

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ROBERT BOSCH LLC, and
MERCEDES-BENZ USA, LLC,
Petitioner,

v.

WESTPORT FUEL SYSTEMS CANADA INC.,
Patent Owner

Inter Partes Review No. IPR2022-00293
Patent No. 6,575,138

DECLARATION OF DR. CHRISTOPHER ATKINSON

1 Westport Fuel Systems Canada, Inc.
EX 2004 – IPR2023-00293
Robert Bosch LLC et al. v.
Westport Fuel Systems Canada, Inc.

TABLE OF CONTENTS

LIST OF DOCUMENTS CONSIDERED.....	3
I. INTRODUCTION AND SCOPE OF WORK	4
II. PROFESSIONAL BACKGROUND.....	4
III. COMPENSATION	5
IV. LEGAL PRINCIPLES.....	5
V. PERSON OF ORDINARY SKILL IN THE ART	8
VI. CLAIM CONSTRUCTION	8
VII. FUEL INJECTORS	9
VIII. THE '138 PATENT.....	13
IX. ART RELIED ON BY THE PETITIONER.....	17
X. THE COMBINATION OF KLÜGL AND WIRBELEIT	26
XI. THE COMBINATION OF KLÜGL AND HAYES	27
XII. CONCLUSION.....	31

LIST OF DOCUMENTS CONSIDERED

Exhibit No.	Description
1001	U.S. Patent No. 6,575,138 (the '138 Patent")
1002	File History of the '138 Patent
1003	Declaration of Dr. Matt Quinlan
1004	U.S. Patent No. 5,479,902 ("Wirbeleit")
1006	Translation of DE 197 08 304 A1 ("Klügl")
1014	U.S. Patent No. 4,284,263 ("Newcomb")
1024	U.S. Patent No. 5,779,149 ("Hayes")

I. INTRODUCTION AND SCOPE OF WORK

1. My name is Dr. Christopher Atkinson. I am over the age of twenty-one (21) years and competent to make this Declaration.

2. I have been retained by Patent Owner to provide my opinions concerning U.S. Patent No. 6,575,138 (the “’138 Patent”) and, in particular, to the challenges made to the ’138 Patent in *inter partes* review No. IPR2023-00293.

II. PROFESSIONAL BACKGROUND

3. I have been working in the field of engineering for over 30 years. I received a Bachelor of Science degree in Chemical Engineering in 1983, a Master of Science degree in Mechanical Engineering in 1987 and a Doctor of Science in Mechanical Engineering in the Thermal Sciences in 1991. I have worked extensively in academia, including as the Director of the Center for Alternative Fuels, Engines and Emissions at West Virginia University, and founded two companies focused on internal combustion engines, fuels, and emission reductions. I currently serve as a tenured Professor of Mechanical and Aerospace Engineering at Ohio State University. A primary focus throughout my career has been transportation and vehicle technologies focused on reduction in greenhouse gases and improvements in

4 Westport Fuel Systems Canada, Inc.
EX 2004 – IPR2023-00293
Robert Bosch LLC et al. v.
Westport Fuel Systems Canada, Inc.

efficiency, including internal combustion engine design, development, integration, control, calibration and optimization. Please see my attached CV for further details.

III. COMPENSATION

4. I am being compensated in this matter at \$450/hr.

5. My compensation is not dependent on the contents of this Declaration, any testimony I may give, or any outcome of this matter.

IV. LEGAL PRINCIPLES

6. I am not an attorney and have not been asked to offer an opinion on the law. I have not researched the law that may relate to this proceeding. However, as an expert assisting the PTAB in analyzing the issues raised by the Petitioners, I understand that I am obliged to follow existing law. I have therefore been asked to apply the following legal principles to my analysis, and I have done so.

7. A patent claim is invalid as obvious if differences between the subject matter of the claim and the prior art are such that the subject matter of the claim as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

8. In determining whether a claimed invention is obvious, one should consider the scope and content of the prior art, the level of ordinary skill in the relevant art, the differences between the claimed invention and the prior art, and

whether the claimed invention would have been obvious to one of ordinary skill in the art in light of those differences.

9. I understand that certain objective factors, sometimes known as “secondary considerations” must, if present, be taken into account in determining whether a claimed invention would have been obvious. Such objective indicia as commercial success, long felt but unsolved needs, and failures of others may often be the most probative and cogent evidence of non-obviousness. Such evidence may often establish that an invention appearing to have been obvious in light of the prior art was not obvious. The person of ordinary skill in the art is a hypothetical person who is presumed to be aware of all of the pertinent art at the relevant point in time. The person of ordinary skill is not an automaton, and may be able to fit together the teachings of multiple prior art references employing ordinary creativity and the common sense that familiar items may have obvious uses beyond their primary purposes.

10. In establishing obviousness, one must avoid the temptation to read into the prior art the teachings of the invention at issue and guard against slipping into the use of hindsight. The prior art itself, and not the applicant’s achievement, must establish the obviousness of the combination. That is, a claim of the challenged patent cannot serve as a motivation to combine prior art references.

11. I have not been asked to opine on, and have not analyzed, the priority date for any of the claims at issue in this petition for *inter partes* review (“IPR”). For the purposes of my analysis, I have been asked to assume the references relied upon by the Petitioners in this IPR meet the definition of prior art. I understand that even if all aspects of the claimed invention were individually known in the art that is not sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references as arranged in the claim under consideration. On this point, I understand that mere statements to the effect that a combination would have been obvious are not sufficient in the absence of articulated reasoning with rational underpinning to support the conclusion of obviousness. I understand that a mere combination of references disclosing individual elements itself does not satisfy the burden of proving invalidity by a preponderance of the evidence.

12. If a proposed modification to a reference would render the prior art unsatisfactory for the intended purpose, or if the prior art teaches away from the proposed modification, then there is no suggestion or motivation to make the proposed modification.

13. If a proposed modification or combination of prior art references would change the principle of operation of the prior art being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious.

V. PERSON OF ORDINARY SKILL IN THE ART

14. A person of ordinary skill in the art (“POSITA”) of the ’138 Patent as of the date of invention would at least have had a degree in mechanical engineering or a similar discipline along with 2 years of professional experience working with fuel injectors or fuel injection systems for internal combustion engines.

VI. CLAIM CONSTRUCTION

15. I have been advised that for an IPR, the terms in the claims are construed based on their ordinary and customary meaning to a POSITA at the time of the invention unless the term has been clearly and unambiguously given a special definition in the specification. I understand that items of intrinsic evidence, including the specification, supplemented by the file history of the patent, are the best sources for understanding a term used differently from its ordinary and customary meaning. Extrinsic evidence, such as dictionaries and expert testimony, are relied on only when the ordinary and customary meaning and the intrinsic evidence are insufficient.

16. In my opinion, the terms of the '138 Patent do not require any construction as their plain and ordinary meaning is sufficient to fully understand the scope of the claims.

VII. FUEL INJECTORS

17. Internal combustion engines in most cases utilize the combustion of an air-fuel mixture in a cylinder(s) to raise the temperature and pressure of a working fluid (such as a mixture of air, products of combustion and exhaust gases) to act on a piston(s) within that cylinder(s) to produce useful engine output work.

18. The introduction of a combustible fuel into a modern engine is ordinarily effected by the use of a 'fuel injector' that introduces the fuel (such as a liquid or gaseous hydrocarbon) into an oxidant-containing gas (such as fresh air, or the mixture of fresh air, products of combustion and exhaust gases, sometimes known as the cylinder 'charge').

19. The fuel injector serves to facilitate the introduction of the fuel into the cylinder charge in a variable quantity that varies with respect to a number of parameters including the amount of oxidant in the cylinder charge (the oxidant normally being the oxygen resident in the fresh intake air), so that the resultant air and fuel combustion process can be regulated and controlled with respect to the desired engine performance, fuel efficiency and emissions production.

20. The fuel(s) introduced into an engine may be in the liquid or gaseous phases, and the combustion process may be initiated through the timely provision of a high energy electrical spark (as in the use of a spark plug(s) for spark-ignition engines) or through the compression of the intake charge and fuel mixture, for example as a piston moves in its cylinder (as in a compression-ignition engine).

21. In recent decades, in order to reduce deleterious combustion exhaust gas emissions, increasing attention has been paid by engine design, engine performance and engine calibration engineers, to the mixture preparation, ignition and combustion processes that occur within engines.

22. Increasingly stringent governmental regulations over the past several decades pertaining to vehicle tailpipe and engine exhaust emissions, including emissions of oxides of nitrogen, carbon monoxide, unburnt hydrocarbons and particulate matter, have required engine developers and manufacturers to constantly improve the design and manufacture of the internal combustion engine and its constituent componentry. Fuel efficiency considerations, increasing fuel costs and vehicle owners' desire for improved vehicle performance have similarly resulted in continual pressure on engine engineers to improve engine efficiency, performance and power output while ensuring increased durability and reduced maintenance requirements and operating costs.

23. To meet these demands, the combustion engine had to evolve in a variety of ways, while balancing concerns such as fuel economy, emissions, efficiency, power, decreasing size, and precision performance.

24. This led to research and design efforts around the development of higher performance fuel injectors, including, for example, injectors that were capable of operating at much higher pressures and providing more efficient or effective fuel spray patterns.

25. In addition, use in a direct fuel injection system—where fuel is not mixed with air before introduction into the combustion cylinder—required integration of fuel injectors in, on and around high-temperature surfaces and zones within the engine, thereby leading to the possibility of significant temperature or thermal gradients across a single injector.

26. Fuel injectors are intricate devices that include a variety of components that must be manufactured with very tight tolerances of their constituent parts to reduce the possibility of internal or external fluid leakage, including to prevent fuel leakage into the cylinder(s) at inappropriate times.

27. Not only were machining tolerances for the constituent parts a concern, but there was a need for higher performance fuel injectors that could deliver precise

actuation in terms of both the duration of actuation (how long a valve was open) and position of actuation (how much the valve is lifted).

28. The time scales of actuation or operation of a fuel injector depend on a number of variables including the engine rotational speed – at characteristic engine speeds, a fuel injector might open and close 50 times per second or more, with an injection valve opening time of less than 1 millisecond and opening duration of less than 10 milliseconds. Dimensional tolerances for the internal components of modern injectors can be measured in low digit microns, or thousandths of a millimeter. With the short time scales of operation (opening, holding open, and closing) required of an injector, the reproducibility and accuracy of the metered quantity of fuel is paramount to achieving the required engine-out emissions levels to allow the engine to meet prevailing exhaust gas emissions regulations. The tight clearances and tolerances required in a modern injector, coupled with the requirement that the injector last for millions of operating cycles without maintenance, modification or repair make self-compensating devices, elements and features within the injector of critical importance.

29. Maintaining injector fuel metering accuracy and precision, and the ability to operate and meter fuel reproducibly in the presence of high temperatures and significant thermal gradients, with significant reliability and longevity are

critical elements in fuel injector design and operation. Directly injecting fuel at high pressure into the combustion chamber of an internal combustion engine during the combustion cycle provides advantages in both engine performance and reducing emissions but causes engineering challenges because injecting fuel rapidly and at high pressure requires fast-actuating fuel injectors that could reliably perform for millions of cycles.

VIII. THE '138 PATENT

30. I reviewed the '138 Patent and its file history in preparation for this Declaration.

31. As explained in the '138 Patent, the inventors sought to address many of the above-discussed challenges. The background section of the specification describes the need for a rapid, high-pressure fuel injector capable of providing duration control (how long a valve is open) and position control (how much the valve is lifted).

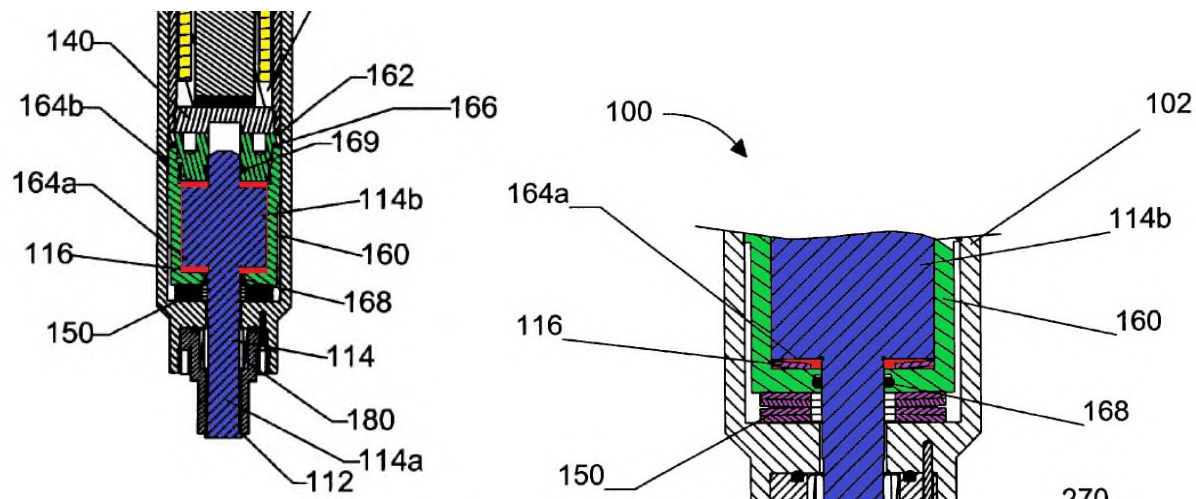
32. One of the ways that the inventors addressed these challenges was to develop a fuel injector having, *inter alia*, a hydraulic link assembly.

33. Their hydraulic link assembly includes a passive hydraulic link having a hydraulic fluid layer through which opening and closing forces are transmitted.

The hydraulic link adjusts between actuation events to maintain desired valve needle lift characteristics.

34. As described in the patent's specification, "the hydraulic link assembly accounts for variations in component dimensions arising from the permitted tolerances in the manufacturing processes and the injection valve assembly methods. Therefore, the hydraulic link assembly reduces manufacturing costs by allowing the injection valve components to be manufactured to less exacting tolerances. In addition, during operation, the hydraulic link assembly auto-adjusts itself between injection events to account for changes in the dimensional relationship between injection valve components that may be caused, for example, by component wear or differential thermal expansion or contraction." Ex. 1001, 13:21-32.

35. Referring to Fig. 2 from the '138 Patent as shown below, valve member 114 shaded in blue, the connected cylinder 160 and cap 162 shaded in green, the actuator 130 shaded in yellow, and the valve spring 116 and disc spring 150 shaded in purple. Hydraulic fluid 164a/b (shaded in red) fills the cylinder 160 and forms a thin layer of fluid in between the valve member and the cylinder.



36. The valve member 114 includes a piston 114b. The outside diameter of piston 114b fits closely within the inside diameter of the hydraulic cylinder 160, allowing longitudinal movement of the piston 114b relative to the cylinder and creating a small diametrical clearance gap. A viscous hydraulic fluid is provided in the clearance gap between the piston 114b and the hydraulic cylinder 160. The hydraulic fluid provides a layer between the cylinder cap 162 and the piston 114b. The hydraulic fluid also provides a layer between the base of the cylinder 160 and the planar surface of the hydraulic piston 114b. Ex. 1001, 11:65 to 13:32.

37. The valve spring 116 provides a closing force that pushes the valve member 114 against a valve seat in the closed position. Ex. 1001, 10:13-30.

38. To open the valve, an electric voltage is applied to the actuator 130, which longitudinally expands the actuator and applies an opening force to the base of the cylinder 160. The opening force is transmitted from the base of the cylinder

160 through the thickness of hydraulic fluid 164b to the valve needle 114, moving the valve needle upward (in the orientation of this exemplary figure). The duration of the actuation is very short, typically less than 250 microseconds. Ex. 1001, 14:26-40.

39. Because of the tight diametrical fit between the piston 114b and the cylinder 160, the flow of hydraulic fluid 164b through the clearance gap is insignificant during the time span of the brief actuation events. The viscous hydraulic fluid acts as an incompressible solid during actuation, providing a substantially constant thickness for that instant. Thus the patent teaches a POSITA that the actuator's instantaneous actuation force will be transmitted through the hydraulic fluid thickness in nearly the same way that such a force would be transmitted through a solid material. Ex. 1001, 12:14-45.

40. When the electric voltage is removed from the actuator 130, it will longitudinally contract. With the actuation force removed, needle spring 116 expands longitudinally and applies a closing force. The hydraulic fluid 164a transmits the closing force to move the valve needle towards the valve seat. Ex. 1001, 12:46-63.

41. When the fuel injector 100 is closed (during typical engine operation the fuel injector 100 is closed normally over 90% of the time), the hydraulic fluid

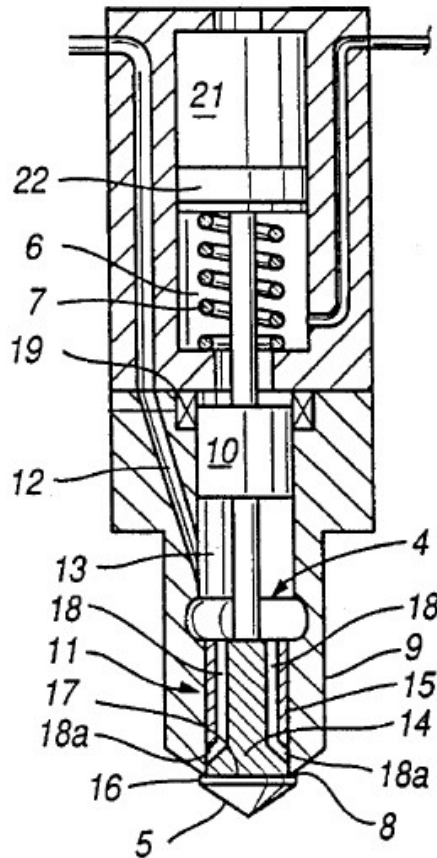
can move within the clearance gap. This allows the thickness of the hydraulic fluid layers 164a and 164b to change to accommodate dimensional variations due to long-term mechanical component wear or shorter-term engine operating thermal gradients and temperature effects. Ex. 1001, 12:46-63.

IX. ART RELIED ON BY PETITIONER

a. U.S. Patent No. 5,479,902 (“Wirbeleit”)

42. Wirbeleit describes a fuel injector with slot-shaped orifices, the opening of which can be controlled by a control needle itself controlled by a needle actuator.

43. With reference to the portion of the figure of Wirbeleit shown below, Wirbeleit’s injector includes an orifice control needle 5 that moves downward and away from valve seat 8 to allow fuel to flow from chamber 13 through grooves 18 and oblong openings 18a into a combustion chamber.



44. The injector is opened by energizing actuator 21, which acts on the control needle 5 by way of a “hydraulic transmission element 22”. The hydraulic transmission element is illustrated as an empty box without any detail in the patent. Wirbeleit also says an “elastomer or mechanical force transmission” could be utilized in place of the hydraulic transmission element.

45. Wirbeleit does not teach and, it not possible to discern from the figures, the internal structure of the hydraulic transmission element. Any number of hydraulic transmission methods or systems could perform as the “hydraulic

transmission element” of Wirbeleit to allow the needle actuator to operate the orifice control needle.

46. Return spring 7 biases the control needle 5 upward into contact with valve seat 8 to close the oblong openings 18a and stop the flow of fluid into the combustion chamber. The actuator 21 will longitudinally contract when its period of energization ends, returning the actuator 21 and the hydraulic transmission element 22 to their initial positions and configurations.

47. Wirbeleit’s fuel injector operates using a needle position sensor 19, and accompanying electronic control unit, to continually monitor the position of the control needle and then to vary the energization of the actuator to adjust the position of the needle that controls the opening of the orifices.

b. German Patent Application DE 197 08 304 A1 (“Klügl”)

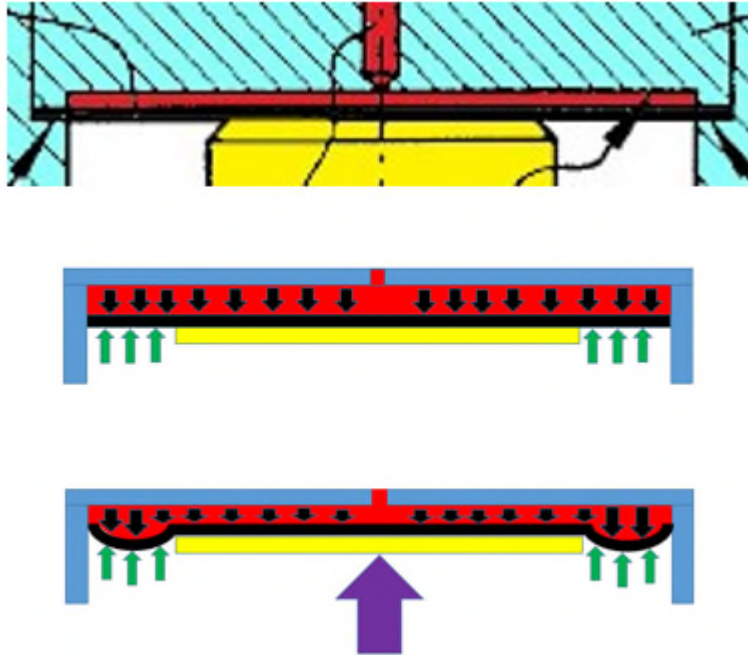
48. Klügl teaches a device that is described as being used as a servo valve that controls the flow of hydraulic fluid that is used to actuate an injection valve.

49. With reference to the annotated Fig. 1 below, the system of Klügl includes an actuator 1 (green) that is connected to a transmission module (blue) that includes a pressure chamber 5 separated from a compensating chamber 7 by a connecting bore 10. The pressure chamber 5 and compensating chamber 7 are filled with a fluid (red). The fluid is pressurized by spring plate 8 forming the compensation chamber 7 and contained by a first membrane 6 that forms the pressure chamber 5. A POSITA would define membrane by its plain and ordinary meaning, which would be a thin, pliable and flexible sheet of material forming a barrier.

50. A drive piston 3 (yellow) has an upper end that is associated with the first membrane 6 and a check ring 17 that is biased by spring 15 against a lower stop 16. The lower end of the drive piston 3 includes a control needle 32 that extends into contact with a ball 4 (orange). The ball 4 is biased into contact with a valve seat by valve spring 33 to close the servo valve.

FIG 1

21 Westport Fuel Systems Canada, Inc.
EX 2004 – IPR2023-00293
Robert Bosch LLC et al. v.
Westport Fuel Systems Canada, Inc.



52. As illustrated above, as the transmission module (light blue) moves downward, the drive piston (yellow) exerts an opposite, upward force on the membrane (black). Due to the inherent flexibility and pliability of the membrane (black), the membrane will tend to deform inward where it contacts the drive piston and bulge outward where unconstrained in the annular area between the edge of the drive piston and the wall of the transmission module in order to accommodate the volume of the fluid contained therein. This deformation will result in the movement of the fluid resident within the confines of the zone bounded by the membrane even as the injector is undergoing actuation.

53. A POSITA would know membranes are flexible and pliable elements that will deform when subjected to the significant forces exerted within an injector at the typical actuation rates of the fuel injection process. Even a small deflection or deformation of the pliable, flexible membrane will be critical as the lift commonly generated in these applications is very small, usually less than 100 microns (about the thickness of a piece of paper).

54. Over time, a POSITA would expect the membrane to be susceptible to failure, including pulling away from points of attachment and leakage. A POSITA would also understand that the stiffness of a membrane would likely change depending on the temperature of the operating environment and the differential pressure across the membrane.

55. In the opposing direction, if operated for a high-pressure fuel system, the membrane 5 would be subjected to forces from the pressurized fuel pushing upwards and potentially deforming the membrane in the opposing direction. A POSITA would further understand the deformations in both directions to pose even greater integrity concerns over time.

56. Klügl does not deny that deformation of the membrane 5 occurs. Klügl's system transmits movement using a chamber of fluid maintained at a constant pressure behind a flexible membrane.

57. Klügl teaches that when activation of the actuator 1 ends, the transmission module 2 and the guide sleeve 11 are pushed upward by the disk spring 14. The check ring 17 and lower stop 16 isolate the closing force generated by spring 15 (and spring 33) from the transmission module 2 and membrane 6.

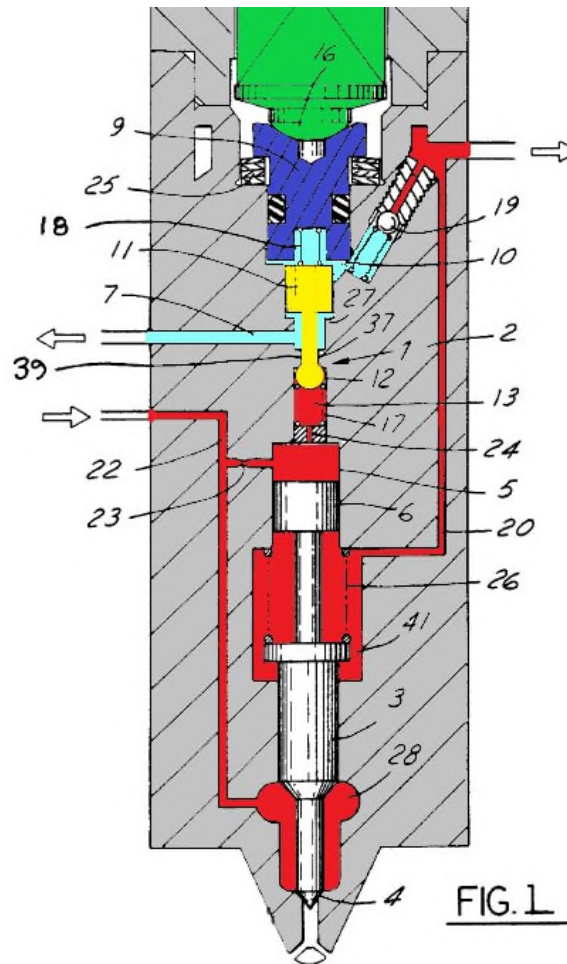
58. If the closing forces were transferred to the membrane 2 by the hydraulic fluid in the pressure chamber 5, then that would mean the drive piston 3 would maintain contact with the first membrane 6. Not only would this eliminate any need for the membrane to adjust to contact the drive piston but the force from the drive piston would tend to push all of the fluid out of the pressure chamber back into the compensation chamber, destroying any effectiveness of the pressure chamber.

c. U.S. Patent No. 5,779,149 (“Hayes”)

59. Hayes teaches a fuel injector that utilizes an active “hydraulic amplifier” mechanism to open a control valve that injects fuel by creating a pressure differential across an injection needle.

60. With reference to the annotated Fig.1 below, high pressure fuel (red) is supplied to the injector. Spring 26 biases the injection needle 3 downward against seat 4. Drain line 7 is maintained at a lower pressure than the high-pressure fuel so

that a volume of lower-pressure fuel (light blue) is maintained above control valve 1 (yellow).



61. In operation, actuator 16 (green) extends and pushes first piston 9 (blue) downward. The first piston 9 (blue) faces a hydraulic chamber (filled with the lower-pressure fuel) that is also faced by second piston 11 (yellow).

62. The surface area of the first piston 9 is substantially larger than the surface area of the second piston 11 such that the stroke of the second piston 11 is

much longer than the stroke of the first piston 9, multiplying or amplifying the movement produced by the extension of the actuator 16.

63. Downward movement of the second piston 11 (and attached sealing component 12) opens control valve 1 and puts control chamber 5 in fluid communication with drain line 7. With the pressure in control chamber 5 reduced, a pressure differential across the power piston 6 will move the injection needle 3 upward and away from seat 4, thus allowing high-pressure fuel to be injected through seat 4.

64. Once control valve 1 is closed, the high-pressure fuel (red) will refill control chamber 5 and the injection needle will again seal against the seat 4.

X. THE COMBINATION OF KLÜGL AND WIRBELEIT

65. For several reasons, a POSITA would not have combined the hydraulic transmission of Klügl with the system of Wirbeleit.

66. First, a POSITA would not have been motivated to make the combination because, if anything, Klügl would make the operation of the system of Wirbeleit more complex.

67. Because Wirbeleit directly monitors and adjusts the control needle, the “electronic control unit” system of Wirbeleit can adjust the position of the control needle to compensate for any dimensional variations due to wear or thermal effects.

Therefore, Wirbeleit would not need to add the complexity of Klügl to solve a problem (of compensation for any dimensional variations) for which it already had a solution.

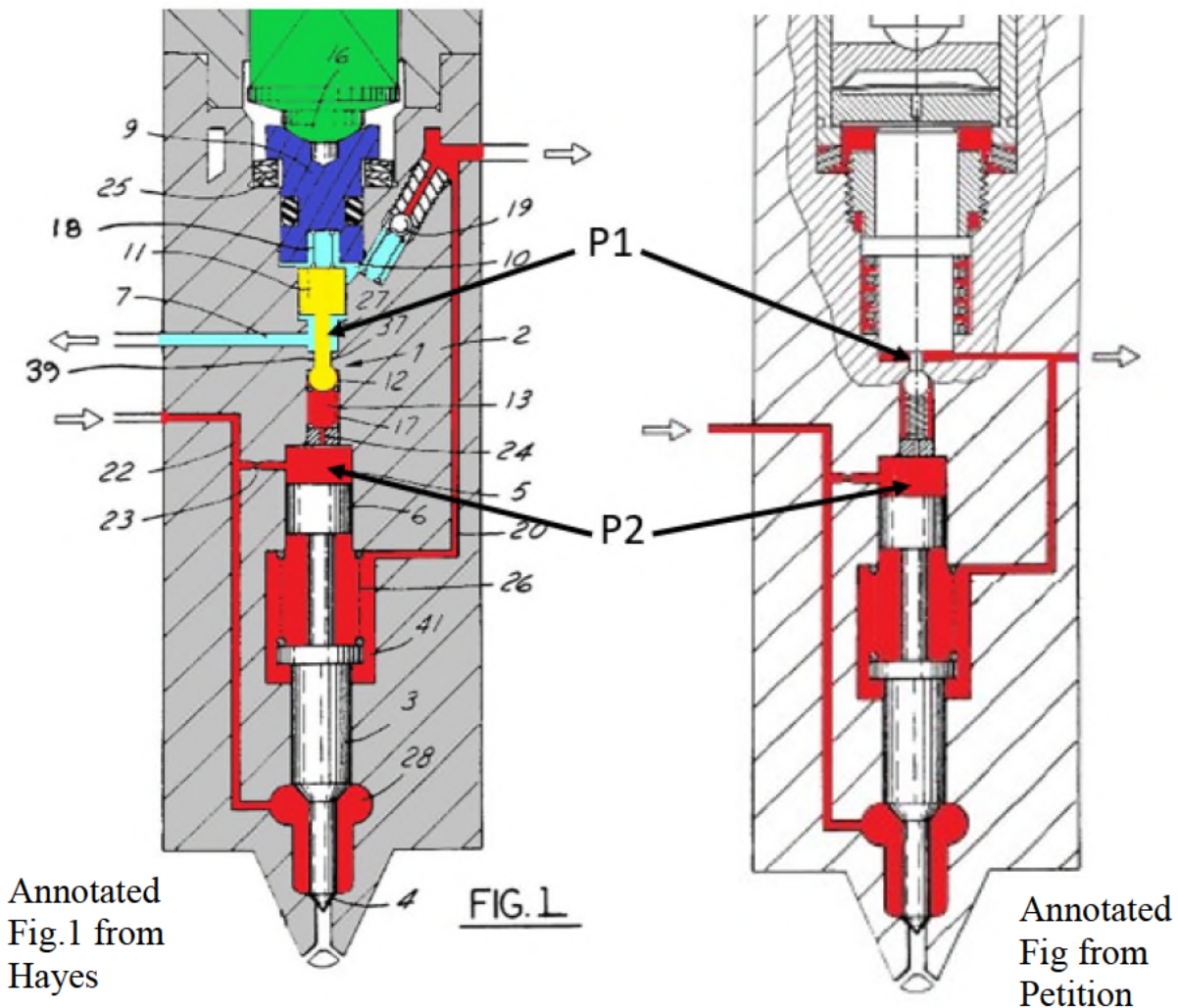
68. Further, adding the membrane-based hydraulic transmission “module” of Klügl, would only add additional dimensional variations (from the inherent flexibility of the membrane under both transient and static pressure and mechanical loads) for which the system of Wirbeleit would have to compensate, likely with variable compensation across the time of actuation – a very difficult requirement for any control system.

69. Second, a POSITA would have been aware that membrane-based systems such as Klügl were known to have technological problems at the high pressures and temperatures that fuel injectors like those disclosed in the ’138 Patent were being designed for, including the variations in pressure and volume inherent in fluid systems contained within flexible elements. These variations would likely be themselves highly susceptible to short- and long-term variations in wear and temperature of the individual components in a fuel injector.

XI. THE COMBINATION OF KLÜGL AND HAYES

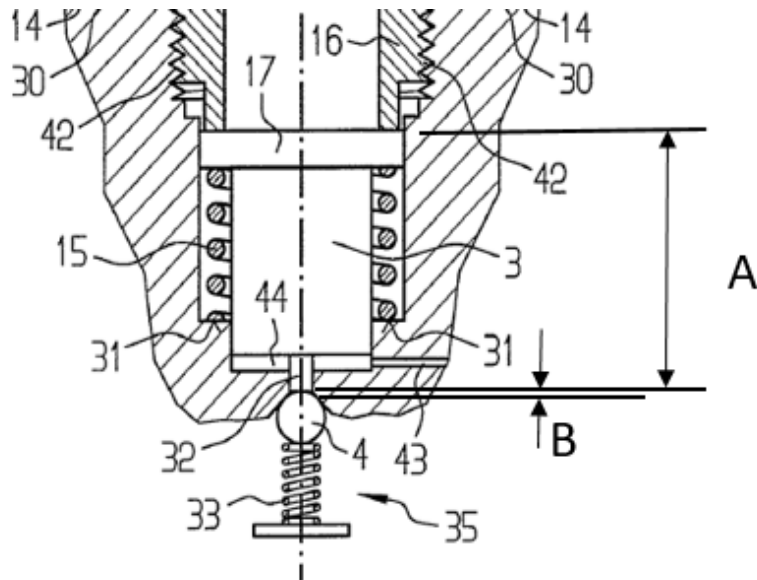
70. For several reasons, a POSITA would not have combined the hydraulic transmission module of Klügl with the system of Hayes as proposed in the Petition.

71. In the annotated version of Fig 1. of Hayes below, volumes open to the high pressure feeding line (22) are shaded red and volumes open to the low pressure drain line (7) are shaded in light blue. The differential pressure between the point labeled as P1 and the point labeled as P2 is critical to the operation of the injector and the pressure at P2 must be higher than the pressure at P1 in order for the injector to operate properly.



72. As proposed in the Petition and shown above, the volumes that are open to the high-pressure feeding line are shaded in red and the fuel present at points P1 and P2 are at the same pressure. Without a differential pressure across the control valve, opening the control valve will not have any effect on the needle position or movement, which means the needle will not lift off the needle seat, and the injector will not operate to regulate the flow of fuel, rendering it useless.

73. As illustrated in the annotated figure below, spring 15 will always push drive piston 3 upward until check ring 17 contacts lower stop 16. Contrast this with the second piston 11 of Hayes, which is not likewise constrained. The distance A from the lower stop 16 to the end of the valve needle 32 is thereby fixed and any adjustment provided by the flexible membrane of Klügl's transmission module will not adjust distance A.



74. Ball 4 is illustrated as being in direct contact with the valve needle 32 but, since the upward movement of the ball is limited by its contact with the housing, thermal expansion or wear can create a gap B between the end of the valve needle 32 and the ball 4. If gap B exists, then the ultimate lift of ball 4 away from the housing will be less than the linear translation of the actuator and the hydraulic transmission of Klügl will not be able to maintain a desired needle lift, and hence its ability to regulate the flow of high-pressure fuel would be severely compromised.

75. Just as thermal expansion or wear may create a gap B, those same effects may operate in the other direction and cause the distance A to extend farther toward the contact between ball 4 and housing 12 when the actuator is closed,

causing sealing pressure to decrease, which could move ball 4 and/or increase the likelihood of leakage between ball 4 and housing 12.

XII. CONCLUSION

76. All statements made herein of my own knowledge are true, all statements made herein on information and belief are believed to be true, and these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

Dated: March 22, 2023

\Christopher M. Atkinson\
Dr. Christopher Atkinson