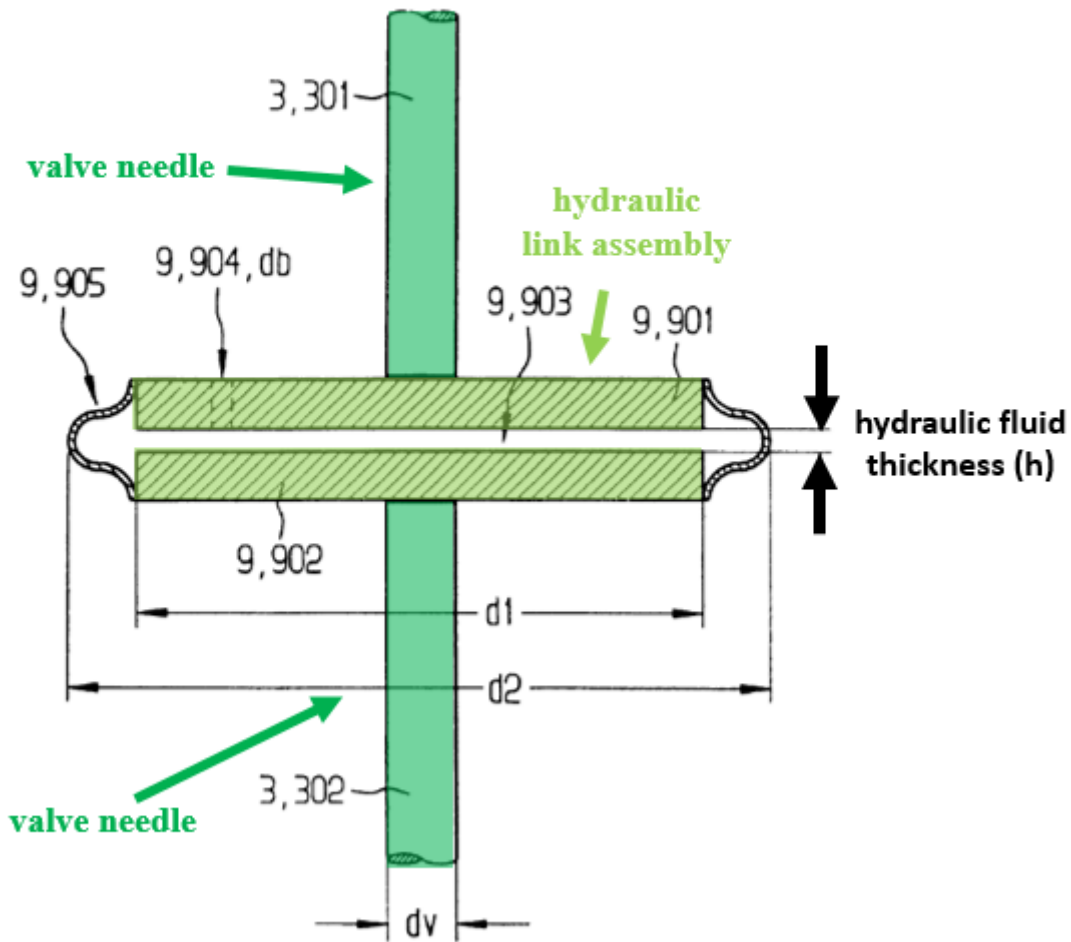
Gottlieb explains that the “valve needle 3 [*i.e.*, valve member] at one end is fastened at an actuating drive 4 and leads through the fluid chamber 2. The actuating drive 4 includes a piezo-actuator 401 that is preferably a ceramic multi-layer piezo-actuator.” (Gottlieb, 3:64-67.) Gottlieb also explains that “[d]uring the metering process, the piezo-actuator 401 moves the valve needle 3 a distance or

length that ranges from 10 μm to 100 μm ” by overcoming the closing force of resetting spring 8. (*Id.*, 4:15-18, 4:26-28.) Moreover, Gottlieb discloses that the actuating drive 4 displaces the needle, with transferred by a compensating element 9, in order to open the valve, and that as part of this “the closing force of the resetting spring 8 must be overcome.” (*Id.*, 6:65-7:3, *see also id.*, 8:13-38.)

Claim 1[H]: *(e) a hydraulic link assembly comprising a passive hydraulic link having a hydraulic fluid thickness through which said opening and closing forces are transmitted, whereby said hydraulic fluid acts substantially as a solid with said thickness being substantially constant while said actuator assembly is activated and wherein said thickness of said hydraulic link is adjustable while said actuator is not activated in response to changes in the dimensional relationship between components of said injection valve to maintain a desired valve needle lift upon activation of said actuator assembly.*

Gottlieb discloses Claim 1[H]. (Bower Dec., ¶¶ 77-82.) With reference to FIG. 1 (below), Gottlieb discloses a hydraulic link assembly comprising a passive hydraulic link, disclosed as compensating element 9, having a hydraulic fluid thickness (h) through which said opening and closing forces are transmitted:

FIG 1



(Gottlieb, FIG. 1 (annotated).)

Gottlieb discloses the hydraulic fluid (of the hydraulic link assembly) acts substantially as a solid with said thickness (h) being substantially constant while said actuator assembly is activated and wherein said thickness of said hydraulic link (h) is adjustable while said actuator is not activated in response to changes in the dimensional relationship between components of said injection valve to

maintain a desired valve needle 3 lift upon activation of said actuator assembly.

(Bower Dec., ¶ 78.)

In particular, with reference to Figure 1 (above), Gottlieb's passive hydraulic link assembly, compensating element 9, "includes hydraulic chamber 903 that is defined by a first wall 901, a second wall 902 and an outside wall 905" and "[t]he spacing between the first wall 901 and the second wall 902 is referred to as a chamber height h." (Gottlieb, 5:4-14.) Gottlieb discloses the "[t]he outside wall preferably includes a stainless steel bellows," so the chamber height can adjust from "approximately 20 μm to 250 μm " (that is, allowing adjustment while the actuator is inactive). (*Id.*, 5:24-28.) Gottlieb then discloses "the compensating element hydraulic chamber 903 is connected to the fluid chamber 2 via at least one compensating element opening 904 that allows for a fluid exchanged between the hydraulic chamber 903 to the fluid chamber 2. In an exemplary embodiment, the opening 904 is shaped as a micro bore that leads through the first wall 901." (*Id.*, 5:36-42; *see also* Bower Dec., ¶ 79.)

Thus, Gottlieb discloses "[t]he hydraulic chamber 903 is . . . filled with a fluid F that is hydrostatically coupled with the surrounding fluid F. In this way, the same static pressure is present in the hydraulic chamber 903 and the fluid chamber 2 in the initial state wherein essentially no forces are acting on the compensating element 9." (Gottlieb, 5:51-57.) The diameter of the opening 904 is such that "the

compensating element 9 effectively operates to compensate for the shifting or movement of the various metering device components due to varying thermal loads or other external factors.” (Bower Dec., ¶ 80.)

At the same time, the compensating element operates to provide little, if any, lift loss during the delivery of fluid within the metering process” (that is, allowing the hydraulic fluid thickness to be “substantially constant” during actuation).

(Gottlieb, 5:59-6:2.) “On the other hand, the diameter d_b must be so small that effectively no volume exchange occurs between the hydraulic chamber 903 and the fluid chamber 2 throughout the duration of the metering process, otherwise a lift loss will result as the lift force is transferred between the first 301 and second 302 valve needle parts.” (*Id.*, 6:20-25.) In addition, the fluid “exhibits a high spring constant” so “lift loss does not occur due to the elasticity of the enclosed fluid F wherein the chamber height is preferably maintained at approximately 100 μm .” (*Id.*, 6:28-32; Bower Dec., ¶ 81.)

This hydraulic fluid thickness is used in transmission of the opening and closing forces. In particular, Gottlieb discloses “[t]he forces that are transferred by the compensating element 9 have two components: 1) the closing force of the resetting Spring 8 must be overcome; and 2) the inertial force of the valve needle 3 and the compensating element 9 [i.e., the opening force] must be transferred.” (Gottlieb, 7:1-5; *see* Bower Dec., ¶ 82.) The fluid in “compensating element 9” is

involved in this force transfer, and is accomplished while the fluid “is analogous to an insertion of an optimally stiff spring.” (Gottlieb, 8:14-27; *see* Bower Dec., ¶ 82.)

b. Dependent Claims 2 and 3

Claim 2: *The injection valve of claim 1 wherein said thickness of said hydraulic link is auto-adjustable while said actuator assembly is not activated in response to changes in said dimensional relationship caused by differential thermal expansion.*

Claim 3: *The injection valve of claim 2 wherein said thickness of said hydraulic link is auto-adjustable while said actuator assembly is not activated in response to changes in said dimensional relationship caused by wear to components of said injection valve.*

Gottlieb discloses Claims 2 and 3. (Bower Dec., ¶ 83.) Gottlieb discloses that “the compensating element . . . acts to compensate for shifting or movement of metering components due to external factors, such as varying thermal loads, aging effects, and settling effects.” (Gottlieb, Abstract, *see also id.*, 1:22-48, 1:63-2:14, 2:32-54, 3:41-43, 4:27-66, 5:58-65, 7:27-8:13.) The compensating element’s movement to compensate for such effects “is at least 100 times slower than the duration of the metering process,” so effectively no lift loss will result as lift force is transferred through the compensating element. (*See id.*, 6:15-25.) A POSITA would understand that the skill would understand that the thickness of fluid in Gottlieb’s compensating element (i.e., hydraulic link) is continuously auto-

adjusting while not activated in response to thermal loads (including differential thermal expansion), aging effects, and settling effects. . (Bower Dec., ¶ 83.)

c. Dependent Claims 6 and 13

Claim 6: *The injection valve of claim 1 wherein said actuator assembly comprises a dimensionally responsive member.*

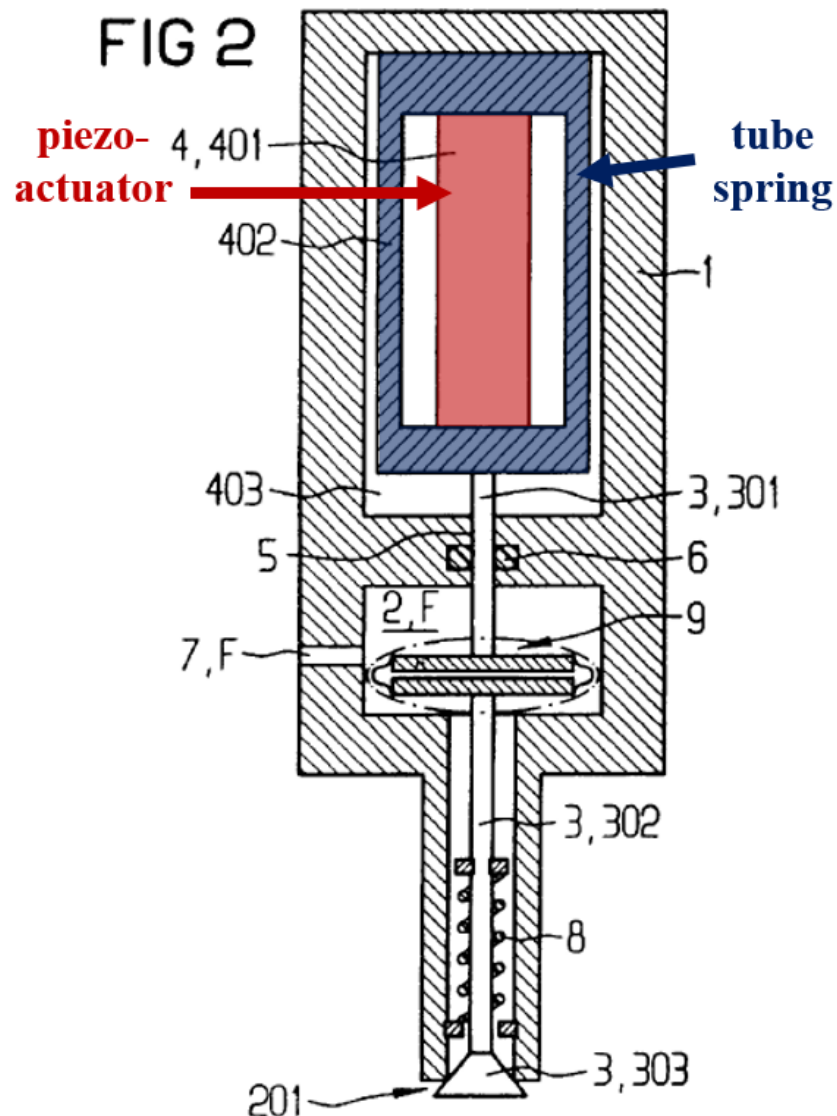
Claim 13: *The injection valve of claim 6 wherein said dimensionally responsive member is formed from a piezoelectric material.*

Gottlieb discloses Claims 6 and 13. (Bower Dec., ¶ 84.) The '138 discloses that a dimensionally responsive member is formable from magnetostrictive or piezoelectric material, and may comprise a compression spring for applying compressive force to said member. ('138, 3:41-4:8.) Gottlieb discloses “actuating drive 4 includes a piezo-actuator 401 [*i.e.*, piezoelectric material] that is preferably a ceramic multi-layer piezo-actuator.” (Gottlieb, 3:65-67.) Gottlieb also describes the piezo-actuator as being held under compressive strain by a tube spring. (*See id.*, 7:28-30.) And Gottlieb describes the actuation distance of the piezo-actuator, which moves the valve needle, at a range from 10 μm to 100 μm (*i.e.*, expanding in dimension by that distance). (*Id.*, 4:25-27.)

d. Dependent Claim 14

Claim 14: *The injection valve of claim 6 further comprising a compression spring member for applying a compressive force to said dimensionally responsive member.*

Gottlieb discloses Claim 14. (Bower Dec., ¶ 85.) With reference to FIG. 2 below, Gottlieb discloses “tube spring 402” (compression spring member) for applying a compressive force to the “piezo-actuator 401” (dimensionally responsive member). (Gottlieb, 7:27-30 (“the piezo-actuator 401 is contracted in an axial direction and held under a compressive strain via a tube spring 402”); *see also id.*, 3:67-4:3.)

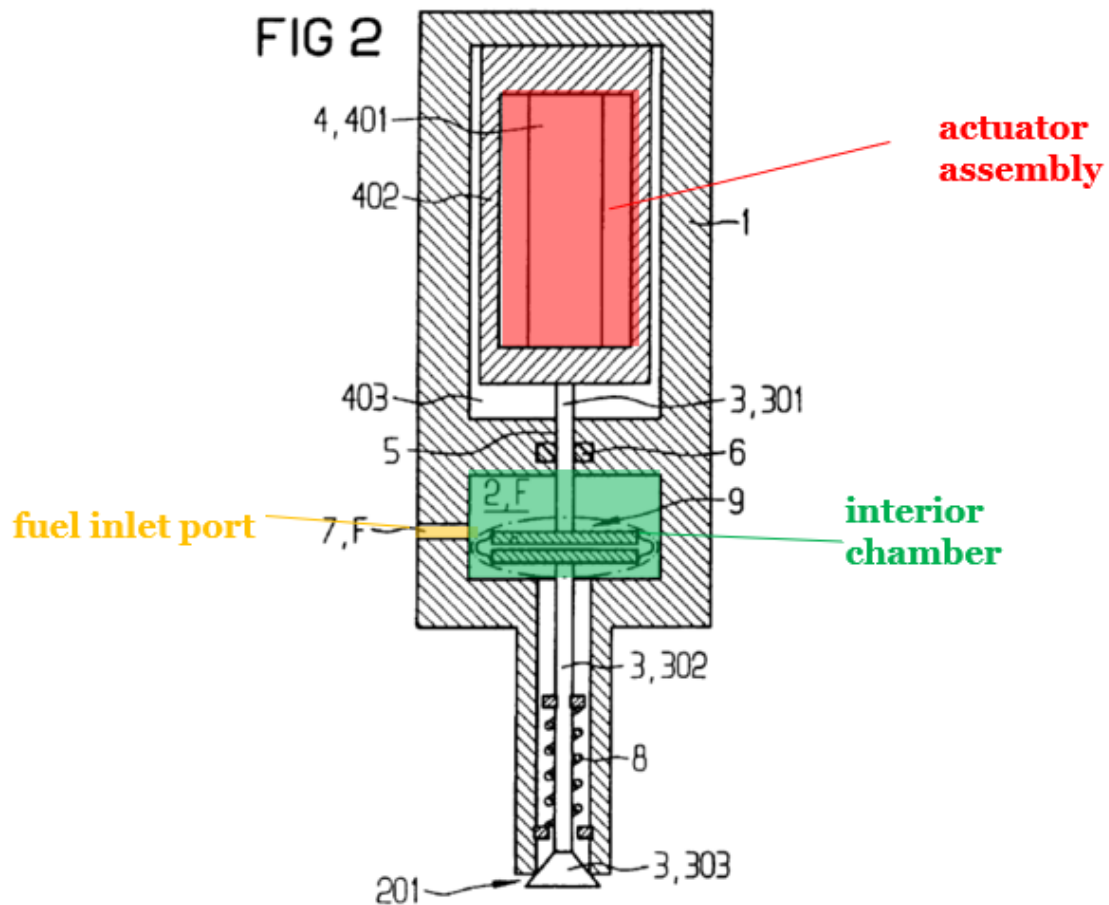


(*Id.*, FIG. 2 (annotated).)

e. **Dependent Claim 16**

Claim 16: *The injection valve of claim 1 wherein said fuel inlet port is position near the valve tip such that fuel flowing through said interior chamber does not contact said actuator assembly.*

Gottlieb discloses Claim 16. (Bower Dec., ¶ 86.) Gottlieb explicitly describes a fuel-injection valve including fuel inlet port, “fluid feeder 7” and actuator assembly “actuating drive 4.” (Gottlieb, 3:62-67.) The fuel from fluid feeder 7 flows into interior chamber “fluid chamber 2” and does not contact said actuator assembly. (*Id.*, 4:20-21.)



(Gottlieb, FIG. 2 (annotated).)

f. Dependent Claim 17

Claim 17: *The injection valve of claim 6 wherein when said actuator assembly is controllable to control said desired lift to between 10 and 100 percent of maximum lift.*

Gottlieb discloses Claim 17. (Bower Dec., ¶¶ 87-88.) Gottlieb discloses “a piezo-actuator 401 that is preferably a ceramic multi-layer piezo-actuator” and that “[d]uring the metering process, the piezo-actuator 401 moves the valve needle 3 a distance or length that ranges from 10 μm to 100 μm .” (Gottlieb, 1:65-67, 4:25-

27.) A POSITA would recognize that the normal operation of a piezo-actuator is dependent on a quantity of voltage and/or current applied to the piezoelectric stack, where greater voltages (to a point) will lead to greater expansion or contraction of the piezo elements forming the actuator. Thus, a POSITA would recognize that Gottlieb explicitly discloses an actuator assembly that is controllable to control lift to between 10 and 100 percent of maximum lift. (Bower Dec., ¶ 87.)

In the alternative, Gottlieb renders Claim 11 obvious. It would be obvious to the POSITA to control lift between 10 and 100 percent of the maximum lift. (*Id.*, ¶ 88.) Controlling ranges of lift is explicitly taught in Gottlieb and a POSITA would understand, as a design choice or preference, that the control system taught by Gottlieb would be able to control the lift between the range provided in claim 11. (*Id.*, ¶ 88.) “[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.” *El DuPont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1006 (Fed. Cir. 2018) (*quoting In re Aller*, 220 F.2d 454, 456 (CCPA 1955)). the ’829 patent identifies no importance or significance to the use of a range of “10 to 100 percent of maximum lift.” Instead, the patent explains that the purpose of the claimed actuator is simply to allow for either “full or partial lift, as desired.” (Ex. 1001, 4:50-55.) Thus, this is not a case where the claimed lift range is new, unexpected, or produces some sort of difference in kind. Instead, the operation of

Gottlieb's valve is indistinguishable from that of the '138 patent: both allow for either full or partial needle lift as desired. (See Bower Dec., ¶ 88.)

g. Dependent Claim 19

Claim 19: *The injection valve of claim 6 wherein said valve member is controllable to move between said open and closed positions in less than about 200 microseconds.*

Gottlieb discloses Claim 19. (Bower Dec., ¶ 89.) Gottlieb discloses that the valve needle (3) (valve member) is controllable to move between said open and closed positions in less than about 200 microseconds. Gottlieb discloses that “the separate stages of the metering process, such as the opening and closing of the orifice 201, can occur over time frames ranging from 1 μ s to 10 μ s” (*i.e.*, less than 200 μ s.) (Gottlieb, 6:8-10, Claim 17.) Gottlieb further discloses an “average duration of a metering process of 100 μ s,” which is again less than 200 μ s. (*Id.*, 6:65-7:20.)

h. Dependent Claim 20

Claim 20: *The injection valve of claim 6 further comprising a biasing mechanism for applying a compressive force to said dimensionally responsive member.*

Gottlieb discloses Claim 20. (Bower Dec., ¶ 90.) Gottlieb discloses a tube spring 402 (compression spring member) for applying a compressive force to the piezo-actuator 401 (magnetostrictive or piezoelectric member). (Gottlieb, 7:27-30 (“the piezo-actuator 401 is contracted in an axial direction and held under a compressive strain via a tube spring 402”); *see also id.*, 3:67-4:3, 7:28-38.)

i. Dependent Claim 21

Claim 21: *The injection valve of claim 1 wherein said biasing mechanism comprises a spring.*

Gottlieb discloses Claim 21. (Bower Dec., ¶ 91.) Gottlieb discloses a biasing mechanism that applies a closing force to the valve member. (*See supra* Claim 1[F].) This biasing mechanism comprises a spring, namely tube spring 402. (*See supra* Claim 14; *see also* Bower Dec., ¶ 91.)

j. Dependent Claim 26

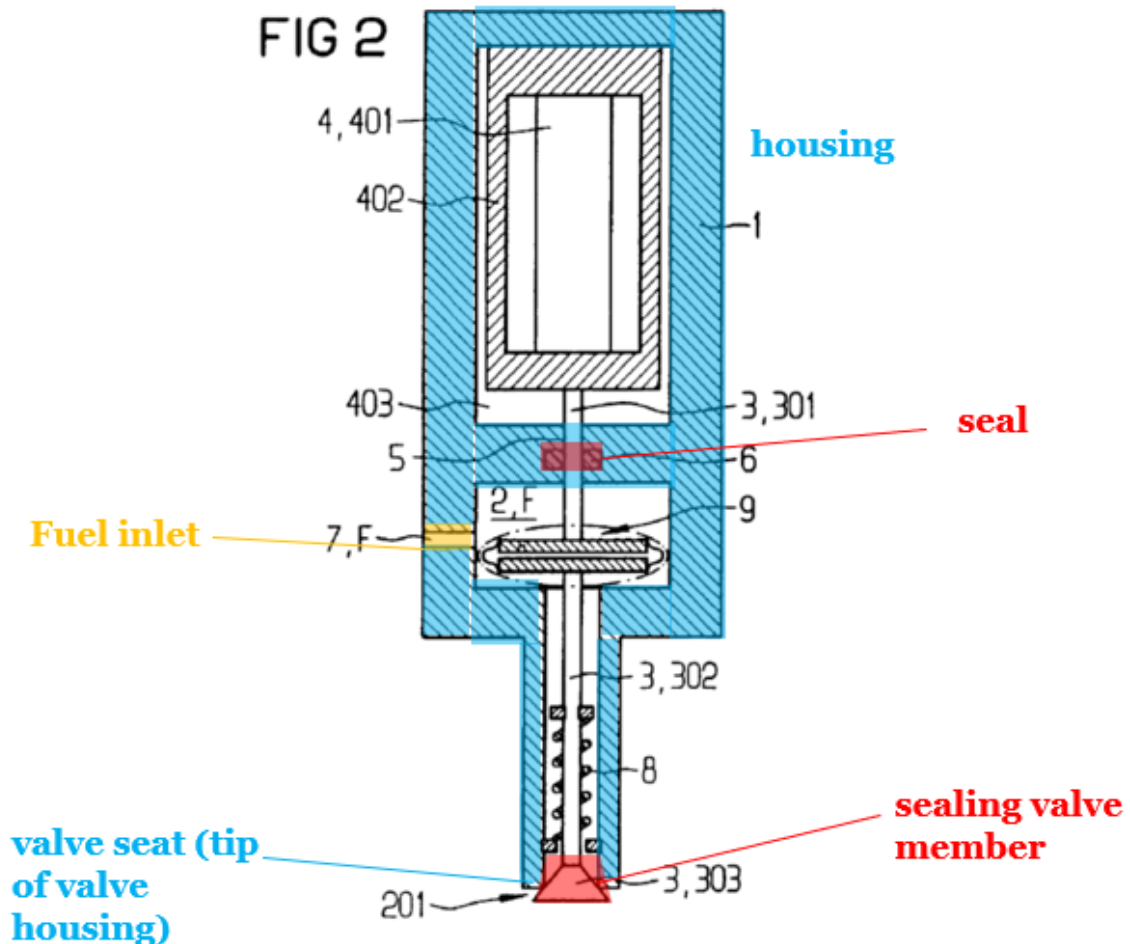
Claim 26: *The injection valve of claim 1 wherein said fuel is injected into said combustion chamber at a pressure greater than about 2000 psi (about 13.8 MPa).*

Gottlieb discloses Claim 26. (Bower Dec., ¶ 92.) Gottlieb discloses that fuel (F) is injected into said combustion chamber at a pressure greater than about 2000 psi (about 13.8 MPa). For example, Gottlieb discloses that the pressurized fluid injected from the metering “includes a fluid pressure, said fluid pressure ranges from approximately 150 bar to approximately 1000 bar.” (Gottlieb, Claim 9.) Gottlieb also describes that “fluid chamber 2 is charged with a fluid F via a fluid feeder 7, typically under a pressure that ranges from 150 bar to 200 bar. The fluid feeder is preferably of a known type such as one that is utilized in a common-rail system.” (*Id.*, 4:20-24.) A POSITA would understand that 150 bar is approximately 2175.6 psi and 1000 bar is 14,503.8 psi (*i.e.*, both greater than 2000 psi), because 1 bar is approximately 14.5038 psi. (Bower Dec., ¶ 92.)

k. Dependent Claim 27

Claim 27: *The injection valve of claim 1 wherein said valve housing comprises a plurality of parts which are joined with each other to provide a fluidly sealed body.*

Gottlieb discloses Claim 27. (Bower Dec., ¶¶ 93-94.)



(Gottlieb, FIG. 2 (annotated).)

With reference to FIG. 2 (above), Gottlieb discloses a valve “housing 1” comprising a plurality of parts which are joined with each other to provide a fluidly

sealed body, including seal 6 and the sealing end of valve needle 303. (*Id.*) Gottlieb discloses a housing 1 having a seal 6 that hydraulically seals the fit between valve needle 3 and the housing 1. (*Id.*, 4:6-9.) Gottlieb also describes that the housing 1 is hydraulically sealed by the seal head 303 of the valve needle 3 that presses against the opening of the metering device 201. (*Id.*, 7:33-36.) Gottlieb further explains that “the housing 1 effectively remains hydraulically sealed even though the components of the metering device expand, shift or move due to changing thermal conditions or other external factors, such as aging or settling effects.” (*Id.*, 7:63-67.)

I. Dependent Claim 28

Claim 28: The injection valve of claim 1 wherein said valve housing, said valve needle, and said actuator assembly, are selected from materials having thermal expansion coefficients sufficiently compatible such that changes in the dimensional relationship between said components caused by changes in temperature are reduced.

Gottlieb discloses Claim 28. (Bower Dec., ¶¶ 95-96.) Gottlieb discloses a valve housing, said valve needle, and said actuator assembly, are selected from materials with similar thermal expansion coefficients to reduce changes in the dimensional relationship between said components caused by changes in temperature, and explains that “selecting thermally compatible materials for each of the individual metering device components” was well-known “[t]o compensate

for [] shifting or movement due to varying temperature loads.” (Gottlieb, , 1:41-45.)

Gottlieb also recognizes that the injection valve may be subject to temperature fluctuations. (*See id.*, 4:52-57.) Accordingly, a POSITA would understand that the selection of thermally compatible materials disclosed by Gottlieb could, in part, address the problems associated with anticipated temperature fluctuations (*i.e.*, by particularly selecting materials having similar thermal expansion coefficients.) (Bower Dec. ¶ 96.)

m. Independent Claim 41

Claim 41[A]: *A method of operating a fuel injection valve for an internal combustion engine, said injection valve having a longitudinal axis, said method comprising:*

To the extent the preamble is limiting, Gottlieb discloses Claim 41[A]. (Bower Dec., ¶ 97; *see supra* Claim 1[A].) Gottlieb discloses a fuel injection valve for an internal combustion engine possessing a longitudinal axis. (*See, e.g.*, Gottlieb Fig. 2.) Gottlieb also discloses that the valve it discloses may be operated. (*See, e.g., id.* Claim 14.)

Claim 41[B]: *(a) actuating a dimensionally responsive member comprising at least one of a magnetostrictive material and a piezoelectric material, said dimensionally responsive member expanding in length in the direction of said longitudinal axis upon actuation of said actuator;*

Gottlieb discloses Claim 41[B]. (Bower Dec., ¶ 98; *see supra* Claims 6, 13.)

Claim 41[C]: *(b) transferring movement caused by said actuated dimensionally responsive member through a passive hydraulic link to cause a corresponding movement of a valve member to open said valve by lifting said valve member away from a valve seat and compressing a biasing mechanism that biases said valve in a closed position, said passive hydraulic link comprising a hydraulic cylinder which houses a piston and is filled with a hydraulic fluid, wherein said hydraulic fluid forms a layer between said piston and a cylinder head and because of the short duration that said valve is open, said hydraulic fluid does not have time to flow from one side of said piston to the other side and while said injection valve is open, said layer of hydraulic fluid acts as an incompressible solid so that movement caused by the actuation of said dimensionally responsive member is transmitted through said fluid layer;*

Gottlieb discloses Claim 41[C]. (Bower Dec., ¶ 99; *see supra* Claims 1[H] (passive hydraulic link); 1[F] (biasing mechanism).)

Claim 41[D]: *(c) deactuating said dimensionally responsive member to contract the length of said dimensionally responsive member to unload said biasing mechanism and cause a corresponding movement of said valve member to close said valve;*

Gottlieb discloses Claim 41[D]. (Bower Dec., ¶ 100.) Gottlieb discloses that the injection valve is movable to a closed position. (*See supra* Claim 19.) Gottlieb also discloses a biasing mechanism applying a closing force to a valve member. (*See supra* Claim 1[F].)

Claim 41[E]: *(d) providing sufficient time between consecutive valve openings to allow at least some of said hydraulic fluid within said passive hydraulic link to flow from one side of said piston to the other side of said piston.*

Gottlieb discloses Claim 41[E]. (Bower Dec., ¶ 101.) Gottlieb discloses the thickness of its hydraulic link is adjustable, which involves exchange in volume, while said actuator is not activated in response to changes in the dimensional

relationship between components of said injection valve to maintain a desired valve needle 3 lift upon activation of said actuator assembly. (Bower Dec., ¶ 101; *see supra* Claim 1[H].)

2. Ground 1b – Gottlieb, Alone or In View of Gottlieb (DE) Anticipates And/Or Renders Obvious Claims 14, 18, and 22

a. Dependent Claim 14

Claim 14: *The injection valve of claim 6 further comprising a compression spring member for applying a compressive force to said dimensionally responsive member.*

Gottlieb alone discloses Claim 14. (*See supra* Ground 1a, claim 14.) In the alternative, Gottlieb in view of Gottlieb (DE) discloses claim 14. (Bower Dec., ¶ 102.) Gottlieb (DE) is a German Patent Application to which Gottlieb claims priority. Gottlieb (DE) is a foreign equivalent to Gottlieb with a disclosure very similar to that of Gottlieb. A certified translation of Gottlieb (DE) is provided as Exhibit 1006. It would have been obvious to one of ordinary skill to modify the piezo actuator of Gottlieb to include any disclosure in Gottlieb (DE), as both disclosures are similar and are directed to the same invention (or, at minimum, very similar inventions). The disclosures of Gottlieb and Gottlieb (DE) perform the same function, and combination of those disclosures would lead to the same result. Gottlieb (DE) discloses that “a spring element such as a tube spring or a disk spring 100 may be provided for the compressive prestress of the piezo actuator.” (Gottlieb (DE) 2:99-100.)

b. Dependent Claim 18

Claim 18: *The injection valve of claim 17 wherein said lift is controllable by varying at least one of the electric current, the electric voltage, and the magnetic field imposed upon said dimensionally responsive member.*

Gottlieb discloses Claim 18. (Bower Dec., ¶¶ 103-04.) Gottlieb discloses “a piezo-actuator 401 [*i.e.*, dimensionally responsive member] that is preferably a ceramic multi-layer piezo-actuator.” (Gottlieb, 1:65-67.) A POSITA would understand that the normal operation of any piezo-actuator is dependent on a quantity of voltage and/or current applied to the piezo, where a difference in voltage will lead to greater expansion or contraction of the piezo elements forming the actuator (*i.e.*, controlling the lift). (Bower Dec., ¶ 103.)

In the alternative, Gottlieb in view of Gottlieb (DE) discloses claim 18. (Bower Dec., ¶ 104.) Gottlieb (DE) is a German Patent Application to which Gottlieb claims priority. Gottlieb (DE) is a foreign equivalent to Gottlieb with a disclosure very similar to that of Gottlieb. A certified translation of Gottlieb (DE) is provided as Exhibit 1006. It would have been obvious to one of ordinary skill to modify the piezo actuator of Gottlieb to include any disclosure in Gottlieb (DE), as both disclosures are similar and are directed to the same invention (or, at minimum, very similar inventions). The disclosures of Gottlieb and Gottlieb (DE) perform the same function, and combination of those disclosures would lead to the same result. Gottlieb (DE) discloses that changes in operating voltage affect the lift of the valve

needle. Figure 2 of Gottlieb (DE) (below) describes a “typical operating sequence” on the basis of voltage applied to a piezo actuator. (Gottlieb (DE) 7:15-18.) Figure 3 of Gottlieb (DE) shows “a diagram of deflection A of the piezo actuator 1 in μm plotted as a function of the voltage U in volts applied to it.” (Gottlieb (DE) 7:24-30.) The two figures show that the lift of the Gottlieb piezo actuator is controllable by changes in voltage. (Bower Dec., ¶ 104.)

c. Dependent Claim 22

Claim 22: *The injection valve of claim 21 wherein said spring comprises at least one disc spring.*

Gottlieb discloses Claim 22. (Bower Dec., ¶¶ 105-06.) Gottlieb discloses compressing a magnetostrictive or piezoelectric member with a spring member, namely, tube spring 402. *See supra* Ground 1a, Claim 15. A POSITA would understand that the spring disclosed in Gottlieb could be a tube spring or any equivalent thereof, which includes disc springs. (Bower Dec., ¶ 105.) In particular, tube springs and disc springs are both well-known types of springs used in mechanical devices to provide biasing or compression forces, including in actuator assemblies such as described in Gottlieb. (*Id.*) The substitution of a disc spring for the tube spring in Gottlieb would have been nothing more than the simple substitution of one known spring device for another, that would have continued to operate for its normal and expected functions. (*Id.*) Thus, a POSITA would have had a reasonable expectation of success that using a disc spring instead

of a tube spring would allow the device in Gottlieb to continue to perform its same functions.

In the alternative, Gottlieb in view of Gottlieb (DE) renders obvious claim 22. (Bower Dec., ¶ 106.) Gottlieb (DE) is a German Patent Application to which Gottlieb claims priority. Gottlieb (DE) is a foreign equivalent to Gottlieb with a disclosure very similar to that of Gottlieb. A certified translation of Gottlieb (DE) is provided as Exhibit 1006. It would have been obvious to one of ordinary skill to modify the piezo actuator of Gottlieb to include any disclosure in Gottlieb (DE), as both disclosures are similar and are directed to the same invention (or, at minimum, very similar inventions). The disclosures of Gottlieb and Gottlieb (DE) perform the same function, and combination of those disclosures would lead to the same result. (Bower Dec., ¶ 106.) Gottlieb (DE)'s disclosure clarifies, when discussing its compression elements, that “a spring element, . . . **a tube spring or a disk spring**, may be provided.” (Gottlieb (DE) (translation), [0019].) To the extent Gottlieb itself fails to inherently disclose a compression member comprising a disc spring, it would have been obvious to one of ordinary skill, viewing Gottlieb in view of its foreign equivalent Gottlieb (DE), that the compression member of Gottlieb could be a disc spring. (Bower Dec., ¶ 106.)

X. TRIAL SHOULD BE INSTITUTED

A. *Fintiv* Factors

The Board should institute review because Petitioners have been diligent in filing the Petition, and the circumstances surrounding the parallel district court cases do not warrant discretionary denial under § 314(a). *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 at 11-21 (Dec. 1, 2020) (precedential) (citing *Apple, Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (Mar 20, 2020) (precedential)). A *Fintiv* analysis shows that discretionary denial is not applicable to this proceeding, as Petitioner has been dismissed from any pending litigation in district court. *See, e.g., Boss Corp. v. Koss Corp.*, IPR2021-00680, Paper 15 at 14 (PTAB Oct. 13, 2021). Moreover, any parallel district court proceedings were dismissed early-on, before *Markman* or any substantive proceedings. The remaining district court actions—none of which include Petitioner—involving the ’829 are in their early stages and likewise have not involved significant expenditure of resources or substantive rulings. It is purely speculative that any court will address the distinct invalidity challenges raised in this Petition.²

B. 35 U.S.C. § 325(d)

The Board should decline to exercise discretion under 35 U.S.C. §325(d) because none of the asserted prior art was considered by the Examiner, let alone applied in a rejection. *See Oticon Med. AB v. Cochlear Ltd.*, IPR2019-00975,

² Should Patent Owner raise a *Fintiv* challenge to the Petition, Petitioner intends to respond to any counter-arguments Patent Owner may raise.

Paper 15 at 20 (Oct. 16, 2019) (precedential) (noting “[t]here is new, noncumulative prior art asserted in the Petition”). Petitioner’s grounds thus present art that is not the same or substantially the same as art previously considered by the Office. *Advanced Bionics v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 at 7-9 (Feb. 13, 2020).

XI. CONCLUSION

Petitioner respectfully requests that a Trial be instituted. Claims 1-3, 6, 13-14, 16-22, 26-28, and 41 of the ’138 should be cancelled as anticipated or obvious over the prior art.

Dated: December 14, 2022

Respectfully submitted,

/s/ Celine J. Crowson

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APPENDIX A
Table of Exhibits

Exhibit No.	Description
1001	U.S. Patent No. 6,575,138 (<i>Challenged Patent</i>)
1002	Declaration of Dr. Glenn Bower
1003	Curriculum Vitae of Dr. Glenn Bower
1004	U.S. Patent No. 6,530,273 (“Gottlieb”)
1005	German Patent Application No. DE1938862A1 (“Gottlieb (DE)”)
1006	Certified Translation of Gottlieb (DE)
1007	U.S. Patent Application No. 60/159,691 (“Provisional”)
1008	Redline Comparison of Challenged Patent and Provisional
1009	U.S. Patent No. 3,598,506 (“O’Neill”)
1010	Prosecution History of U.S. Patent No. 6,298,829
1011	U.S. Patent No. 5,630,550 (“Kurishige”)
1012	Prosecution History of U.S. Patent No. 6,575,138

APPENDIX B
Certificate of Word Count

I certify that, in accordance with 37 C.F.R. § 42.24(d), the word count for the foregoing Petition totals 10,970. This is less than the permitted total under the 37 C.F.R. 42.24(a)(1)(i).

/s/ Celine J. Crowson

Celine J. Crowson (Reg. No. 40,357)

*One of the attorneys for Petitioner Mercedes-Benz
USA, LLC*

APPENDIX C
Certificate of Service

The undersigned certifies that, in accordance with 37 C.F.R. § 42.6(e) and 37 C.F.R. § 42.105, the foregoing Petition for Inter Partes Review, and Exhibits 1001 through 1012 were served on December 14, 2022, by Overnight Courier at the following address of record and addresses known to Petitioner as likely to effect service and the address of record for the '138 patent:

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Intellectual Property – Patents
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Houston, TX

/s/ Nicole Lynch

Hogan Lovells US LLP
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