

**UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

Westport Fuel Systems Canada Inc.,

Plaintiff,

v.

Nissan North America, Inc.,

Defendant.

Case No. 2:21-cv-00455[JRG/RSP]
(LEAD CASE)

JURY TRIAL DEMANDED

Westport Fuel Systems Canada Inc.,

Plaintiff,

v.

General Motors, LLC,

Defendant.

Case No. 2:21-cv-00456[JRG/RSP]
(MEMBER CASE)

**P.R. 4-3 REPORT OF DR. J. MATT QUINLAN IN SUPPORT OF DEFENDANT
GENERAL MOTORS, LLC'S CLAIM CONSTRUCTION POSITIONS**

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I, Dr. J. Matt Quinlan, do hereby declare:

1. I am making this declaration at the request of Defendant General Motors, LLC (“GM”) in the above-captioned case, and have been asked to provide testimony and opinions regarding certain aspects of U.S. Patent Nos. 6,298,829 B1 (“829 Patent”) and 6,575,138 B2 (“138 Patent”) (collectively, “Asserted Patents”). Specifically, I was asked to testify about what the plain and ordinary meaning is of certain claim terms to one of ordinary skill in the art. This declaration is submitted in accordance with Eastern District of Texas Local Patent Rule 4-3(b).

2. This declaration, including the exhibits hereto and cited materials, identifies my opinions to date, although I may provide further testimony and opinions if asked to testify in court or at a deposition. I also reserve the right to supplement or amend my opinions, as well as the bases for those opinions, if I receive additional relevant information or to respond to opinions offered by other experts in this case. I may rely on demonstrative exhibits, including pictures, figures, and drawings that appear in this report and the referenced exhibits and materials.

3. In preparing this declaration, I have reviewed the Asserted Patents and their prosecution histories, as well as the documents mentioned in this declaration. This declaration provides background information regarding fuel injectors and my expert opinions regarding the Asserted Patents, including opinions relating to the proper construction of certain claim terms and the bases for my opinions. In forming my opinions, I relied on my education, knowledge, and experience and I considered the level of ordinary skill in the art as discussed below.

I. QUALIFICATIONS

4. My curriculum vitae (“CV”) is attached hereto as Exhibit A and provides an accurate identification of my background and experience.

5. I am currently an assistant professor in the Mechanical and Aerospace Engineering department at the University of Colorado, Colorado Springs (“UCCS”). I am also the Director of UCCS’s Combustion and Acoustics Lab.

6. I received a B.S. in mechanical engineering from Colorado State University in 2001.

7. From 2001 to 2006, I worked as a fuel systems engineer at Sturman Industries. My responsibilities included the development, testing, design, analysis, and customer interface/installation of diesel fuel injectors.

8. Starting in 2006, I returned to Colorado State University to continue my studies. I received a M.S. in mechanical engineering in 2009.

9. Starting in 2009, I attended the Georgia Institute of Technology. While there, I served as a Graduate Research Assistant and Research Engineer, focusing on combustion instability in liquid propellant rocket engines and the remote measurement of rocket engine chamber pressure dynamics.

10. I received a Ph.D. in aerospace engineering from the Georgia Institute of Technology in 2015.

11. From 2005 to the present, I also worked as a consultant engineer for my own consulting firm, known as Quinlan Engineering and Design, LLC. I engage in engineering design, development, and analysis in fuel systems.

12. I joined the faculty at UCCS in 2018 as a visiting assistant professor and permanently in 2019 as an assistant professor.

13. I am the named inventor on a number of patents relating to automotive technology, including fuel injectors. These patents include, for example, U.S. Patent No. 7,681,592 (entitled

“Three-way poppet valves with floating seat”), U.S. Patent No. 8,282,020 (entitled “Three-way valves and fuel injectors using the same”), and U.S. Patent No. 8,366,018 (entitled “Oil Intensified common rail injectors”).

14. I have also co-authored papers relating to fuel injectors, including “Evaluation of a 3-Way Direct Needle Control Unit Injector on Hydraulic Test Bench and V8 Engine,” SAE Technical Paper 2004-01-0024 (2004).

15. A complete list of my patents and publications is included as part of my attached CV.

II. MATERIALS REVIEWED

16. In preparing this declaration, I have reviewed the following materials:

- a. The Asserted Patents;
- b. The file histories of the Asserted Patents;
- c. The parties’ proposed constructions of claim terms for the Asserted Patents;
- d. Plaintiff Westport Fuel Systems Canada Inc.’s (“Westport”) Disclosure of Asserted Claims and Infringement Contentions in this action;
- e. Merriam-Webster’s Collegiate Dictionary Excerpt (10th ed. 1997) (Exhibit B); and
- f. American Heritage Dictionary Excerpt (3d ed. 1996) (Exhibit C).

III. LEGAL STANDARDS

17. I am not an attorney but have been instructed in and applied the law as described in this section.

A. Claim Construction

18. I have been informed and understand that the words of a patent claim are generally given their ordinary and customary meaning, which is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention, i.e., as of the effective

filing date of the patent application. The person of ordinary skill in the art is deemed to read the claim term or claim limitation not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification. I understand that claim construction may deviate from the ordinary and customary meaning of a disputed term only if (1) a patentee sets out a definition and acts as his or her own lexicographer, or (2) the patentee disavows the full scope of a claim term either in the specification or during prosecution.

19. I have been informed and understand that the first step in claim construction is to look to the language of the claims themselves. I understand it is a bedrock principle of patent law that the claims of a patent define the invention to which the patentee may exclude others from using.

20. I have been informed and understand that claims should also be read in view of other claims of the patent, both asserted and unasserted. I understand that claim terms are normally used consistently throughout the patent, and therefore the usage of a term in one claim can often help in understanding the meaning of the same term in other claims. Further, I understand that differences among claims can also be a useful guide in understanding the meaning of particular claim terms. As a specific example, I understand that the presence of a dependent claim with a particular limitation gives rise to a presumption that this limitation is not present in the independent claim from which it depends.

21. I have been informed and understand that claims must be read in view of the specification, of which they are a part. But while claim terms are understood in light of the specification, a claim construction must not import limitations from the specification into the claims. Absent limiting circumstances, a patentee is entitled to the full breadth of claim scope supported by the claims and specification.

22. I have been informed and understand that a court may rely on extrinsic evidence to shed useful light on the relevant art. Though extrinsic evidence is generally less significant and less reliable than intrinsic evidence, the court may rely on extrinsic evidence at least to (1) help educate the court regarding the field of the invention, and (2) determine what a person of ordinary skill in the art would understand the claim terms to mean.

23. I have been asked to review the claims and provide testimony regarding the plain and ordinary meaning of the claims from the perspective of one of ordinary skill in the art. My opinions on claim construction expressed in this Declaration are from the perspective of, and based upon the knowledge of, a person of ordinary skill in the art at the time of the invention, and are consistent with my understanding as stated above.

B. Person of Ordinary Skill in the Art

24. I have been informed and understand that the level of ordinary skill in the relevant art at the time of the invention is relevant to inquiries such as the meaning of claim terms, the meaning of disclosures found in the prior art, and the reasons a person of ordinary skill in the art (“POSITA”) may have for combining references.

25. I have been informed and understand that factors that may be considered in determining the level of ordinary skill include: (1) the education of the inventor; (2) the type of problems encountered in the art; (3) prior art solutions to those problems; (4) rapidity with which innovations are made; (5) sophistication of the technology; and (6) education level of active workers in the relevant field. I have been further informed and understand that a POSITA is also a person of ordinary creativity.

26. A POSITA in the technology field of the Asserted Patents would, in my opinion, 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.

27. In my opinion, this POSITA would have been aware of and generally knowledgeable about how fuel injectors and the valves used within are structured and operate, and how they are used to deliver fuel to an engine's combustion chambers.

28. In my opinion, a POSITA would have had the same basic level of skill and background knowledge regardless of whether the '829 patent is entitled to an October 1999 or March 2000 filing date, as set forth below.

29. In my opinion, a POSITA would have had the same basic level of skill and background knowledge regardless of whether the '138 patent is entitled to an October 1999, March 2000, or May 2001 filing date, as set forth below.

30. In view of my educational background (e.g., a M.S. in mechanical engineering and Ph.D. in aerospace engineering) and work experience in the fuel injector field, I am a person of more than the ordinary level of skill in the art of the Asserted Patents. In forming my opinion, I have drawn on my academic background and professional experiences. My opinions herein, however, were formed taking into account the perspective of an ordinarily skilled artisan.

IV. THE ASSERTED PATENTS

A. The '829 Patent

1. Effective Filing Date

31. I understand that the application leading to the '829 Patent was filed on March 9, 2000.

32. Based on my review of the '829 Patent, I note that it also references an October 15, 1999 provisional application filing on its face.

33. For purposes of this declaration, I have been instructed to use October 15, 1999 as the effective filing date of the '829 Patent. My opinions in this declaration were formed from the perspective of a POSITA as of October 15, 1999, including both the knowledge of a POSITA at that time as well as how a POSITA would have understood the prior art. Nevertheless, the opinions I express in this declaration would be the same regardless of whether the '829 Patent has an October 15, 1999 or a later March 9, 2000 effective filing date.

2. Overview

34. The '829 Patent relates to “high pressure fuel injection valves or injectors for internal combustion engines” that are “directly controllable by” a “piezoelectric or magnetostrictive” activator. ('829 Patent, 1:12-16.)

35. According to the '829 Patent, the injector also includes a “passive hydraulic link.” (*Id.*, 1:17.)

36. The '829 Patent begins by discussing prior art fuel injectors.

37. Here, the '829 Patent explains that as of its filing, it was known to be beneficial to engage in “[d]irect injection.” Direct injection entails injection directly into the “combustion chamber of an internal combustion engine[.]” (*Id.*, 1:21-29.) The '829 Patent explains that this type of injection—in contrast to indirect injection into the manifold and outside of the combustion chamber—is “desirable” because it improves engine performance and reduces emissions. (*Id.*)

38. The '829 Patent also explains that “prior direct fuel injection systems” that were “hydraulically actuated,” employ “solenoid actuators,” or “use piezoelectric or magnetostrictive actuation” were all known and available. (*E.g., id.*, 1:56-57, 2:24-27, 2:62-65.)

39. The '829 Patent goes on, however, to identify certain purported problems with these known systems.

40. For instance, hydraulically actuated systems require “additional hydraulic hardware” which adds “increased bulkiness” and subjects the system to a “delayed response” and reduced “controllability of movement of the injection valve.” (*Id.*, 2:1-23.)

41. Solenoid actuators are “not suitable for” use with “high-pressure fuels.” (*Id.*, 2:45-48.)

42. Further, known piezoelectric and magnetostrictive 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” resulting in delayed injector operation and increased complication. (*Id.*, 3:39-50.)

43. After discussing these known fuel injectors, the ’829 Patent proposes a “directly actuated” injector that does not include “an intermediate active hydraulic operator generating any actuating forces.” (*Id.*, 3:45-48.)

44. The ’829 Patent explains that its injector does include a “passive hydraulic link.” (*Id.*, 4:20, 7:10-20.)

45. The patent explains however, that in contrast to “[c]onventional active hydraulic operators,” the passive “hydraulic link” employed by its injector “merely transmits the actuating forces” or serves as a “load path” “but is not employed to generate an actuating force for actuating the valve.” (*Id.*)

46. The ’829 Patent also notes that the “passive hydraulic link” 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.*, 7:43-46.)

47. The link 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.*, 7:46-51.)

48. The below annotated versions of Figures 1 and 2 of the '829 Patent provide an example of a “directly actuated fuel injection valve 100.” (*Id.*, 8:39-41.)

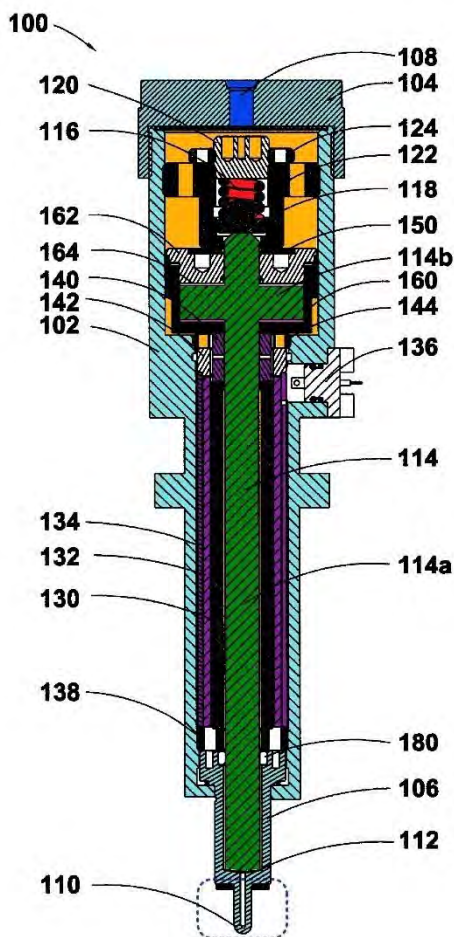


Figure 1

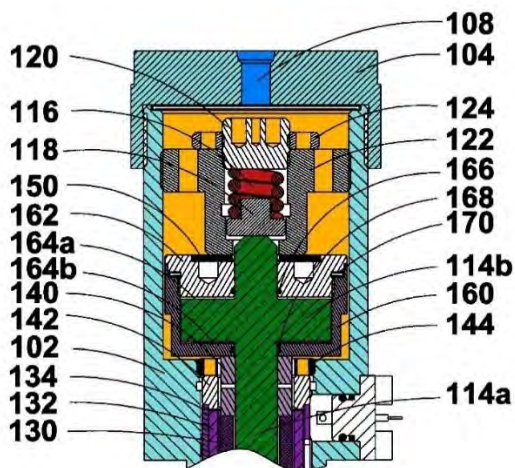


Figure 2

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

49. The elements of this injector have been annotated as follows:

50. **Teal:** A “valve housing 102,” “cap 104,” and “tip 106” that “provide a fluidly sealed valve body.” (*Id.*, 8:41-43.)

51. **Blue:** An “inlet port 108” (blue) allows fuel to enter the hollow injector interior (partially annotated orange). (*Id.*, 8:45-46.)

52. **Orange:** interior space within the injector that receives fuel from the inlet port. (*Id.*)
53. **Dashed blue outline:** A “valve tip 106” with a “nozzle orifice 110” “through which fuel exits” the injector. (*Id.*, 8:46-48.)
54. **Green:** A “valve needle 114” within the injector. (*Id.*, 8:59-60.) One end of the needle is located at the nozzle “seat 112,” adjacent to the nozzle orifice. (*Id.*, 8:52-62.)
55. **Red:** A “needle spring 116” that is located at the end of the needle opposite the nozzle and “biases valve needle 114 in the closed position.” (*Id.*, 9:16-19.)
56. **Purple:** A “magnetostrictive actuator” including a member 130, coil 132, and flux tube 134 located within the housing. (*Id.*, 9:45-49.)
57. **Pink:** “[H]ydraulic fluid 164b” of “a hydraulic link assembly.” (*Id.*, 10:62-64; 12:46-51.)
58. The ’829 Patent also explains how the injector operates. More particularly, to open the injector and inject fuel, current is applied to the actuator causing it to “expand” and “provide[] an opening force in opposition to the closing force of the spring assembly.” (*Id.*, 9:51-10:8.)
59. “The opening force generated by the actuator assembly is transmitted to valve needle 114 through” “hydraulic fluid 164b” of “a hydraulic link assembly.” (*Id.*, 10:62-64; 12:46-51.)
60. The ’829 Patent also explains that the injector can auto adjust because the space containing fluid 164b is connected to another space containing fluid 164a (**light pink**) via a “narrow clearance gap between” the needle’s “piston 114b and hydraulic cylinder 160.” (*Id.*, 12:57-60.)

61. During actuation, fluid “does not have time to flow” through this gap and the fluid 164b instead “acts as a solid and transfers the movement of magnetostrictive member 130 to valve needle 114.” (*Id.*, 12:57-66.)

62. When the injector is at “rest,” however, “fluid” 164b and 164a can “redistribute itself by flowing through the clearance gap” so as to “re-zero” the piston. (*Id.*, 11:41-49.)

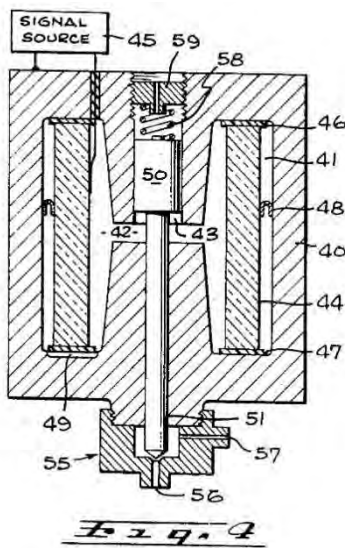
3. Prosecution History of the '829 Patent

63. As noted above, I have reviewed the '829 Patent's prosecution history.

64. Originally filed claims 1–20 were rejected in a March 2001 office action as anticipated by or obvious over U.S. Patent No. 3,598,506 to O'Neill.

65. Claims 21-30, which either required a particular “magnetostrictive member” structure or were directed to a method, were allowed.

66. In rejecting claims 1-20, the Examiner pointed to Fig. 4 of O'Neill as pertinent, which I have reproduced below for reference:



(O'Neill, Fig. 4.)

67. The Examiner explained that chambers 42 and 43 shown in this figure correspond to the “hydraulic link assembly” required by the pending claims. (*Id.*, p. 120.)

68. I have reviewed the O’Neill reference. In O’Neill, to open the injector, “electroexpansive material 44” expands as a result of the application of an electrical signal. This then results in fluid being pushed out of chamber 41 and the transmission of the expansive force of material 44 through the fluid stored “chamber 41,” to “passage 42,” to “piston cylinder 43,” and finally to a “piston 50” for purposes of opening a “valve 55” to which the piston is attached. (O’Neill, 4:10-49.)

69. The applicant responded to the Examiner’s rejection in June 2001 by noting that “O’Neill ... rel[ies] on the dynamic flow of a hydraulic fluid to actuate/open the valve.”

70. According to the applicant, 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.”

71. Because of this, the applicant characterized O’Neill’s device as employing fluid flow and displacement, and not the “‘passive’ hydraulic link” required by the claims. Similarly, the applicant argued that 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.

72. The claims were allowed immediately after this response.

4. The ’829 Patent’s Claims

73. For reference, claims 1-3, 6, 11-12, 14-15, and 18-20 of the ’829 Patent are reproduced below:

1. An injection valve for injecting fuel into a combustion chamber of an internal combustion engine, said injection valve comprising:

- (a) a valve housing comprising:
 - a fuel inlet port;
 - an interior chamber fluidly connected to said fuel inlet port;
 - a nozzle comprising a nozzle orifice providing a fluid passage from said interior chamber to said combustion chamber;
- (b) a valve needle disposed within said valve housing wherein said valve needle is movable between a closed position at which a sealing end of said valve needle contacts a valve seat to fluidly seal said interior chamber from said nozzle orifice, and an open position at which said sealing end of said valve needle is spaced apart from said valve seat whereby said interior chamber is fluidly connected with said nozzle orifice, wherein valve needle lift equals the distance traveled by said sealing end away from said valve seat;
- (c) a needle spring associated with said valve needle, wherein said needle spring applies a closing force to said valve needle for biasing said valve needle in said closed position;
- (d) an actuator assembly associated with said valve needle, wherein said actuator assembly may be activated to apply an opening force to said valve needle stronger than said closing force, for moving said valve needle to said open position; and
- (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.

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.

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.

6. The injection valve of claim 1 wherein said actuator assembly comprises a magnetostrictive member or a piezoelectric stack.

11. 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.

12. The injection valve of claim 11 wherein said lift is controllable by controlling the electric current directed or voltage applied to said respective magnetostrictive or piezoelectric actuator assembly.

14. The injection valve of claim 6 wherein said valve needle is controllable to move between said open and closed positions in less than about 200 microseconds.

15. The injection valve of claim 6 further comprising a compression spring member for applying a compressive force to said magnetostrictive or piezoelectric member.

18. 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).

19. 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.

20. The injection valve of claim 1 wherein said 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.

B. The '138 Patent

1. Effective Filing Date

74. I understand that the application leading to the '138 patent was filed on May 23, 2001.

75. Based on my review of the '138 patent, I note that it both identifies itself as a continuation-in-part of a March 9, 2000 application, and makes reference to an October 15, 1999 provisional application.

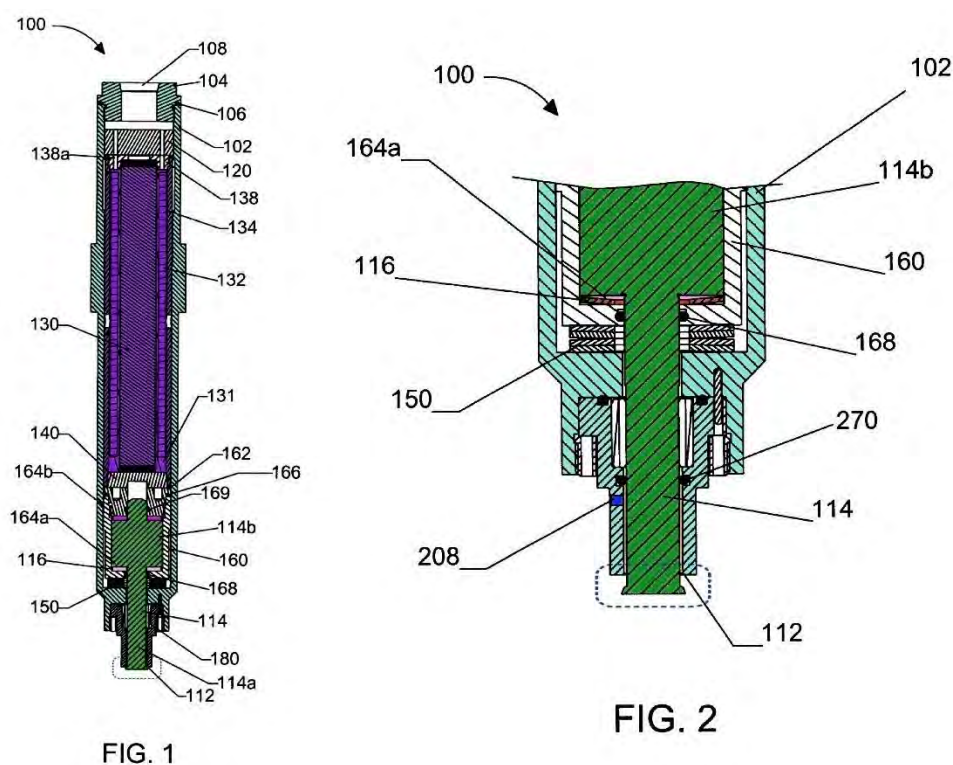
76. For purposes of this declaration, I have been instructed to use October 15, 1999 as the effective filing date of the '138 patent. My opinions in this declaration were formed from the perspective of a POSITA as of October 15, 1999, including both the knowledge of a POSITA at that time as well as how a POSITA would have understood the prior art. Nevertheless, the opinions

I express in this declaration would be the same regardless of whether the '138 patent has an October 15, 1999, a March 9, 2000, or a May 23, 2001 effective filing date.

2. Overview

77. The '138 Patent is a continuation-in-part of the '829 Patent, and, thus, includes a similar specification to the '829 Patent, with some differences as noted below.

78. The below annotated versions of Figures 1 and 2 of the '138 patent provide an example of an “outwardly opening directly actuated fuel injection valve.” ('138 Patent, 8:61-63.)



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

79. The elements of this injector have been annotated as follows:

80. **Teal:** A “valve housing 102” and “[v]alve cap 104” that “provide a fluidly sealed valve body.” (*Id.*, 9:4-6.)

81. **Blue:** A “fuel inlet 208,” as shown in Figure 2. (*Id.*, 13:34.)

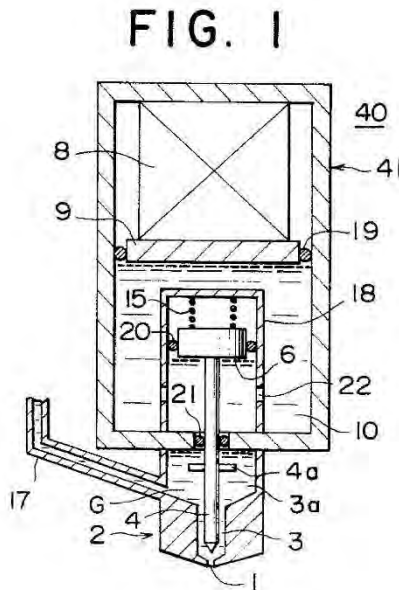
82. **Orange:** The injector interior that receives fuel from the inlet. (*Id.*, 9:4-9.)

83. **Green:** A “valve member 114” located within the injector. (*Id.*, 9:23-27.)
84. **Dashed blue outline:** A “valve seat 112” that is contacted by one end of the valve member 114 to close the injector. (*Id.*, 9:23-27, 59-64.)
85. **Red:** A “valve spring 116” in the form of a “disc or washer spring” (or a “coil spring”) that “biases” the member 114 “in the closed position.” (*Id.*, 10:13-19.)
86. **Purple:** A “magnetostrictive actuator” including a member 130, bobbin 131, coil 132, and flux tube 134 located within the housing. (*Id.*, 10:41-46.)
87. **Pink:** “[H]ydraulic fluid 164b” of “a hydraulic link assembly.” (*Id.*, 11:65-67; 14:16-22.)
88. The ’138 Patent also explains how the injector operates. More particularly, to open the injector, current is applied to the actuator causing it to “grow[] in length.” (*Id.*, 10:51-60.)
89. 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.)
90. “The opening force generated by the actuator assembly is transmitted to valve member 114 through” “hydraulic fluid 164b” of the “a hydraulic link assembly.” (*Id.*, 11:65-67; 14:16-22.) During actuation, fluid “does not have time to flow” out of the space that contains it and fluid 164b thus “acts as a solid.” (*Id.*, 14:26-40.)
91. The patent also explains that the injector allows for “[a]uto-adjustments” via “the migration of hydraulic fluid from chamber 164b on one side of the hydraulic piston 114b to chamber 164a” (**light pink**) “on the other side” of the piston. (*Id.*, 15:14-25.)

3. Prosecution History of the ’138 Patent

92. As noted above, I have reviewed the ’138 Patent’s prosecution history.
93. The originally filed claims were rejected in a November 2002 office action as obvious over U.S. Patent No. 5,630,550 to Kurishige.

94. I have reviewed the Kurishige reference. Fig. 1 of Kurishige is reproduced below:



(Kurishige, Fig. 1.)

95. To open the depicted injector, element 8 is actuated and expands. This then forces piston 9 down. The movement of piston 9 applies force to fluid in chamber 10, shown in the figure, which flows from the outer chamber 10, through holes 22, and into the narrower inner cylinder 18 causing piston 6 to move by an amplified distance. Needle 4, which is connected to the piston 6, then lifts and valve 1 opens. (*Id.*, 5:45-67.)

96. The applicant responded to the Examiner's rejection in February 2003 by noting that Kurishige is 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."

97. The applicant then argued that Kurishige 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."

98. The claims were allowed immediately after this response.

4. The '138 Patent's Claims

99. For reference, claims 1-3, 6, 13-14, 17-21, and 26-28 of the '138 Patent are reproduced below:

1. An injection valve for injecting fuel into a combustion chamber of an internal combustion engine, said injection valve comprising:

(a) a valve housing comprising:

a fuel inlet port;

an interior chamber fluidly connected to said fuel inlet port;
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;

(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;

(c) a biasing mechanism associated with said valve member, said biasing mechanism applying a closing force to said valve member when said valve member is in said closed position;

(d) an actuator assembly associated with said valve member, wherein said actuator assembly may be actuated to apply an opening force to said valve member stronger than said

closing force, for moving said valve member to said open position; and

- (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 actuated and wherein said thickness of said hydraulic link is adjustable while said actuator assembly is not actuated in response to changes in the dimensional relationship between components of said injection valve to maintain a desired valve lift upon actuation of said actuator assembly.

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

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

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

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

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

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

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.

19. The injection valve of claim **6** wherein said valve member is controllable such that said valve member moves between said open and closed positions in less than about 200 microseconds.

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

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

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).

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.

28. The injection valve of claim **1** wherein said valve housing, said valve member 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.

V. DISPUTED TERMS OF THE ASSERTED PATENTS

A. “passive hydraulic link”

Claim	Term, Phrase, or Clause	Plain Meaning To One Of Skill In The Art	Westport’s Construction
'829 Patent, Cl. 1; '138 Patent, Cl. 1	“passive hydraulic link”	sealed hydraulic fluid transmitting actuating forces but not employed to generate an actuating force	Defined by the claim itself: “a hydraulic fluid thickness through which said opening and closing forces are transmitted.”

100. Claim 1 of the '829 Patent and claim 1 of the '138 Patent each recite the term “passive hydraulic link.” The plain and ordinary meaning of this term to a person having skill in the art when reading the '829 Patent and the '138 Patent is: “sealed hydraulic fluid transmitting actuating forces but not employed to generate an actuating force.” The intrinsic record is consistent with, and supports, this plain meaning understanding of the term “passive hydraulic link,” as set forth below.

101. First, the immediate context of this term is the same in both claims of the two patents: “a hydraulic link assembly comprising a passive hydraulic link having a hydraulic fluid thickness through which said opening and closing forces are transmitted.”

102. Second, the specifications of the Asserted Patents distinguish between conventional hydraulic links and the passive hydraulic link disclosed in the Asserted Patents: “Conventional active hydraulic operators are different from 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.” ('829 Patent, 7:14-20; '138 Patent 7:28-34).

103. Third, the applicant, during prosecution of the application of the '829 Patent, indicated that this passage defined the term “passive hydraulic link.” *See* Response dated June 20,

2001 at 4 (“None of the cited references...disclose or suggest a ‘passive’ hydraulic link, as defined in the present specification”) (citing ’829 Patent, 7:14-20).

104. The applicant further defined what this term means during prosecution of the application of the ’138 Patent: “A major difference between a ‘dynamic’ hydraulic system and a ‘passive’ hydraulic system is the presence in dynamic hydraulic systems of fluid passages that allow the hydraulic fluid to flow during an actuation event.” See Response dated February 21, 2003 at 9.

105. The applicant continued: “In passive hydraulic systems like the applicants’, the hydraulic oil is substantially contained, thereby avoiding the flow of hydraulic fluid during an actuation event when the valve member is moving from a closed position to an open position.” *Id.* at 9-10.

106. Thus, starting with the words of the claims themselves read in view of the specifications, and considering the applicant’s discussion during prosecution, in my opinion, a POSITA would understand the term “passive hydraulic link” to mean “sealed hydraulic fluid transmitting actuating forces but not employed to generate an actuating force.”

107. Westport’s construction is incomplete and is not the plain and ordinary meaning of this term. Westport’s construction does not accurately reflect the understanding of one of skill in the art in view of the intrinsic evidence described above.

108. First, Westport’s proposed construction does not account for the hydraulic fluid being sealed, but that is a specific feature of a “passive hydraulic link” as defined and described in the specifications (“the hydraulic fluid sealed within the hydraulic link assembly,” ’829 Patent, 7:14-20; ’138 Patent 7:28-34) and by the applicant during prosecution (“[i]n passive hydraulic

systems like the applicants', the hydraulic oil is substantially contained," '138 Patent Prosecution History, Response dated 2/21/2003 at 9).

109. Westport's construction also excludes the requirement that the hydraulic fluid is not employed to generate an actuating force. This too is explicitly recited in the specification ("the hydraulic fluid...is not employed to generate an actuating force for actuating the valve," '829 Patent, 7:14-20; '138 Patent 7:28-34), which the applicant identified as the definition of the term "passive hydraulic link" during prosecution ("None of the cited references...disclose or suggest a 'passive' hydraulic link, as defined in the present specification," '829 Patent Prosecution History, Response dated June 20, 2001 at 4 (citing '829 Patent, 7:14-20)). That is, this requirement was used by the applicant to distinguish the "passive hydraulic link" from a "dynamic" hydraulic link. Without this requirement, Westport's proposed construction does not distinguish the "passive" hydraulic link from a "dynamic" hydraulic link, and therefore would broaden the scope of the claims to capture subject matter ("dynamic" hydraulic link) that the applicant expressly distinguished and did not consider to be the invention.

110. It is also worth noting that Westport's proposed construction for this term is simply the words of the claim that are already recited in the claim itself: "a hydraulic link assembly comprising a passive hydraulic link having **a hydraulic fluid thickness through which said opening and closing forces are transmitted.**" Westport's proposed construction thus effectively reads the words "passive hydraulic link" out of the claim. As discussed above, I understand that a construction should give a term its plain meaning to one of ordinary skill in the art, and should not read out the claim term.

B. “valve needle”

Claim	Term, Phrase, or Clause	Plain Meaning To One Of Skill In The Art	Westport’s Construction
'829 Patent, Cls. 1, 14, 20	“valve needle”	valve consisting of a slender elongated pointed rod that directly seals interior chamber from combustion chamber	“a valve component having a cylindrical portion with a sealing end”

111. Claims 1, 14, and 20 of the '829 Patent each recite a “valve needle.” The plain and ordinary meaning of this term to a person having skill in the art when reading the '829 Patent is: “valve consisting of a slender elongated pointed rod that directly seals interior chamber from combustion chamber.” The intrinsic record is consistent with, and supports, this plain meaning understanding of the term “valve needle,” as set forth below.

112. The context of the term in claim 1 is “a valve needle disposed within said valve housing wherein said valve needle is movable between a closed position at which a sealing end of said valve needle contacts a valve seat to fluidly seal said interior chamber from said nozzle orifice, and an open position at which said sealing end of said valve needle is spaced apart from said valve seat whereby said interior chamber is fluidly connected with said nozzle orifice.”

113. There are two key differences between my plain meaning construction for this term and Westport’s, which, in my view, is incomplete and not the plain and ordinary meaning of this term. First, Westport’s construction does not account for the valve needle’s role in directly sealing the interior chamber from the combustion chamber. Second, Westport impermissibly broadens the structure recited, interpreting valve needle to be a generic “valve component.” I address each issue in turn below.

114. First, according to the plain meaning of the language of claim 1 quoted directly above, the valve needle must be structured to itself seal and open the fluid path from the “interior

chamber” to the “nozzle orifice” and subsequently the “combustion chamber.” It is not a valve member that could, for instance, be used to simply open an intermediate/pilot control valve that does not open to the combustion chamber.

115. The valve needle is identified as reference numeral 114 in the specification of the '829 Patent and is shown in **green** below:

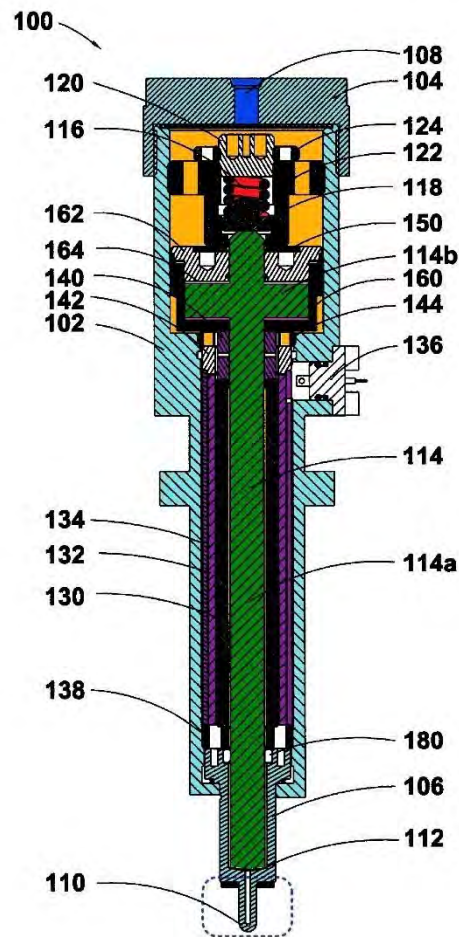


Figure 1

('829 Patent, Fig. 1 (annotated).)

116. As shown in Figure 1 above, and as described in the specification, the “[v]alve needle 114 is disposed within the interior of the valve body and contacts valve seat 112 to close

injection valve 100 by preventing fuel from passing beyond valve seat 112 to nozzle orifice 110.”
'829 Patent, 8:59-62.

117. The “valve needle” as claimed, described in the specification, and shown in the figures of the '829 Patent pertains to a directly actuated injector, and it is my opinion that a POSITA reading the entire '829 Patent would likewise understand the valve needle to be for a directly actuated injector. Significantly, the actuator directly applies forces, transmitted unchanged through the passive hydraulic link, to open and close the injection valve needle, which seals the fluid path to the combustion chamber.

118. In particular, the specification repeatedly and consistently characterizes the “invention” as “an injection valve that is directly controllable.” (*Id.*, 1:12-17.)

119. The specification also explains that the injector meets a “need for an injector that is directly actuated.” (*Id.*, 3:45-48.)

120. Further, the '829 Patent explains that it provides “advantages” and “benefits” because it is a “directly actuated injector.” (*Id.*, 8:18-19; 16:18-20.)

121. For instance, the '829 Patent lists a benefit that the invention “eliminat[es] the need for ... valves that are employed by conventional hydraulically actuated injection valves.” (*Id.*, 16:24-28.) In other words, the directly-actuated injector of the '829 Patent is beneficial because it does not use intermediate/pilot control valves used in “conventional” indirectly actuated fuel injectors.

122. Moreover, the patent contrasts its directly-actuated valve with prior art valves that are indirectly actuated. (*See, e.g., id.*, 3:33-45.)

123. The '829 Patent is even entitled “Directly Actuated Injection Valve.” (*Id.*, Cover.) The first line of the abstract of the '829 Patent recites: “A directly actuated injection valve....” (*Id.*, Abstract.)

124. The only embodiments in the '829 Patent disclose a directly actuated injection valve, where the “valve needle” operates to directly seal the interior chamber of the device from the engine’s combustion chamber. There is no disclosure of a valve needle operating as an intermediate device connecting the interior chamber to some other valve that in turn opens the fluid path from the interior chamber to the internal combustion chamber—thus acting as a pilot valve.

125. The above evidence from the '829 Patent supports my opinion that a POSITA would understand the “invention” described and claimed in the '829 Patent is a specific improvement to a directly actuated injector, and, thus, the valve needle directly seals the interior chamber from the combustion chamber, which is the plain and ordinary meaning of this term in the context of a directly actuated injector. The invention does not pertain to an indirectly actuated injection valve.

126. Westport’s construction, however, appears to impermissibly broaden the term to cover this very different arrangement of an indirectly actuated injection valve—the type of arrangement that the patents criticized and that the invention purports to overcome.

127. The differences between a *directly* actuated injector and an *indirectly* actuated injector are important in understanding the proper interpretation of the term “valve needle.” A directly actuated injector has a single valve, on which the actuator operates. Furthermore, the single valve directly seals the fuel supply from the combustion chamber when this injection valve needle is closed. On the other hand, an indirectly actuated injector has a control valve on which

the actuator operates—a second valve in addition to the injection valve needle. The control valve, in turn, hydraulically changes the injection valve needle opening/closing forces. This latter type of injector is not what is disclosed in the '829 Patent.

128. In my opinion, the term “valve needle” within the '829 Patent must therefore refer to an injection valve needle that separates the injector’s interior chamber from the combustion chamber.

129. As set forth above, the plain and ordinary meaning of the claim language and surrounding context makes it clear that the valve needle opens to the combustion chamber and not any other chamber. The specification is fully consistent with, and supports, this understanding of the term; all disclosed embodiments describe the valve needle opening to the combustion chamber and all figures show the same.

130. Second, Westport’s construction attempts to broaden the term “valve needle” to be a “valve component.” In my opinion, however, the use of the term “needle” indicates that there is a specific structure ascribed to the valve such that it is not simply a “valve component.”

131. A valve can be any variety of mechanical structure. A valve *needle*, however, is a specific type of valve. Specifically, every figure of the '829 Patent shows the valve needle 114 as a slender elongated pointed rod, which is exactly how one of skill in the art would understand the term. (*See, e.g., id.*, Figs. 1-3.) Further, the specification describes the “differential *angle* between the end surface of valve needle 1[1]4 and valve seat 112,” indicating that the valve needle includes an angled tip, i.e., is a slender elongated pointed rod. (*Id.* at 8:50-57.)

132. This interpretation is further supported by the dictionary definition of “needle” at the time of the filing of the '829 Patent: “a slender pointed rod controlling a fine inlet or outlet (as in a valve).” (Ex. B, 3(d).) Similarly, the definition of “needle valve” around this timeframe was

“[a] valve having a slender point fitting into a conical seat, used to regulate accurately the flow of a liquid or gas.” (Ex. C). A POSITA would understand that the terms “valve needle” and “needle valve” are interchangeable. (*See, e.g.*, ’829 Patent at 2:21-23 (using these terms interchangeably).)

133. Additionally, the dictionary distinguishes between a “valve” and a “needle valve,” indicating that a “valve needle” is more specific than just a generic valve. (*See* Ex. C (defining valve as “[a]ny various devices that regulated the flow of gases, liquids, or loose materials through piping or through apertures by opening, closing, or obstructing ports or passageways; *see also* Ex. B (providing similar definition for valve).)

134. By contrast, the ’138 Patent discloses a different valve structure, which uses a valve that is not a needle. (’138 Patent, Figs. 1-3.) This valve is claimed in the ’138 Patent and described as a “valve member”, and the ’138 Patent distinguishes it from a valve needle: “Opposed to a needle valve, which employs a needle that is retracted into the valve body to open the valve, an outward opening injection valve extends a valve member outward and away from the valve body to open the valve. To open an outward opening fuel injection valve for injecting fuel into an engine, a valve member is moved away from a valve seat and towards the combustion chamber.” (’138 Patent, 8:63-9:3.) Also: “Another advantage of an outward opening injection valve is that when the valve is closed, there is less concern about combustion products fouling or clogging the injection valve because unlike a needle valve there are no exposed nozzle holes.” (*Id.*, 9:32-36.)

135. Despite this, Westport construes “valve needle” in the ’829 Patent and “valve member” in the ’138 Patent the same, both as a generic “valve component.” This improperly equates the two and fails to recognize that a valve needle is a specific type of valve, and that a valve member would necessarily be broader.

136. Thus, for all the reasons above, in my opinion, a POSITA would understand the term “valve needle” to mean “valve consisting of a slender elongated pointed rod that directly seals interior chamber from combustion chamber,” which is the plain and ordinary meaning of this term in the context of a directly actuated injector.

C. “valve member”

Claim	Term, Phrase, or Clause	Plain Meaning To One Of Skill In The Art	Westport’s Construction
'138 Patent, Cls. 1, 19, 28	“valve member”	member that directly seals interior chamber from combustion chamber	Defined by the claim itself: a valve component having “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”

137. Claims 1, 19, and 28 of the '138 Patent each recite a “valve member.” The plain and ordinary meaning of this term to a person having skill in the art when reading the '138 Patent is: “member that directly seals interior chamber from combustion chamber.” The intrinsic record is consistent with, and supports, this plain meaning understanding of the term “valve member,” as set forth below.

138. The broader context of the term in claim 1 is “a valve seat for cooperating with a valve member to seal said interior chamber from said combustion chamber when said injection valve is closed; (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.”

139. Thus, according to the language of the claim itself, claim 1 requires a “valve member” that “cooperat[es] with” a “valve seat” “to seal” an “interior chamber from [the] combustion chamber.” (’138 Patent, claim 1.)

140. In my opinion, this shows that it is the valve member itself, and not some other structure, that operates to open and close/seal a fluid path from the injector’s “interior chamber” to the “combustion chamber.”

141. Claim 1 also provides that the “valve member” has “one end disposed within said valve housing and an opposite end extendable from said valve seat toward said combustion chamber.”

142. This means that one end of the “valve member” must exist at a point inside of the housing and the other end must exist on the combustion chamber side of the nozzle valve seat. Furthermore, the valve member opens the nozzle—connecting the injector’s interior chamber to the combustion chamber—by moving away from the nozzle valve seat, towards the combustion chamber. It is not an intermediate valve located entirely inside and within the housing – where the entire valve is located on one side of the valve seat that seals the interior of the injector from the combustion chamber.

143. The valve member is identified as reference numeral 114 in the specification of the ’138 Patent and is shown in **green** below:

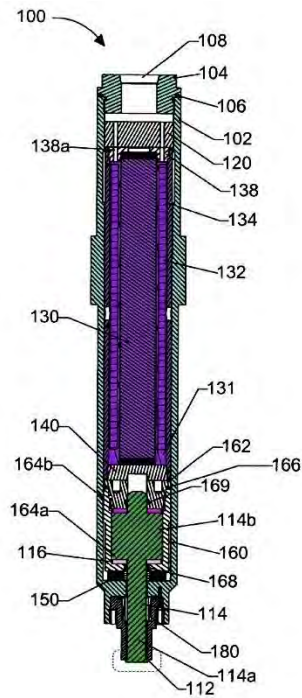


FIG. 1

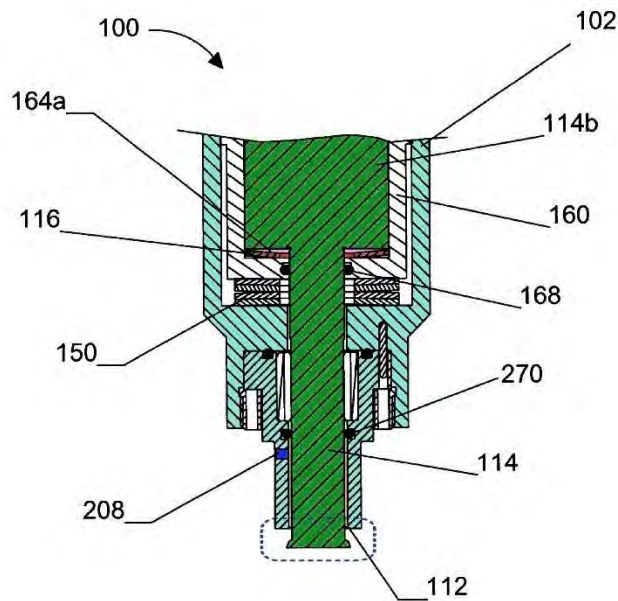


FIG. 2

('138 Patent, Figs. 1-2 (annotated).)

144. As shown in Figures 1-2 above, and as described in the specification, the “valve member 114 is disposed within the interior of valve housing 102 and extends through an opening in the tip of valve housing 102. The sealing surface of valve member 114 contacts valve seat 112 to close injection valve 100 by preventing fuel from passing beyond valve seat 112 and into the combustion chamber.” (*Id.*, 9:59-64.)

145. The “valve member” as claimed, described in the specification, and shown in the figures of the '138 Patent pertains to a directly actuated injector, and it is my opinion that a POSITA reading the entire '138 Patent would likewise understand the valve member to be for a directly actuated injector. Significantly, the actuator directly applies forces, transmitted unchanged through the passive hydraulic link, to open and close the injection valve member,

which seals the fluid path to the combustion chamber, as described above in my discussion of the term “valve needle.”

146. In particular, the specification repeatedly and consistently characterizes the invention is a “directly actuated injector.” (*Id.*, 8:32-33; *see also* Abstract, 1:16-21; 2:66-67; 16:37-39.)

147. Further, the ’138 Patent explains that it provides “advantages” and “benefits” because it is a “directly actuated injector.” (*Id.*, 8:32-33; 16:37-39.)

148. For instance, the ’138 Patent lists a benefit that the invention “eliminat[es] the need for ... the hydraulic fluid control valves that are employed by conventional hydraulically actuated injection valves.” (*Id.*, 16:43-46.) In other words, the directly-actuated injector of the ’138 Patent is beneficial because it does not use intermediate/pilot control valves used in “conventional” indirectly actuated fuel injectors.

149. Moreover, the patent contrasts its directly actuated valve with prior art valves that are indirectly actuated. (*See, e.g., id.*, 2:52-3:7.)

150. The ’138 patent is even entitled “Directly Actuated Injection Valve.” (*Id.*, Cover.)

151. The only embodiments in the ’138 Patent disclose a directly actuated injection valve, where the “valve member” operates to directly seal the interior chamber of the device from the engine’s combustion chamber. There is no disclosure of a valve member operating as an intermediate device connecting the interior chamber to some other valve that in turn opens the fluid path from the interior chamber to the internal combustion chamber.

152. The above evidence from the ’138 Patent supports my opinion that a POSITA would understand the invention described and claimed in the ’138 Patent is a directly actuated

injector, and, thus, the valve member directly seals the interior chamber from the combustion chamber, which is the plain and ordinary meaning of this term in the context of a directly actuated injector. The invention does not pertain to an indirectly actuated injection valve.

153. Westport’s construction, however, is not the plain and ordinary meaning of this term, and, instead, appears to broaden the term to cover this very different arrangement of an indirectly actuated injection valve—the type of arrangement that the patents criticized and that the invention purports to overcome.

154. The differences between a *directly* actuated injector and an *indirectly* actuated injector are important in understanding the proper interpretation of the term “valve member.” A directly actuated injector has a single valve, on which the actuator operates. Furthermore, the single valve directly seals the fuel supply from the combustion chamber when this injection valve member is closed. On the other hand, an indirectly actuated injector has a control valve on which the actuator operates—a second valve in addition to the injection valve member. The control valve, in turn, hydraulically changes the injection valve member opening/closing forces. This latter type of injector is not what is disclosed in the ’138 Patent.

155. In my opinion, the term “valve member” within the ’138 Patent must therefore refer to an injection valve member that separates the injector’s interior chamber from the combustion chamber.

156. As set forth above, the plain and ordinary meaning of the claim language and surrounding context makes it clear that the valve member opens to the combustion chamber and not any other chamber. The specification is fully consistent with, and supports, this understanding of the term; all disclosed embodiments describe the valve member opening to the combustion chamber and all figures show the same.

157. Notably, the '138 Patent's recitation of the term "valve member" is contrasted with the '829 Patent's recitation of the term "valve needle." Both of these terms are described as performing similar functions, i.e., directly sealing the interior chamber from the combustion chamber, but it is clear from the specification and figures of the '138 Patent that the valve member cannot be a valve needle, as that term requires the valve to be a slender elongated pointed rod.

158. Indeed, the specification of the '138 Patent distinguishes the valve member from a valve needle: "Opposed to a needle valve, which employs a needle that is retracted into the valve body to open the valve, an outward opening injection valve extends a valve member outward and away from the valve body to open the valve. To open an outward opening fuel injection valve for injecting fuel into an engine, a valve member is moved away from a valve seat and towards the combustion chamber." ('138 Patent, 8:63-9:3.) Also: "Another advantage of an outward opening injection valve is that when the valve is closed, there is less concern about combustion products fouling or clogging the injection valve because unlike a needle valve there are no exposed nozzle holes." (*Id.*, 9:32-36.)

159. As shown in Figures 1-2 of the '138 Patent above, the valve member 114 is not pointed. Rather, the valve member 114, at its distal end, includes a greater diameter than the opening in the valve housing 102 to ensure the sealing end of the valve member 114 contacts the valve seat 112 in the closed position. (*See id.*, 9:59-10:11.)

160. Thus, for all the reasons above, in my opinion, a POSITA would understand the term "valve member" to mean "member that directly seals interior chamber from combustion chamber," which is the plain and ordinary meaning of this term to one of ordinary skill in the art reading the '138 Patent

D. “fluid passage from said interior chamber to said combustion chamber”

Claim	Term, Phrase, or Clause	Plain Meaning To One Of Skill In The Art	Westport’s Construction
'829 Patent, Cl. 1	“fluid passage from said interior chamber to said combustion chamber”	passage for fuel to flow from the interior chamber to the combustion chamber	“a pathway fluidly connecting the interior chamber and the combustion chamber”

161. Claim 1 of the '829 Patent recites “a fluid passage from said interior chamber to said combustion chamber.” The plain and ordinary meaning of this phrase to a person having skill in the art when reading the '829 Patent is: “passage for fuel to flow from the interior chamber to the combustion chamber.” The intrinsic record is consistent with, and supports, this plain meaning understanding of the claim phrase, as set forth below.

162. The context of the term in claim 1 is “a nozzle comprising a nozzle orifice providing a fluid passage from said interior chamber to said combustion chamber.”

163. The specification of the '829 Patent describes this term as follows:

The movement of valve needle 114 is guided near valve tip 106 by guide 180 (see FIG. 3). FIG. 3 shows annular space 182 disposed around valve stem 114 *a*. Between injection events, fuel remains in annular space 182. When injection valve 100 is open, fuel flows through annular space 182, other gaps between valve components, and openings provided in certain valve components, which all cooperate *to permit the free flow of fuel from inlet port 108 through to nozzle orifice 110* (which may be one of a plurality of nozzle orifices radially oriented from the nozzle throat). For example, FIGS. 1 through 3 show *openings that provide fluid passages through components* such as needle spring housing 122, lock nut 144, and pole 138. FIG. 3 also shows seal 184 between valve housing 102 and valve tip 106, and cylinder head face seal 186, which seals between injection valve 100 and the engine cylinder head (not shown).

('829 Patent, 13:5-20) (emphasis added).

164. As set forth above, the plain and ordinary meaning of the claim language and surrounding context makes it clear that the fluid passage is a passage for fuel to flow from the

interior chamber to the combustion chamber. The specification is fully consistent with, and supports, this understanding of the term; all disclosed embodiments describe the fuel flowing from the interior chamber to the combustion chamber and all figures show the same.

165. As I discussed above, one of skill in the art reading the '829 Patent would understand that the “invention” is an improvement to a “directly actuated injection valve,” not an indirectly actuated injection valve. The only embodiments in the '829 Patent disclose a directly actuated injection valve, where the fuel flows from the interior chamber to the combustion chamber. There is no disclosure of fuel flowing in the opposite direction, i.e., from the combustion chamber to the interior chamber. Westport’s construction, however, is not the plain and ordinary meaning of the term, and, instead, appears to broaden the term to cover this very different arrangement.

166. For similar reasons as set forth above in Section V.B., the “fluid passage from said interior chamber to said combustion chamber” as claimed, described in the specification, and shown in the figures of the '829 Patent pertains to a directly actuated injector.

167. Westport’s proposed construction is not the plain and ordinary meaning of this term, inasmuch as it effectively reads out the direction of the fuel flow.

168. Specifically, the claim recites a “fluid passage **from** said interior chamber **to** said combustion chamber.” ('829 Patent, claim 1 (emphasis added).) In my opinion, based on the operation of directly actuated injectors, this language indicates a specific direction of the fuel flow **from** the interior chamber **to** the combustion chamber. Westport’s proposal, however, simply recites a fluid connection between the interior chamber and the combustion chamber, seemingly allowing for fluid to flow in either direction. This improperly broadens the scope of the claim and reads out a necessary requirement. I understand claims should not be construed to

alter the scope of the plain meaning absent an explicit disavowal or express definition. I have not seen any, and in contrast, the intrinsic evidence, starting with the words of the claims themselves, fully supports my plain meaning construction.

VI. CONCLUSION

169. I reserve the right to supplement, modify, or revise my opinions and constructions based on additional information that is provided to me in this litigation.

170. I hereby declare under penalty of perjury that the foregoing is true and correct; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: December 2, 2022



Dr. J. Matt Quinlan

EXHIBIT A

John “Matt” Quinlan

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EXPERIENCE

Assistant Professor

August 2019 to Present

University of Colorado—Colorado Springs, Colorado Springs, CO

- Designed, constructed, and tested an outwardly-opening pintle fuel injector to study hydrodynamics and atomization
- Designed, constructed, and tested a rocket baffle nonlinear acoustic damping facility, now developing software to calculate the theoretical damping magnitude
- Simulated 3-D detonation wave fronts with detailed (skeletal) chemical models to develop next generation rotating detonation engines
- Developing diffuse interface methods for reacting, two-phase flow simulations
- First co-PI on funded five-year NSF MRI project to purchase and oversee UCCS’s first supercomputer (over 125 TFLOPS) in 2020—installed and rolling out to users currently
- Appointed as a fellow in 2022 and 2020 for the Air Force Research Lab Summer Faculty Fellowship—funding for faculty and graduate student for research at the United States Air Force Academy in combustion diagnostics and detonation simulations
- Was awarded a UCCS CRCW Seed Grant for work in hydrodynamic instabilities
- Taught eleven undergraduate and graduate courses

Consultant/Owner

2005 to Present

Quinlan Engineering and Design, LLC, Woodland Park, CO

- Diesel fuel system design, development, and analysis
- Mechanical component design, structural analysis, and failure analysis
- Combustion instability analysis and mitigation
- Hydraulic hybrid vehicle powertrain design and analysis

Visiting Assistant Professor

August 2018 to August 2019

University of Colorado—Colorado Springs, Colorado Springs, CO

- Taught eight courses over the year

Adjunct Instructor

August 2016 to August 2018

University of Colorado—Colorado Springs, Colorado Springs, CO

Research Engineer

April 2014 to August 2015

Georgia Institute of Technology, Atlanta, GA

- Co-Principal Investigator on NASA supported (about \$150,000/year) acoustic sensing in liquid rocket engine project
- Designed, built, and tested swirling, co-axial rocket injector with adjustable swirl.
- Developed pseudo-linear techniques to analyze high-amplitude acoustic sensor ports

Diesel Fuel System Engineer

2001 to 2006

Sturman Industries, Fuel System group, Woodland Park, CO

- Developed advanced prototype hydraulically intensified diesel fuel injectors, 3000 bar capable
- Developed advanced prototype common-rail diesel fuel injectors
- Primary structural analyst for Fuel System group
- Designed of mechanical components and assemblies for fuel systems
- Created print packages with geometric dimensioning and tolerancing (GD&T)
- Performed installations twice for German universities with a major automobile manufacturer
- Performed dynamometer and emissions mapping

EDUCATION

Doctor of Philosophy, Aerospace Engineering

Georgia Institute of Technology, Atlanta, GA

December 2015

Thesis: Investigation of Driving Mechanisms of Combustion Instabilities
in Liquid Rocket Engines via the Dynamic Mode Decomposition

Advisor: Ben T. Zinn

Concentration: Thermoacoustic instability

Minor: Mathematics

Focus areas: Combustion, acoustics, viscous flow, turbulence, and high-temperature gas dynamics

Research:

- Developed data analysis techniques to experimentally find stability determining Floquet multipliers for systems with periodic governing equations
- Responsible for laboratory-scale facility concept, design, analysis, and development capable of exhibiting full-scale-like combustion instabilities
- Used sub-scale facility to study mechanisms that drive combustion instability, including the acquisition and analysis of data from high-speed diagnostics
- Performed synchronized 10 kHz OH-planar laser induced fluorescence, particle image velocimetry, CH*-chemiluminescence, and acoustic pressure measurements to probe complex reacting/swirling flow
- Developed technique to analyze data based on dynamic mode decomposition, which preserves spatial/temporal relationship between synchronized diagnostics, extracting coupled dynamical modes
- Used the sub-scale facility, two-microphone wave decomposition, and real-time active acoustic impedance control to simulate a full-scale combustion instability at a frequency that is not a natural acoustic frequency of the system
- Wrote a finite element method based code to find the acoustic modes for geometrically complex combustion chambers

Masters of Science, Mechanical Engineering

Colorado State University, Fort Collins, CO

May 2009

Thesis: Combustion Stability in Baffled Rocket Engines

Advisor: Charles E. Mitchell

Co-Advisor: Allan T. Kirkpatrick

Concentration: Thermoacoustic instability

Other focus areas: Structural mechanics

Research:

- Developed and delivered new liquid rocket engine combustion stability code
- Code uses a Fourier matching technique allowing stability predictions for more complex combustion chambers
- Demonstrated ability to locate the stability boundary based on a number of parameters including acoustic mode, frequency, combustion gain, and combustion phase
- Code currently being used by commercial rocket engine manufacturer

Bachelor of Science, Mechanical Engineering

Colorado State University, Fort Collins, CO

May 2001

- Co-Captain FSAE Formula car team, 2000–2001

PUBLICATIONS & PATENTS

Refereed Journals

- Schmidt, E. M., **Quinlan, J. M.**, and Runnels, B. “Self-similar Diffuse Boundary Method for Phase Boundary Driven Flow,” *Physics of Fluids*, Vol. 34, No. 11, 2022.
- Kanagraajan, B., **Quinlan, J. M.**, Bojko, B., and Runnels, B. “A Diffuse Interface Method for Solid-Phase Modeling of Regression Behavior in Solid Composite Propellants,” *Combustion and Flame* Vol. 242, 2022.
- Alsulami, R., Lucas, S., Hageman, M., Knadler, M., **Quinlan, J. M.**, and Windom, B., “Coupling Effects of Physical and Chemical Properties on Jet Fuel Spray Flame Blowout,” *Proceedings of the Combustion Institute* Vol. 38, No. 2, 2021
- **Quinlan, J. M.**, and Zinn, B. T. “Development and Dynamical Analysis of Laboratory Facility Exhibiting Full-Scale Combustion Instability Characteristics,” *AIAA Journal*, Vol 55, No. 12, 2017.
- Emerson, B., Jagtap, S., **Quinlan, J. M.**, Renfro, M. W., Cetegen, B. M., Lieuwen, T. “Stability Analysis of Reacting Wakes: Flow and Density Asymmetry Effects,” *Physics of Fluids*, Vol. 28, No. 4, 2016.
- **Quinlan, J. M.**, Kirkpatrick, A., Milano, D., Mitchell, C. E., and Hinerman, T. D. “Analytical and Numerical Development of a Baffled Liquid Rocket Combustion Stability Code,” *Journal of Propulsion and Power*, Vol. 28, No. 1, 2012.

U.S. Patents

- 8,622,859 – Systems and methods for hybridization of a motor vehicle using hydraulic components – 2014
patentimages.storage.googleapis.com/98/12/19/b5196276017a4a/US8622859.pdf
- 8,366,018 – Oil intensified common rail injectors – 2013
patentimages.storage.googleapis.com/bc/bf/15/7f6af484c4c669/US8366018.pdf
- 8,282,020 – Three-way valves and fuel injectors using the same – 2012
patentimages.storage.googleapis.com/18/27/4d/b43fe73b70ab64/US8282020.pdf
- 7,681,592 – Three-way poppet valves with floating seat – 2010
patentimages.storage.googleapis.com/20/70/33/24dfd50ac9b5e0/US7681592B2.pdf

Journal Manuscripts in Preparation or Review

For current preprints visit www.researchgate.net/profile/Matt-Quinlan

- **Quinlan, J. M.** “Parametric Combustion Instabilities,” *AIAA Journal*.
- **Quinlan, J. M.** “Data Based Analysis of Periodic Phenomena: Floquet Theory Extended Dynamic Mode Decomposition,” *Journal of Fluid Mechanics*.

Conference Papers

- **Quinlan, J. M.** “Parametric Combustion Instabilities,” *AIAA Science and Technologies Forum and Exposition*. Vol. AIAA-2022-1857, San Diego, California, 2022.
- Schmidt, E. M., **Quinlan, J. M.**, and Runnels, B. “Diffuse Interface Method for Coupling of Solid and Gaseous Phases in a 1D Verification Problem for Combustion of AP/HTPB,” *AIAA Science and Technologies Forum and Exposition*. Vol. AIAA-2022-2196, San Diego, California, 2022.
- Day, J. A., Erazo Papagayo, S., and **Quinlan, J. M.** “Baffle Blade Acoustic Damping,” *AIAA Propulsion and Energy Forum*. Vol. AIAA-2021-3573, Denver, Colorado, 2021.
- Erazo Papagayo, S., Day, J. A., Gamertsfelder, J. , Khare, P., and **Quinlan, J. M.** “Pintle Injector Spray Atomization: Liquid Sheet Breakup Quantification,” *AIAA Propulsion and Energy Forum*. Vol. AIAA-2021-3630, Denver, Colorado, 2021.
- Rehl, A., **Quinlan, J. M.**, Scarborough, D., and Zinn, B. T. “Nonlinear Acoustic Response of Stand-Off Tubes Used in Acoustic Pressure Measurements—Part I: Experimental Study,” *170th Meeting of the Acoustical Society of America*. Vol. 2PEA4, Jacksonville, Florida, 2015.

- **Quinlan, J. M.**, Scarborough, D., Rehl, A., and Zinn, B. T. “Nonlinear Acoustic Response of Stand-Off Tubes Used in Acoustic Pressure Measurements—Part II: Analysis,” *170th Meeting of the Acoustical Society of America*. Vol. 2PEA5, Jacksonville, Florida, 2015.
- Damião, A., **Quinlan, J. M.**, Kim, Y. J., and Zinn, B. T. “Determination of Combustion Stability Margin Using the Filter Diagonalization Method,” *51st AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit*. Vol. AIAA-2015-4019, Orlando, Florida, 2015.
- **Quinlan, J. M.**, and Zinn, B. T. “Transverse Combustion Instabilities: Modern Experimental Techniques and Analysis,” *50th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit*. Vol. AIAA-2014-3682, Cleveland, Ohio, 2014.
- **Quinlan, J. M.**, and Zinn, B. T. “Simulating Full-Scale Transverse Combustion Instabilities in a Lab-scale Facility,” *49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit*. Vol. AIAA-2013-4019, San Jose, California, 2013.
- Bibik, A. V., Lubarsky, E., **Quinlan, J. M.**, Shcherbik, D., and Zinn, B. T. “Control of Tangential Combustion Instability by Asymmetric Baffle,” *Critical Phenomena under Extreme Impact (CPUEI-2012)*, Kharkov, Ukraine, 2012.
- **Quinlan, J. M.**, Bibik, O., and Zinn, B. T. “Experimental and Numerical Combustion Instability Modes in Asymmetric Baffled Chambers,” *46th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit*. Vol. AIAA-2010-6802, Nashville, Tennessee, 2010.
- **Quinlan, J. M.**, Kirkpatrick, A., Milano, D., Mitchell, C. E., and Hinerman, T. D. “Analytical and Numerical Development of a Baffled Liquid Rocket Combustion Stability Code,” *45th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit*. Vol. AIAA-2009-4865, Denver, Colorado, 2009.
- Milano, D., **Quinlan, J. M.**, Kirkpatrick, A., Mitchell, C. E., and Hinerman, T. D. “Computation of Acoustic Oscillations and Combustion Stability in a Rocket Engine with Combined Hub/Blade Baffles,” *45th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit*. Vol. AIAA-2009-4866 Denver, Colorado, 2009.
- Wolverton, M. A., Giordano, D., **Quinlan, J. M.**, and Zukouski, R. “Evaluation of a 3-Way Direct Needle Control Unit Injector on Hydraulic Test Bench and V8 Engine,” *2004 SAE World Congress*. Vol. SAE-2004-01-0024, Detroit, Michigan, 2004.

Talks

- **Quinlan, J. M.** “Combustion Instabilities and Nonlinear Acoustic Damping,” *Invited talk—MAE Research Seminar, University of Colorado—Colorado Springs*, Colorado Spring, Colorado, October 2021.
- **Quinlan, J. M.** “Combustion Instabilities and Nonlinear Acoustic Damping,” *Invited talk—MAE Research Seminar, University of Colorado—Colorado Springs*, Colorado Spring, Colorado, October 2020.
- **Quinlan, J. M.** “Global Variational Methods: Numerical Approximations for Ordinary Differential Equations,” *Invited talk—Computational Science & Engineering Seminar, University of Colorado—Colorado Springs*, Colorado Spring, Colorado, July 2019.
- **Quinlan, J. M.** “Swirling Flames and Floquet Multipliers: Parametric Combustion Instabilities,” *Invited talk—Department of Mechanical and Aerospace Engineering, University of Colorado—Colorado Springs*, Colorado Spring, Colorado, March 2019.
- **Quinlan, J. M.**, Kim, Y. J., Damião, A., Yang, V., Zinn, B. T. “Theoretical, Numerical, and Experimental Investigations of the Fundamental Processes that Drive Combustion Instabilities in Liquid Rocket Engines,” *Air Force Office of Scientific Research (AFOSR) 2015 Space Propulsion and Power Contractors Meeting*, Arlington, Virginia, 2015.
- **Quinlan, J. M.**, Kim, Y. J., Damião, A., Yang, V., Zinn, B. T., Law, C. K. “Theoretical, Numerical, and Experimental Investigations of the Fundamental Processes that Drive Combustion Instabilities in Liquid Rocket Engines,” *Triservice Basic Science Energetic Materials Program Review*, Arlington, Virginia, 2014.
- **Quinlan, J. M.**, Kim, Y. J., Damião, A., Yang, V., Zinn, B. T., Law, C. K. “Theoretical, Numerical, and Experimental Investigations of the Fundamental Processes that Drive Combustion Instabilities in Liquid Rocket Engines,” *Air Force Office of Scientific Research (AFOSR) 2013 Space Propulsion and Power Contractors Meeting*, Arlington, Virginia, 2013.

- **Quinlan, J. M.**, Kim, Y. J., Baroncelli, M., Dumitrache, C., Zinn, B. T. “Development Of Actively Controlled LRE Simulator (ACLRES) Rig,” *Air Force Office of Scientific Research (AFOSR) 2012 Space Propulsion and Power Contractors Meeting*, Arlington, Virginia, 2012.

HONORS

<i>Fellowship:</i> Air Force Research Lab Summer Faculty Fellowship	2022
AFOSR Appointed as a fellow at the USAFA to perform research simulating detonations for application to rotating detonation engines; grant received with student Santiago Erazo for summer research	
<i>Fellowship:</i> UCCS Undergraduate Research Academy	2022
University of Colorado—Colorado Springs Research grant received with undergraduate student Duncan Schlueter for summer research	
<i>Fellowship:</i> UCCS Undergraduate Research Academy	2021
University of Colorado—Colorado Springs Research grant received with undergraduate student Sarah Chancellor for summer research	
<i>Fellowship:</i> Air Force Research Lab Summer Faculty Fellowship	2020
AFOSR Appointed as a fellow at the USAFA to perform research on combustion diagnostics for mono-propellant, pintle injectors for various liquids; grant received with student Joseph Day for summer research	
<i>Fellowship:</i> UCCS Undergraduate Research Academy	2019
University of Colorado—Colorado Springs Research grant received with undergraduate student Joseph Day for summer research	
<i>Fellowship:</i> UCCS EAS Undergraduate Research Scholars Program	2019
University of Colorado—Colorado Springs Research grant received with undergraduate student Joseph Day	
<i>Scholarship:</i> Combustion Energy Frontier Research Center—Summer School	2012
Princeton University , Princeton, NJ Combustion Theory and Internal Combustion Engines	
<i>Scholarship:</i> Combustion Energy Frontier Research Center—Summer School	2011
Princeton University , Princeton, NJ Combustion Theory and Combustion Chemistry	

TEACHING

Principles of Combustion (full responsibility for course—Grad) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Fall 2022
Control of Aero. and Mech. Systems (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Fall 2022
Compressible Flow (full responsibility for course—Grad) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Spring 2022
Control of Aero. and Mech. Systems (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Spring 2022
Rocket Propulsion (full responsibility for course—Grad) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Fall 2021
Control of Aero. and Mech. Systems (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Fall 2021
Incompressible Flow (full responsibility for course—Grad) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Spring 2021
Engineering Thermodynamics II (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Spring 2021
Engineering Thermodynamics II (full responsibility for course—two sections) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Fall 2020
Principles of Combustion (full responsibility for course—Grad) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Spring 2020
Engineering Thermodynamics II (full responsibility for course—two sections) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Fall 2019
Control of Aero. and Mech. Systems (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Summer 2019
Machine Design I (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Spring 2018
Materials Engineering (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Spring 2018
Engineering Measurement Lab (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Spring 2018
Machine Design I (full responsibility for course—two sections) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Fall 2018
Engineering Mechanics I (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Fall 2018
Engineering Measurement Lab (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Fall 2018
Control of Aero. and Mech. Systems (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Summer 2018
Liquid Rocket Engines: Fundamentals and Green Propellants <i>AIAA Joint Propulsion Conference Short Course, Cincinnati, OH</i>	Summer 2018

Control of Aero. and Mech. Systems (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Spring 2018
Engineering Thermodynamics II (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Spring 2017
Engineering Mechanics II (full responsibility for course) <i>University of Colorado—Colorado Springs, Colorado Springs, CO</i>	Fall 2016
Introduction to Thermal Sciences (full responsibility for course) <i>Colorado State University, Fort Collins, CO</i>	Summer 2008
<i>Teaching Assistant –</i> Mechanics and Thermodynamics of Flow Processes <i>Colorado State University, Fort Collins, CO</i>	Fall 2008
<i>Mentoring – Undergraduate and Graduate Students</i> <i>Georgia Institute of Technology, Atlanta, GA</i>	2010 to 2015
• Mentored one PhD student—primary supervisor of his research • Mentored two Masters students, both went on to pursue doctoral degrees • Supervised undergraduate research with multiple students for multiple semesters	

DISSERTATION AND THESIS COMMITTEES

<i>Committee member</i> Sean Coughenour—Masters of Science in Mechanical Engineering “Design and Validation of a Microbubble Levitation Chamber Using an Acoustic Vortex Beam” University of Colorado—Colorado Springs, Colorado Springs, CO	2022
<i>Committee member</i> Andrew Gibson—Masters of Science in Mechanical Engineering “Application of Koopman Linear Quadratic Regulator to the Control of a Spherical Microbubble” University of Colorado—Colorado Springs, Colorado Springs, CO	2022
<i>Committee member</i> Danny Paredes—Masters of Science in Mechanical Engineering “Inviscid Flow Past Canonical Bodies” University of Colorado—Colorado Springs, Colorado Springs, CO	2021
<i>Committee member</i> Lluís Umbert Amat—Masters of Science in Mechanical Engineering “Tethered Aerobraking Design for Repeatable Maneuvers” University of Colorado—Colorado Springs, Colorado Springs, CO	2020

SERVICE

Committees

- Technical Discipline Co-Chair—AIAA SciTech Liquid Propulsion Technical Committee 2023
- Member—UCCS CRCW Seed Grant Review Committee 2022
- Technical Discipline Chair—AIAA SciTech Liquid Propulsion Technical Committee 2022
- Member—AIAA Liquid Propulsion Technical Committee 2015–2022
 - Education Subcommittee
 - Helped develop and teach content for rocket propulsion short course
 - Chaired technical sessions
- Member—UCCS Aerospace BS/MS Degree Committee 2021–2022
- Member—UCCS INCLINE (supercomputer) Management Committee 2020–2022
- Member—UCCS MAE Graduate Committee 2019–2022
- Member—UCCS MAE Instructor Hiring Committee 2019–2020
- Volunteer reviewer—interviewed candidates for the 2020 Georgia Tech President’s Scholars Program (four-year, full-ride scholarship for the top incoming student) and our recommended student was selected for the award 2020
- Member—UCCS MAE Curriculum Committee 2018–2019
- Member—ASA Engineering Acoustics Technical Committee 2016–2018
- Member—Aerospace Engineering Combustion Laboratory/Carbon-Neutral Energy Solutions Laboratory Safety Committee 2012–2015
 - Helped develop and implement formal Safety Review Process plan to ensure safe operation of laboratory facilities and experiments
- Member—Combustion Laboratory Long Term Planning Committee 2014
 - Helping formulate a 10-year plan for the direction of the laboratory
- Advisor—Aerospace Engineering Manufacturing and Prototyping Faculty Task Force 2014
 - Recommended equipment and personnel that should be available to students to properly learn about manufacturing processes and communication
- Member—Aerospace Engineering Combustion Laboratory Calibration Committee 2013
 - Committee proposed equipment and processes to properly calibrate the most commonly used measurements in the laboratory
- Member—Particle Image Velocimetry Error Analysis Group 2011–2012
 - Group organized to study and attempt to quantify the level and sources of experimental error

Peer Review

- Reviewer—Combustion and Flame 2022
- Reviewer—AIAA SciTech Forum 2022
- Reviewer—AIAA Propulsion & Energy Conference 2016–2021
- Reviewer—Journal of Propulsion and Power 2015, 2021
- Reviewer—AIAA Journal 2019
- Reviewer—Journal of the Acoustical Society of America 2018
- Reviewer—ASME Turbo Expo: Turbine Technical Conference 2015, 2017, 2018, 2019
- Reviewer—ACS PRF grants 2020

Organizations

- Order of the Engineer
- American Institute of Aeronautics and Astronautics

SKILLS

Certifications: Passed Fundamentals of Engineering Examination – 2000

Qualified to take Professional Engineering licensing exam

Programing Languages & Software: Fortran, Python, Julia, Git, CMake, LaTeX, Maple, Matlab, Tecplot, Chemkin, Cosmos (structural FEA), Abaqus (structural FEA), Mathcad, Ricardo Wave (engine simulation), Fluent (CFD), SolidWorks, Ubuntu, and Microsoft Office

Fabrication: CNC machining, EDM machining, milling, turning, forging, grinding, diamond tooling, engine building, MIG, TIG, and arc welding, injection molding, vacuum/pressure casting, metal matrix composites, material selections, heat treating, and carbon fiber composites

EXTRACURRICULAR ACTIVITIES

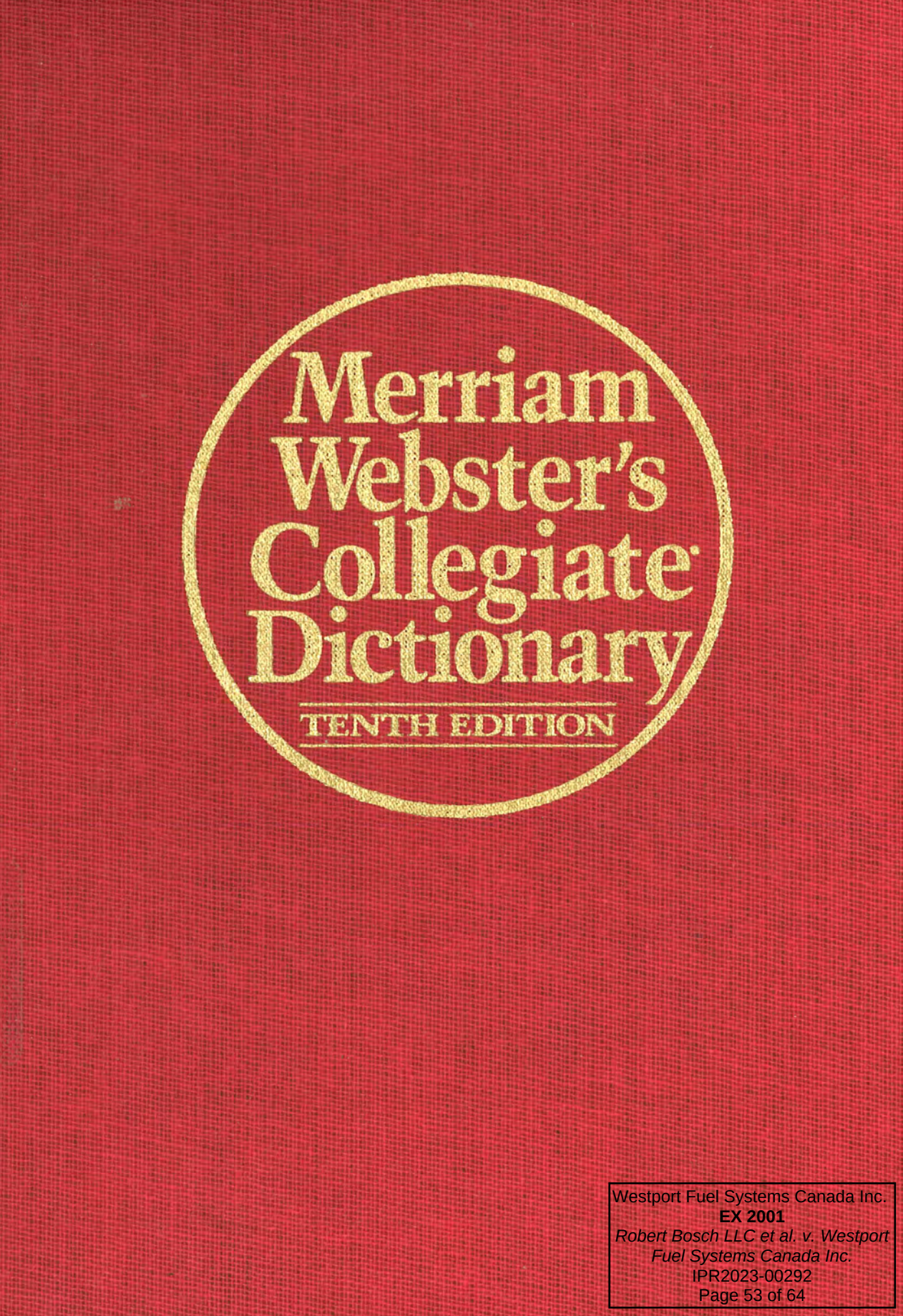
Outdoor Enthusiast

- Climbed Mount Rainer, July 2005
- Completed Imogene Pass Run three times (17.1 miles and over 5,000 feet elevation gain)

Avid Photographer

- 24 years experience developing film and photographs in personal darkroom
- Gallery Visitors' Choice Award during 2007 "Alternative Processes" show at nationally known Center for Fine Art Photography

EXHIBIT B

The image shows the front cover of the Merriam Webster's Collegiate Dictionary, Tenth Edition. The cover is a deep red color with a fine, woven texture. In the center, there is a large, thin gold-colored circle. Inside this circle, the title "Merriam Webster's Collegiate Dictionary" is printed in a gold-colored serif font, arranged in four lines. Below the title, the words "TENTH EDITION" are printed in a smaller, gold-colored, all-caps sans-serif font, flanked by two horizontal gold lines.

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EX 2001

**Robert Bosch LLC et al. v. Westport
Fuel Systems Canada Inc.**

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neat *adv* (1649): without admixture or dilution: STRAIGHT
neat-en \ne-'n- / **vt** **neat-ened**; **neat-en-ing** \ne-'n- / (1898) 1: to set in order; make neat 2: to finish (as a piece of sewing) carefully
neath \ne-'th / *prep* (1787) *dial*: BENEATH
neat-herd \ne-'hord / *n* (14c): HERDSMAN
neat's-foot oil \ne-'ts-fut- / *n* (1787): a pale yellow fatty oil made esp. from the bones of cattle and used chiefly as a leather dressing
neb \ne-'b / [ME, fr. OE; akin to ON *nef* *beak*] (bef. 12c) 1 a: the beak of a bird or tortoise; BILL b *chiefly dial*: a person's mouth c: NOSE 1, SNOUT 2: NIB, TIP
neb-bishy \ne-'bish- / *n* [Yiddish *nebekh* poor, unfortunate, fr. Czech *nebohy*] (1951): a timid, meek, or ineffectual person — **neb-bishy** \bi-'sh- / *adj*
ne-ben-kern \nə-'bən-kərn-, -kərn- / *n* [G, lit., subsidiary nucleus] (1898): a 2-stranded helical structure of the proximal tail region of a spermatozoon that is derived from mitochondria
neb-u-la \ne-'byə-lə / *n*, *pl* -lae \-l- / also -las [NL, fr. L, mist, cloud; akin to OHG *nebul* fog, Gk *nephelē*, *nephos* cloud] (ca. 1738) 1: any of numerous clouds of gas or dust in interstellar space 2: GALAXY: esp.: a galaxy other than the Milky Way galaxy — not used technically — **neb-u-lar** \-lə- / *adj*
nebular hypothesis *n* (1837): a hypothesis in astronomy: the solar system has evolved from a hot gaseous nebula
neb-ulize \ne-'byə-līz- / *vt* -lized; -lizing [L *nebulā*] (1872): to reduce to a fine spray — **neb-ul-iz-a-tion** \ne-'byə-lā-'zā-shən- / *n* — **neb-ul-izer** \ne-'byə-lī-zər- / *n*
neb-u-los-ity \ne-'byə-lā-'sə-tē / *n*, *pl* -ties (1761) 1: the quality or state of being nebulous 2: nebulous matter; also: NEBULA 1
neb-u-lous \ne-'byə-ləs- / *adj* [L *nebulosus* misty, fr. *nebulā*] (1784) 1: of, relating to, or resembling a nebula 2: INDISTINCT, VAGUE — **neb-u-lously** *adv* — **neb-u-lous-ness** *n*
nece-sar-i-ly \ne-'sə-sə-'rē- / *adv* (15c) 1: of necessity: UNAVOIDABLY 2: as a logical result or consequence
nece-sary \ne-'sə-'sə-'rē- / *adj* [ME *necessarie*, fr. L *necessarius*, fr. *necesse* necessary, prob. fr. *ne-* not + *cedere* to withdraw — more at NO] (14c) 1 a: of an inevitable nature: INESCAPABLE b (1): logically unavoidable (2): that cannot be denied without contradiction c: determined or produced by the previous condition of things d: COMPULSORY 2: absolutely needed: REQUIRED
necessary *n*, *pl* -saries (14c): an indispensable item: ESSENTIAL
necessary condition *n* (1817) 1: a proposition whose falsity assures the falsity of another 2: a state of affairs that must prevail if another is to occur: PREREQUISITE
ne-ces-si-tar-i-an-ism \ni-'se-sə-'tēr-ē-ā-, -ni-zəm- / *n* (1854): the theory that results follow by invariable sequence from causes — **ne-ces-si-tar-i-an** \-tēr-ē-ā- / *adj* or *n*
ne-ces-si-tate \ni-'se-sə-'tāt- / *vt* -tated; -tating (1628) 1: to make necessary: REQUIRE 2: FORCE, COMPEL — **ne-ces-si-ta-tion** \-se-sə-'tā-shən- / *n*
ne-ces-si-tous \ni-'se-sə-'təs- / *adj* (1611) 1: NEEDY, IMPOVERISHED 2: URGENT, PRESSING 3: NECESSARY — **ne-ces-si-tous-ly** *adv* — **ne-ces-si-tous-ness** *n*
ne-ces-si-ty \ni-'se-sə-'tē-, -sē-tē- / *n*, *pl* -ties [ME *necessite*, fr. MF *necessité*, fr. L *necessitas*, *necessitas*, fr. *necesse*] (14c) 1: the quality or state of being necessary 2 a: pressure of circumstance b: physical or moral compulsion c: impossibility of a contrary order or condition 3: the quality or state of being in need; esp.: POVERTY 4 a: something that is necessary: REQUIREMENT b: an urgent need or desire — *of necessity*: in such a way that it cannot be otherwise; also: as a necessary consequence
neck \nek- / [ME *nekke*, fr. OE *hnecca*; akin to OHG *hnac* nape] (bef. 12c) 1 a (1): the part of an animal that connects the head with the body (2): the siphon of a bivalve mollusk (as a clam) b: the part of a garment that covers or is next to the neck 2: a relatively narrow part suggestive of a neck; as a (1): the constricted end of a bottle (2): the slender proximal end of a fruit b: CERVIX 2 c: the part of a stringed musical instrument extending from the body and supporting the fingerboard and strings d: a narrow stretch of land e: STRAIT 1b f: the part of a tooth between the crown and the root — see TOOTH illustration g: a column of solidified magma of a volcanic pipe or laccolith 3: a narrow margin (won by a ~) 4: REGION, PART (my ~ of the woods)
neck *vt* (1842) 1: to kiss and caress amorously 2: to reduce in diameter ~ *vi* 1: to engage in amorous kissing and caressing 2: to become constricted: NARROW
neck and neck *adv* or *adj* (1799): very close (as in a race)
necked \nek- / *adj* (14c): having a neck esp. of a specified kind — often used in combination (long-necked)
neck-er-chief \nek-ər-'chāf-, -chēf-, -chēf- / *n*, *pl* -chiefs also -chieves [see HANDKERCHIEF *pk*] [ME *nekkerchief*, fr. *nekke* + *kerchief* *kerchief*] (14c): a kerchief for the neck
neck-ing \nek- / *n* (1804): a narrow molding near the top of a column or pilaster 2: the act or practice of kissing and caressing amorously
neck-line \nek-'lās- / *n* (ca. 1590): an ornament worn around the neck
neck-line \nek-'līn- / *n* (1904): the line of the neck opening of a garment
neck-rein \-rēn- / *vi* (1940) of a saddle horse: to respond to the pressure of a rein on one side of the neck by turning in the opposite direction ~ *vt*: to direct (a horse) by pressures of the rein on the neck
neck-tie \-tī- / *n* (1838): a narrow length of material worn about the neck and tied in front; esp.: FOUR-IN-HAND
neck-wear \-wə-, -wər- / *n* (ca. 1879): articles of clothing (as ties and scarves) worn about the neck
neer- or **neero-** *comb form* [LL, fr. Gk *nekr-*, *nekrō-*, fr. *nekros* dead body — more at NOXIOUS] 1: those that are dead (*neerophilia*) 2: one that is dead (*neeropsy*)
ne-cro-log-y \nə-'krā-lə-jē-, ne- / *n*, *pl* -gies [NL *neurologium*, fr. *neer-* + *logia* (as in ML *neurologia* eulogy)] (1799) 1: OBITUARY 2: a list of the recently dead — **ne-cro-log-ic-al** \ne-'krā-lā-'jē-kəl- / *adj* — **ne-cro-log-ist** \nə-'krā-lā-'jē-, ne- / *n*
ne-cro-man-cy \ne-'krā-'man(t)-sē- / *n* [alter. of ME *nigromantie*, fr. MF, fr. ML *nigromantia*, by folk etymology fr. LL *necromantia*, fr. L Gk *nekromanteia*, fr. Gk *nekr-* + *-manteia* -mancy] (1522) 1: conjuration of the spirits of the dead for purposes of magically revealing the future or influencing the course of events 2: MAGIC, SORcery — **ne-cro-man-cer** \-sər- / *n* — **ne-cro-man-tic** \ne-'krā-'man-tik- / *adj* — **ne-cro-man-ti-cal-ly** \-ti-k(ə)-lē- / *adv*
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needlefish 1

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necro- or **necr-** *pref.* 1. Dead body; corpse: *necrophilia*. 2. Death: *necrobiosis*. [Greek *nekro-*, from *nekros*. See **nek-** in Appendix.]

nec-ro-bi-o-sis (nĕk'rō-bī-ō'sis) *n.* The natural death of cells or tissues through aging, as distinguished from necrosis or pathological death. —**nec-ro-bi-ot'ic** (-ō'tik) *adj.*

nec-crol-o-gy (nā-krōl'ō-jē, nē-) *n., pl. -gies*. 1. A list of people who have died, especially in the recent past or during a specific period. 2. An obituary. —**nec-ro-log'ic** (nĕk'rā-lōj'ik), **nec-ro-log'i-cal** *adj.* —**nec-crol-o-gist** *n.*

nec-ro-man-cy (nĕk'rā-mān'sē) *n.* 1. The practice of supposedly communicating with the spirits of the dead in order to predict the future. 2. Black magic; sorcery. 3. Magic qualities. [Alteration of Middle English *nigromancie*, from Old French *nigremancie*, from Medieval Latin *nigromantia*, alteration (influenced by Latin *niger*, black) of Late Latin *necromantia*, from Greek *nekromanteia*: *nekros*, corpse; see **nek-** in Appendix + *manteia*, divination; see **-MANTY-**.] —**nec-ro-man'cer** *n.* —**nec-ro-man'tic** (-mān'tik) *adj.*

nec-ro-pha-gia (nĕk'rā-fā'jō) *n.* The act or practice of feeding on dead bodies or carrion.

nec-croph-a-gous (nā-krōf'ā-gōs, nē-) *adj.* Feeding on carrion or corpses: *necrophagous organisms*.

nec-ro-phil-i-a (nĕk'rā-fil'ē-ā) also **nec-ro-ph'i-lism** (nĕk'rōf'ā-liz'm, nē-) *n.* 1. Obsessive fascination with death and corpses. 2. Erotic attraction to or sexual contact with corpses. —**nec-ro-phil'i-ac'** (-ē-āk') *adj.* & *n.* —**nec-ro-phile'** (-fil') *n.* —**nec-ro-phil'ic** (-fil'ik) *adj.*

nec-ro-pho-bi-a (nĕk'rā-fō-bē-ā) *n.* An abnormal fear of death or corpses. —**nec-ro-pho-bic** *adj.*

nec-crop-o-lis (nā-krōp'ā-lis, nē-) *n., pl. -lis-es* or *-leis* (-lās'). A cemetery, especially a large and elaborate one belonging to an ancient city. [Greek *nekropolis*: *nekro-*, *necro-* + *polis*, city; see **pelo-** in Appendix.]

nec-ro-py (nĕk'rōp'sē) *n., pl. -sies*. See **autopsy** (sense 1). —**nec-ro-py** *v.*

nec-crose (nē-krōs', -krōz', nĕk'rōs', -rōz') *intr. & tr.v.* -**crosed**, -**cros-ing**, -**cros-es**. To undergo or cause to undergo necrosis. [Back-formation from **NECROSIS**.]

nec-cro-sis (nā-krō'sis, nē-) *n., pl. -ses* (-sēz'). Death of cells or tissues through injury or disease, especially in a localized area of the body. [Late Latin *necrosis*, a causing to die, killing, from Greek *nekrosis*, death, from *nekroun*, to make dead, from *nekros*, corpse. See **nek-** in Appendix.] —**nec-crot'ic** (-krōt'ik) *adj.*

nec-ro-tize (nĕk'rā-tiz') *intr. & tr.v.* -**tized**, -**tiz-ing**, -**tiz-es**. To undergo necrosis or cause to necrose.

nec-crot-o-my (nĕk'rōt'ō-mē, nē-) *n., pl. -mies*. 1. Surgical excision of dead tissue. 2. Dissection of a dead body.

nec-tar (nĕk'tar) *n.* 1. A sweet liquid secreted by flowers of various plants, consumed by pollinators, such as hummingbirds and insects, and gathered by bees for making honey. 2. Greek & Roman Mythology. The drink of the gods. 3. A delicious or invigorating drink. [Latin, from Greek *nektar*. See **nek-** in Appendix.] —**nec-tar-ous** *adj.*

nec-tar-ine (nĕk'tā-rēn') *n.* A variety of aromatic peach of ancient origin, having a smooth, waxy skin. [From obsolete *nectarine*, sweet as nectar, from **NECTAR**.]

nec-ta-ry (nĕk'tā-rē) *n., pl. -ries*. A glandlike organ, located outside or within a flower, that secretes nectar. [New Latin *nectarium*, from **NECTAR**.] —**nec-tar'i-al** (-tār'ē-ol) *adj.*

Ne-der-land (nē'dar-lānd') *n.* A city of southeast Texas between Beaumont and Port Arthur. Population, 16,855.

née also **nee** (nā) *adj.* 1. Born. Used to indicate the maiden name of a married woman. 2. *Usage Problem*. Formerly known as. [French, feminine past participle of *naitre*, to be born, from Old French *naistre*, from Latin *nāsci*. See **geno-** in Appendix.]

USAGE NOTE: The traditional conventions of address dictate that *née* or *nee* be followed only by a family name (which is, to be sure, the only name one has at birth): *Mrs. Mary Parks, née Case*, not *née Mary Case*. • *Née* is a feminine form in French, and both its spelling and its pronunciation indicate that it has not been fully nativized. Its use to describe men who have changed their names is likely to raise eyebrows among people who recognize the etymology of the word, unless the intention is clearly jocular. A phrase like *John Smith, née Schmidt*, would be more accurately — and less affectedly — paraphrased with an unexceptionally English word such as *born* or *formerly known as*.

need (nēd) *n.* 1. A lack of something required or desirable: *crops in need of water*; *a need for affection*. 2. Something required or wanted; a requisite: *Our needs are modest*. 3. Necessity; obligation: *There is no need for you to go*. 4. A condition of poverty or misfortune: *The family is in dire need*. —**need v.** **need-ed**, **need-ing**, **needs**. —**need aux.** To be under the necessity of or the obligation to: *They need not come*. —**tr.** To have need of; require: *The family needs money*. —**intr.** 1. To be in need or want. 2. To be necessary. [Middle English *neede*, from Old English *nēod*, *nēd*, distress, necessity.]

SYNONYMS: *need, necessity, exigency, requisite*. These nouns denote a condition in which something essential is required or wanted; they also refer to that which is required or wanted. *Need* is the most general: *There's no need to be concerned. She is serene and*

contented; her emotional and spiritual needs are being met. Necessity more strongly than *need* suggests urgency, inevitability, or unavoidable obligation: *"I think the necessity of being ready increases. — Look to it"* (Abraham Lincoln). *"The rehabilitation of the cabin became a necessity"* (Bret Harte). *Exigency* implies acute urgency, especially that arising from conditions or circumstances such as those of an emergency: *"No . . . more pernicious [doctrine] was ever invented . . . than that any of [the Constitution's] provisions can be suspended during any of the great exigencies of government"* (David Davis). *Requisite* applies to something indispensable: *"a place where the three grand requisites of water, fuel and fodder were to be obtained"* (James Fenimore Cooper). See also **Synonyms at lack**.

USAGE NOTE: Depending on the sense, the verb *need* behaves sometimes like an auxiliary verb (such as *can* or *may*) and sometimes like a main verb (such as *want* or *try*). When used as a main verb, *need* agrees with its subject, takes to before the verb following it, and combines with *do* in questions, negations, and certain other constructions: *He needs to go. Does he need to go so soon? He doesn't need to go*. When used as an auxiliary verb, *need* does not agree with its subject, does not take to before the verb following it, and does not combine with *do*: *He needn't go. Need he go so soon?* The auxiliary forms of *need* are used primarily in present-tense questions, negations, and conditional clauses. They differ subtly in meaning from the main verb forms in that they always refer to an externally imposed obligation. Hence one might say *You needn't* (or less formally, *don't need to*) *fill out both forms*, but where the sense of necessity is internal to the subject, only the main verb can be used: *I don't need to* (not *needn't*) *be told how to manage my own affairs*. Note also that the use of *need* as an auxiliary is often accompanied by a presupposition that the activity in question has in fact been performed. *The boys needn't have spoken frankly* implies that they did in fact speak frankly, whereas the sentence *The boys did not need to speak frankly* does not; only the latter could be followed by a clause like *they conveyed their meanings by indirection*.

need-ful (nēd'fəl) *adj.* Necessary; required. See **Synonyms at indispensable**. —**need-ful-ly** *adv.* —**need-ful-ness** *n.*

Need-ham (nē'dəm). A town of eastern Massachusetts; a mainly residential suburb of Boston. Population, 27,901.

nee-dle (nēd'l) *n.* 1. *a.* A small, slender implement used for sewing or surgical suturing, made usually of polished steel and having an eye at one end through which a length of thread is passed and held. *b.* Any one of various other implements, such as one used in knitting or crocheting. 2. A small, pointed stylus used to transmit vibrations from the grooves of a phonograph record. 3. *a.* A slender pointer or indicator on a dial, scale, or similar part of a mechanical device. *b.* A magnetic needle. 4. *a.* A hypodermic needle. *b.* Informal. A hypodermic injection; a shot. 5. A narrow stiff leaf, as those of conifers. 6. A fine, sharp projection, as a spine of a sea urchin or a crystal. 7. A sharp-pointed instrument used in engraving. 8. Informal. A goading, provoking, or teasing remark or act. —**needle v.** -**dled**, -**dling**, -**dles**, -**ly**. 1. To prick, pierce, or stitch with a small, slender, sharp-pointed implement. 2. Informal. To goad, provoke, or tease. 3. Slang. To increase the alcoholic content of (a beverage). —**intr.** To sew or do similar work with a small, slender, sharp-pointed implement. [Middle English *nedle*, from Old English *nēd*. See **(s)nē-** in Appendix.] —**nee'dler** *n.*

nee-dle-craft (nēd'l-kraft') *n.* The art or process of needle work.

nee-dle-fish (nēd'l-fish') *n., pl. needlefish* or *-fish-es*. 1. Any of several marine fishes of the family Belontiidae, having slender bodies, needlelike teeth, and narrow jaws. 2. Any of various other fishes, such as the pipefish, having projecting jaws.

needle grass *n.* See **feather grass**.

nee-dle-point (nēd'l-point') *n.* 1. Decorative needlework on canvas, usually in a diagonal stitch covering the entire surface of the material. 2. A type of lace worked on paper patterns with a needle. In this sense, also called *point lace*. —**nee'dle-point'ly** *adv.*

need-less (nēd'lis) *adj.* Not needed or wished for; unnecessary. —**need-less-ly** *adv.* —**need-less-ness** *n.*

needle valve *n.* A valve having a slender point fitting into a conical seat, used to regulate accurately the flow of a liquid or gas.

nee-dle-work (nēd'l-würk') *n.* Work, such as sewing or embroidery, that is done with a needle.

need-n't (nēd'nt). *Need not*.

needs (nēdz) *adv.* Of necessity; necessarily: *We must needs go*. [Middle English *needes*, from *neede*, from Old English *nēde*, *nēd*, *neede*, necessity. See **NEED**.]

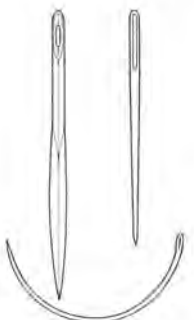
need-y (nēd'ē) *adj.* -**i-er**, -**i-est**. Being in need; impoverished. See **Synonyms at poor**. —**need-i-ness** *n.*

Né-el (nā-ēl'). Louis Eugène Félix. Born 1904. French physicist. He shared a 1970 Nobel Prize for his research on magnetism. **neem** (nēm) *n.* A tall, usually evergreen East Indian tree (*dirachta indica*) widely cultivated in tropical Asia for its timber, resin, bitter bark, and aromatic seed oil. [Hindi *nīm*, from Sanskrit *nimbah*.]

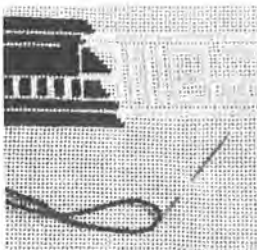
Nee-nah (nē'na). A city of eastern Wisconsin on Lake Winnebago north-northeast of Oshkosh. Population, 23,272.

ne'er (nār') *adv.* Never.

ne'er-do-well (nār'dō-wél') *n.* An idle, irresponsible person. —**ne'er-do-well'** *adj.*



needle
Sailmaking needle (top left), tapestry needle (top right), and curved embroidery needle (bottom)



needlepoint

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gent is both sound and compelling: *cogent testimony*; a *cogent explanation*. Convincing implies the power to dispel doubt or overcome resistance or opposition: *convincing proof*. Telling means strikingly effective: *The attorney's summation was telling*.

val-i-date (vāl'i-dāt') *tr.v.* -dat-ed, -dat-ing, -dates. 1. To declare or make legally valid. 2. To mark with an indication of official sanction. 3. To establish the soundness of; corroborate. See Synonyms at **confirm**. —**val'i-da-tion** *n.*

val-ine (vāl'ēn', vāl'ēn') *n.* An essential amino acid, $C_5H_{11}NO_2$, [VAL(ERIC ACID) + -INE²].

val-in-o-mycin (vāl'a-nō-mī'sin) *n.* An antibiotic, $C_{54}H_{90}N_6O_{16}$, produced by the actinomycete *B. Streptomyces fulvissimus*, that increases the transport of potassium across cell membranes. [VALIN(E) + -MYCIN.]

va-lise (vā-lēs') *n.* A small piece of hand luggage. [French, from Italian *valigia*.]

Val-i-um (vāl'ē-əm). A trademark used for diazepam.

Val-kyr-ie (vāl-kī'r'ē, -kī'r'ē, vāl'ka-rē, vāl'k-) *n.* *Mythology.* Any of Odin's handmaidens who conducted the souls of the slain to Valhalla. [Old Norse *Valkyria*. See **wale-** in Appendix.]

Val-la-do-lid (vāl'a-dā-lid', bāl'yā-thō-lēth') *n.* A city of northwest-central Spain north-northwest of Madrid. It became the chief residence of the Castilian court in the mid-15th century and was the site of the marriage of Ferdinand and Isabella in 1469. Population, 331,404.

val-la-tion (vā-lā'shān) *n.* 1. An earthwork wall used for military defense; a rampart. 2. The process of planning or erecting earth fortifications. [Late Latin *vallatiō*, *vallatiōn-*, from Latin *vallātus*, past participle of *vallāre*, to surround with a rampart, from *vallum*, rampart, from *vallus*, stake.] —**val'la-to-ry** (vāl'a-tōr'ē, -tōr'ē) *adj.*

val-lec-u-la (vāl-lēk'ya-lā, vā-) *n., pl. -lae* (-lē'). A shallow groove, depression, or furrow, as between the hemispheres of the brain. [Late Latin, diminutive of Latin *vallēa*, valley.] —**val-lec-u-lar**, **val-lec-u-late** (-līt, -lāt') *adj.*

Val-le d'A-os-ta (vāl'lā dā-ō'stā, -ō'stā). A region of north-west Italy bordering on France and Switzerland. Separated from Piedmont in the 1940's, it has a predominantly French linguistic and cultural heritage.

Val-le-jo (vā-lā'ō, -hō). A city of western California on San Pablo Bay north of Oakland. It is a trade and processing center and has a large naval shipyard, founded by Adm. David Farragut in 1854. Population, 80,188.

Val-let-ta (vā-lēt'tā). The capital of Malta, on the northeast coast of the main island. Dating to the 16th century, it contains many relics of the Knights of Malta. Population, 14,013.

val-ley (vāl'ē) *n., pl. -leys*. *Abbr. val.* 1. An elongated lowland between ranges of mountains, hills, or other uplands, often having a river or stream running along the bottom. 2. An extensive area of land drained or irrigated by a river system. 3. A depression or hollow resembling or suggesting a valley, as the point at which the two slopes of a roof meet. [Middle English *valey*, from Old French *valee*, from Vulgar Latin **vallāta*, from Latin *vallēs*. See **wal-** in Appendix.] —**val'leyed** *adj.*

Val-ley East (vāl'ē). A town of central Ontario, Canada, a suburb of Sudbury. Population, 20,433.

valley fever *n.* See **coccidioidomycosis**.

Val-ley-field (vāl'ē-fēld'). A city of southern Quebec, Canada, on the St. Lawrence River southwest of Montreal. It is a port of entry and an industrial center. Population, 29,574.

Valley Forge. A village of southeast Pennsylvania on the Schuylkill River northwest of Philadelphia. It was the site of the Continental Army headquarters from December 1777 to June 1778. The encampment was subjected to severe winter weather that caused extensive illness and suffering.

Valley of Ten Thou-sand Smokes (tēn' thou'zand smōks') *n.* A volcanic region of southwest Alaska at the upper end of the Alaska Peninsula. It was formed by the eruption of Mount Katmai in 1912 and continues to emit hot gases through countless cracks in the surface.

Valley of the Kings (kīngz). A narrow valley of east-central Egypt surrounding the site of ancient Thebes between Karnak and Luxor. The valley contains the tombs of numerous pharaohs of the XVIII, XIX, and XX Dynasties, including that of Tutankhamen.

Valley Stream. A village of southeast New York on southwest Long Island. It is mainly residential. Population, 35,769.

Va-lois¹ (vāl'wā, vāl-wā'). A French ruling dynasty (1328–1589) that succeeded the Capetian line when Philip VI ascended to the throne.

Va-lois² (vāl'wā, vāl-wā'). A historical region and former duchy of northern France. A county from the 10th to the 12th century, it was an appanage of the royal house of Valois after 1285.

va-lo-ni-a (vā-lō'nē-ā, -lōn'ya) *n.* The dried acorn cups of an oak tree (*Quercus aegilops*) of the eastern Mediterranean, used chiefly in tanning and dyeing. [Italian *vallonia*, from Modern Greek *balania*, pl. of *balani*, acorn, from Greek *balanos*.]

val-or (vāl'ar) *n.* Courage and boldness, as in battle; bravery. [Middle English *valour*, from Old French, from Late Latin *valor*, from Latin *valēre*, to be strong. See **wal-** in Appendix.]

val-or-ize (vāl'a-rīz') *tr.v.* -ized, -iz-ing, -iz-es. 1. To es-

tablish and maintain the price of (a commodity) by governmental action. 2. To give or assign a value to: "The prophets *valorized* history" (Mircea Eliade). [Portuguese *valorizar*, from *valor*, value, from Late Latin. See **VALOR**.] —**val'or-i-za-tion** (-ar-i-zā'shān) *n.*

val-or-ous (vāl'ar-əs) *adj.* Marked by or possessing great personal bravery; valiant. See Synonyms at **brave**. —**val'or-ous-ly** *adv.* —**val'or-ous-ness** *n.*

val-our (vāl'ər) *n.* Chiefly British. Variant of **valor**.

Val-pa-rai-so (vāl'pa-rī'sō). 1. Also **Val-pa-ra-i-so** (bāl'pā-rā-ē'sō). A city of central Chile on the Pacific Ocean west-northwest of Santiago. Founded in 1536, it has frequently been subject to severe earthquakes. The modern city developed as an industrial center and the chief port of Chile in the early 20th century. Population, 265,355. 2. A city of northwest Indiana southeast of Gary. It is a manufacturing and educational center. Population, 22,247.

val-pro-ate (vāl-prō'āt) *n.* An anticonvulsive drug, $C_8H_{15}NaO_2$, given orally in the treatment of epilepsy. [*valproic acid* (VAL(ERIC ACID) + PRO(PYL) + -IC) + -ATE²].

Val-sal-va maneuver (vāl-sāl'vā) *n.* 1. Expiratory effort when the mouth is closed and the nostrils are pinched shut, which forces air into the eustachian tubes and increases pressure on the inside of the eardrum. 2. Expiratory effort against a closed glottis, which increases pressure within the thoracic cavity and thereby impedes venous return of blood to the heart. [After Antonio Maria Valsalva (1666–1723), Italian anatomist.]

val-u-a-ble (vāl'yōō-a-bəl, vāl'ya-) *adj.* 1. Having considerable monetary or material value for use or exchange: a *valuable diamond*. 2. Of great importance, use, or service: *valuable information*; *valuable advice*. 3. Having admirable or esteemed qualities or characteristics: a *valuable friend*. —**valuable** *n.* A personal possession, such as a piece of jewelry, having a relatively high monetary value. Often used in the plural. —**val'u-a-ble-ness** *n.* —**val'u-a-bly** *adv.*

val-u-ate (vāl'yōō-āt') *tr.v.* -at-ed, -at-ing, -ates. To set a value for; appraise. [Back-formation from **VALUATION**.]

val-u-a-tion (vāl'yōō-ā'shān) *n.* *Abbr. val.* 1. The act or process of assessing value or price; an appraisal. 2. Assessed value or price. 3. An estimation of value, merit, or character: *set a high valuation on friendship*. —**val'u-a-tion-al** *adj.*

val-u-a-tor (vāl'yōō-ā'tər) *n.* One that estimates values; an appraiser.

val-ue (vāl'yōō) *n.* *Abbr. val.* 1. An amount, as of goods, services, or money, considered to be a fair and suitable equivalent for something else; a fair price or return. 2. Monetary or material worth: *the fluctuating value of gold and silver*. 3. Worth in usefulness or importance to the possessor; utility or merit: *the value of an education*. 4. A principle, standard, or quality considered worthwhile or desirable: "The speech was a summons back to the patrician values of restraint and responsibility" (Jonathan Alter). 5. Precise meaning or import, as of a word. 6. *Mathematics.* An assigned or calculated numerical quantity. 7. *Music.* The relative duration of a tone or rest. 8. *Color.* The relative darkness or lightness of a color: "I establish the colors and principal values by organizing the painting into three values—dark, medium . . . and light" (Joe Hing Lowe). 9. *Linguistics.* The sound quality of a letter or diphthong. 10. One of a series of specified values: *issued a stamp of new value*. —**value** *tr.v.* -ued, -u-ing, -ues. 1. To determine or estimate the worth or value of; appraise. 2. To regard highly; esteem. See Synonyms at **appreciate**. 3. To rate according to relative estimate of worth or desirability: *evaluate: valued health above money*. 4. To assign a value to (a unit of currency, for example). [Middle English, from Old French, from feminine past participle of *valoir*, to be strong, be worth, from Latin *valēre*. See **wal-** in Appendix.] —**val'u-er** *n.*

val-ue-add-ed (vāl'yōō-ād'id) *adj.* Of or relating to the estimated value that is added to a product or material at each stage of its manufacture or distribution: "Unlike the steel or aluminum industries, where heavier profits come from value-added fabrication, mining is the most lucrative stage of copper production" (Forbes).

value-added tax *n.* *Abbr. VAT, V.A.T.* A tax on the estimated market value added to a product or material at each stage of its manufacture or distribution, ultimately passed on to the consumer.

val-ued policy (vāl'yōōd) *n.* An insurance policy requiring the insurer to pay the insured the full face value of the policy in the event of total loss, regardless of the actual value of the lost property.

value judgment *n.* A judgment that assigns a value, as to an object or action; a subjective evaluation.

val-ue-less (vāl'yōō-līs) *adj.* Having no value; worthless. —**val'ue-less-ness** *n.*

val-var (vāl'var) *adj.* Valvular.

val-vate (vāl'vāt') *adj.* 1. Having valvelike parts. 2. *Botany.* a. Meeting at the edges without overlapping, as some petals do. b. Opening by valves, as the capsule of a lily or iris.

valve (vāl'v) *n.* 1. *Anatomy.* A membranous structure in a hollow organ or passage, as in an artery or a vein, that folds or closes to prevent the return flow of the body fluid passing through it. 2. a. Any of various devices that regulate the flow of gases, liquids, or loose materials through piping or through apertures by opening, closing, or obstructing ports or passageways. b. The



Valkyrie



vambrace
c. 1550 Spanish

movable control element of such a device. **c.** *Music.* A device in a brass wind instrument that permits change in pitch by a rapid varying of the air column in a tube. **3.** *Biology.* **a.** One of the paired, hinged shells of certain mollusks and of brachiopods. **b.** One of the two silicified halves of the cell wall of a diatom. **c.** The entire, one-piece shell of a snail and certain other mollusks. **4.** *Botany.* **a.** One of the sections into which the wall of a seedpod or other dehiscent fruit splits. **b.** A lidlike covering of an anther. **5.** *Chiefly British.* An electron tube or a vacuum tube. **6.** *Archaeol.* Either half of a double or folding door. — *valve tr.v.* **valved, valving, valves.** **1.** To provide with a valve. **2.** To control by means of a valve. [Middle English, leaf of a door, from Latin *valva*. See *wel-2* in Appendix.] — *valve/less* *adj.*

valve-in-head engine (vāl'vīn-héd') *n.* An internal-combustion engine, as in some automobiles, that has the inlet and exhaust valves in the cylinder head instead of in the engine block.

val-vu-la (vāl'vyā-lā) *n.* Variant of *valvule*.

val-vu-lar (vāl'vyā-lār) *adj.* Relating to, having, or operating by means of valves or valvelike parts.

val-vule (vāl'vyool') also **val-vu-la** (-vyā-lā) *n., pl. -vules* also **-vu-lae** (-vyā-lē'). A small valve or valvelike structure.

val-vu-li-tis (vāl'vyā-lī'tis) *n.* Inflammation of a valve, especially a cardiac valve.

val-vu-lo-plas-ty (vāl'vyā-lō-plās'tē) *n., pl. -ties.* Plastic surgery to repair a valve, especially a heart valve.

vam-brace (vām'brās') *n.* Armor used to protect the forearm. [Middle English *vambras*, from Anglo-Norman *vambras* : *vauit* (variant of Old French *avaunt*, before; see *VANGUARD*) + *bras*, arm; see *BRACER-2*.]

va-moose (vā-mōos', vā-) *intr.v.* **-moosed, -moos-ing, -moos-es.** *Slang.* To leave hurriedly. [From Spanish *vamos*, let's go, from Latin *vādāmus*, first person pl. subjunctive of *vādere*, to go.]

vamp¹ (vāmp) *n.* **1.** The upper part of a boot or shoe covering the instep and sometimes extending over the toe. **2.a.** Something patched up or refurbished. **b.** Something rehearsed, as a book based on old material. **3.** *Music.* An improvised accompaniment. — **vamp v.** **vamped, vamp-ing, vamps.** — *tr.* **1.** To provide (a shoe) with a new vamp. **2.** To patch up (something old); refurbish. **3.** To put together; fabricate or improvise: *With no hard news available about the summit meeting, the reporters vamped up questions based only on rumor.* **4.** *Music.* To improvise (an accompaniment, for example) for a solo. — *intr.* *Music.* To improvise simple accompaniment or variation of a tune. [Middle English *vampe*, sock, from Old French *avanpie* : *avaunt*, before; see *VANGUARD* + *pie*, foot (from Latin *pēs*; see *ped-* in Appendix).] — **vamp'er** *n.*

vamp² (vāmp) *Informal n.* An unscrupulous, seductive woman who uses her sex appeal to entrap and exploit men. — **vamp v.** **vamped, vamp-ing, vamps.** — *tr.* To seduce or exploit (someone) in the manner of a vamp. — *intr.* To play the part of a vamp. [Short for *VAMPIRE*.] — **vamp'ish** *adj.* — **vamp'ish-ly** *adv.* — **vamp'y** *adj.*

vam-pire (vām'pīr') *n.* **1.** A reanimated corpse that is believed to rise from the grave at night to suck the blood of sleeping people. **2.** A person, such as an extortionist, who preys upon others. **3.** A vampire bat. [French, from German *Vampir*, of Slavic origin.] — **vam-pir'ic** (vām-pīr'ik), **vam-pir'i-cal** (-i-kəl), **vam-pir'ish** (-ish) *adj.*

WORD HISTORY: Dracula might terrify some younger members in the audience of a horror film, but we know he is an imaginary creature. The word *vampire*, however, comes to us from other words and other times, when these bloodsucking reanimated corpses were considered real. The word entered English by way of French (*vampire*) and German (*Vampir*), but it came into German from an Old West Slavic source of the form **vampir*. The word *vampire* is first recorded in English in a work written before 1734.

vampire bat *n.* **1.** Any of various tropical American bats of the family *Desmodontidae* that bite mammals and birds to feed on their blood and that often carry diseases such as rabies. **2.** Any of various other bats, as those of the family *Megadermatidae*, erroneously believed to feed on blood.

vam-pir-ism (vām'pīr-iz'm) *n.* **1.** Belief in vampires. **2.** The behavior of a vampire.

van¹ (vān) *n.* **1.a.** An enclosed boxlike motor vehicle having rear or side doors and side panels especially for transporting people. **b.** A covered or enclosed truck or wagon often used for transporting goods or livestock. **2.** *Chiefly British.* A closed railroad car used for carrying baggage or freight. — **van v.** **vanned, van-ing, vans.** — *tr.* To transport by van: *vanned the horses to the racetrack.* — *intr.* To drive or travel in a van: *vanned around the country.* [Short for *CARAVAN*.]

van² (vān) *n.* The vanguard; the forefront. [Short for *VANGUARD*.]

van³ (vān) *n.* **1.** A wing. **2.** *Archaic.* A winnowing device, such as a fan. [Middle English, from Old English *fann* and Old French *van*, both from Latin *vannus*. See *wet-1* in Appendix.]

Van (vān, vān), **Lake.** A salt lake of eastern Turkey. The largest lake in the country, it has no known outlet.

van-a-date (vān'a-dāt') *n.* Any of three anions, VO_3^- , VO_4^{3-} , or $V_2O_7^{4-}$, containing pentavalent vanadium. [VANAD(IUM) + -ATE².]

va-na-dic acid (vā-nā'dik, -nād'ik) *n.* **1.** An acid containing

a vanadate group, especially HVO_3 , H_2VO_4 , or $H_4V_2O_7$, not existing in a pure state. **2.** See *vanadium pentoxide*.

va-na-di-nite (vā-nād'n-īt', -nād'ī-, vān'a-dē'nīt') *n.* A red, yellow, or brown mineral, essentially an ore of vanadium and lead. [VANAD(IUM) + -IN + -ITE¹.]

va-na-di-um (vā-nā'dē-əm) *n.* *Symbol V* A bright white, soft, ductile metallic element found in several minerals, notably vanadinite and carnotite, having good structural strength and used in rust-resistant high-speed tools, as a carbon stabilizer in some steels, as a titanium-steel bonding agent, and as a catalyst. Atomic number 23; atomic weight 50.942; melting point 1,890°C; boiling point 3,000°C; specific gravity 6.11; valence 2, 3, 4, 5. See table at **element**. [From Old Norse *Vanadis*, the goddess Freya. See *wen-1* in Appendix.]

vanadium pentoxide *n.* A yellow to red crystalline powder, V_2O_5 , used as a catalyst in various organic reactions and as a starting material for other vanadium salts. Also called *vanadic acid*.

vanadium steel *n.* Steel alloyed with vanadium for added strength, hardness, and high-temperature stability.

Van Al-len belt (vān āl'an) *n.* Either of two zones of high-intensity particulate radiation trapped in Earth's magnetic field and surrounding the planet, beginning at an altitude of about 800 kilometers (500 miles) and extending tens of thousands of kilometers into space. [After James Alfred Van Allen (born 1914), American physicist.]

Van-brugh (vān'brā, vān-brōō') *Sir John.* 1664–1726. English playwright and architect who wrote *The Provok'd Wife* (produced 1697) and designed Blenheim Palace.

Van Bu-ren (vān byōr'an), **Martin.** 1782–1862. The eighth President of the United States (1837–1841). A powerful Democrat from New York, he served in the U.S. Senate (1821–1828), as secretary of state (1829–1831), and as Vice President (1833–1837) under Andrew Jackson before being elected President in 1836. He unsuccessfully sought reelection in 1840 and 1848.

van-co-my-cin (vāng'kō-mī'sīn, vān'kō-) *n.* An antibiotic, $C_{66}H_{72}Cl_2N_6O_{24}$, produced by the actinomycete *Streptomyces orientalis*, found in Indonesian and Indian soil, and effective against staphylococci and spirochetes. [*vanco-* (of unknown origin) + -MYCIN.]

Van-co-ver (vān-kōō'vār). **1.** A city of southwest British Columbia, Canada, on the Strait of Georgia opposite Vancouver Island. The largest city in the province, it is a major port, commercial and industrial center, and railroad hub. Population, 414,281.

2. A city of southwest Washington on the Columbia River opposite Portland, Oregon. Founded as Fort Vancouver by the Hudson's Bay Company in the 1820's, it is a deep-water port with shipyards, lumber mills, and other processing facilities. Population, 42,834.

Vancouver, George. 1757–1798. British navigator who led an expedition to the coasts of Australia, New Zealand, and the Hawaiian Islands (1791–1792) and to the Pacific coast of North America (1792–1794).

Vancouver, Mount. A peak, 4,873.6 m (15,979 ft) high, in the St. Elias Mountains of southwest Yukon Territory, Canada, near the border of Alaska.

Vancouver Island. An island of southwest British Columbia, Canada, in the Pacific Ocean separated from the mainland by the Strait of Georgia and Queen Charlotte Strait. The Strait of Juan de Fuca flows between the southern end of the island and the coastline of northwest Washington. First sighted by Spanish explorers in 1774 and visited by Capt. James Cook in 1778, it was named in honor of Capt. George Vancouver, who circumnavigated the island in 1792.

Van-dal (vān/dl) *n.* **1.** *vandal.* One who willfully or maliciously defaces or destroys public or private property. **2.** A member of a Germanic people that overran Gaul, Spain, and northern Africa in the fourth and fifth centuries A.D. and sacked Rome in 455. [Latin *Vandalus*, probably of Germanic origin.] — **Van-dal'ic** (vān-dāl'ik) *adj.*

van-dal-ism (vān/dl-iz'm) *n.* Willful or malicious destruction of public or private property. — **van'dal-is'tic** *adj.*

van-dal-ize (vān/dl-iz') *tr.v.* **-ized, -iz-ing, -iz-es.** To destroy or deface (public or private property) willfully or maliciously. — **van'dal-i-za'tion** (-i-zā'shən) *n.*

Van de Graaff generator (vān' dō grāf') *n.* An electrostatic generator in which an electric charge is either removed from or transferred to a large hollow spherical electrode by a rapidly moving belt, accelerating particles to energies of about ten million electron volts. [After Robert Jemison Van de Graaff (1901–1967), American physicist.]

Van-der-bilt (vān'dər-bilt'), **Cornelius.** Known as "Commodore Vanderbilt." 1794–1877. American transportation promoter and financier who amassed a great fortune through railroad and shipping interests. His heirs included his son William Henry (1821–1885), a financier and philanthropist, and William Henry's sons Cornelius (1843–1899), a railroad director; William Kissam (1849–1920), a railroad executive and philanthropist; Frederick William (1856–1938), a railroad manager; and George Washington (1862–1914), who commissioned Biltmore, located in Asheville, North Carolina, the largest private home in America.

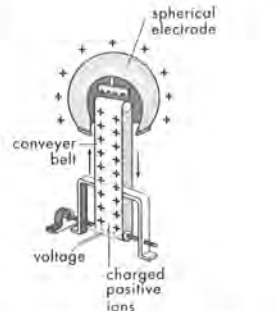
Van Der Ro-he (vān dər rō'hə, fān). See Ludwig Mies Van Der Rohe.



vampire bat



Martin Van Buren



Van de Graaff generator

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ā pay	ou out
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ō toe	ā about, item
ō paw	♦ regionalism

Stress marks: / (primary); ' (secondary), as in dictionary (dik'shā-nēr'ē)