Robert Bosch LLC and Daimler AG.,
Petitioner
v.
Orbital Australia PTY LTD,
Patent Owner

Cases IPR2015-01254, 01255, 01256

U.S. Patent No. 6,923,387

Witness Notes Prepared by Dr. Ron Matthews

Matthews
EXHIBIT NO. 26
KY 3/17/16

Summary of Instituted Grounds

IPR2015-01254

Reference(s)	Basis	Challenged Claim(s)
Masubuchi	§ 102(b)	1, 2, 4, 5, 7, 10, 13–16, 18, 19
Masubuchi	§ 103(a)	1, 2, 4, 5, 7, 10, 13–16, 18, 19
Masubuchi and Breslau	§ 103(a)	16
Masubuchi and Bishop	§ 103(a)	19
Sczomak	§ 102(b)	1, 2, 4, 5, 7–9, 14–16, 18, 19
Sczomak	§ 103(a)	1, 2, 4, 5, 7–9, 14–16, 18, 19
Sczomak and Breslau	§ 103(a)	16
Sczomak and Bishop	§ 103(a)	19

IPR2015-01255

Reference(s)	Basis	Challenged Claim(s)
Allen	§ 102(b)	1, 2, 4, 5, 7, 10, 14–16, 18, 19
Allen	§ 103(a)	1, 2, 4, 5, 7, 10, 14–16, 18, 19
Allen and Breslau	§ 103(a)	16
Allen and Bishop	§ 103(a)	1, 15, 19

IPR2015-01256

Reference(s)	Basis	Challenged Claim(s)
Tartrais	§ 102(b)	1, 2, 4, 5, 7, 10, 14–16, 18, 19
Tartrais	§ 103(a)	1, 2, 4, 5, 7, 10, 14–16, 18, 19
Tartrais and Breslau	§ 103(a)	16
Tartrais and Bishop	§ 103(a)	19

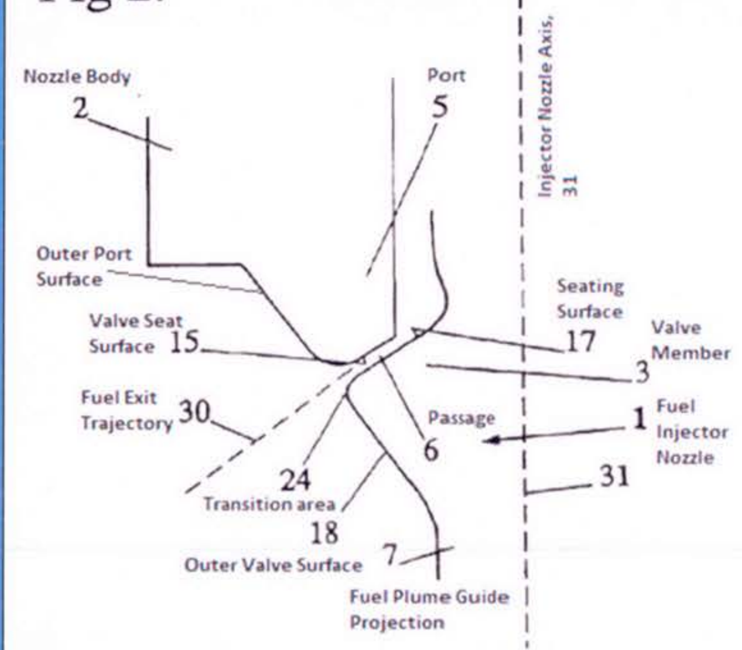
Asserted Patent – Prior Art Injector Nozzle 1

Referring now to FIG. 2, the nozzle geometry at the nozzle passage **6** of a prior art injector nozzle **1** is shown. The nozzle **1** is in an open position with the nozzle passage **6** being provided between the port **5** and the valve member **3**. The nozzle body **2** supports a valve seat surface **15** of the port **5**. The valve member **3** includes a seating surface **17** which cooperates with the valve seat surface **15** to define the nozzle passage **6**. When the valve seating surface **17** is seated on the valve seat surface **15**, no fuel is able to flow through the passage **6** due to the sealing engagement which exists between the port **5** and the valve member **3**. Movement of the valve member **3** relative to the port **5** occurs along a longitudinal axis which corresponds to the axis of the injector nozzle **1** which is shown as line **31**.

The valve member **3** further includes an outer valve surface **18** located adjacent to the seating surface **17** of the valve member **3**. At the transition area **24** between the seating surface **17** and the outer valve surface **18** of the valve member **3**, a slight radius is typically provided therebe-

'387 patent at 6:31-49

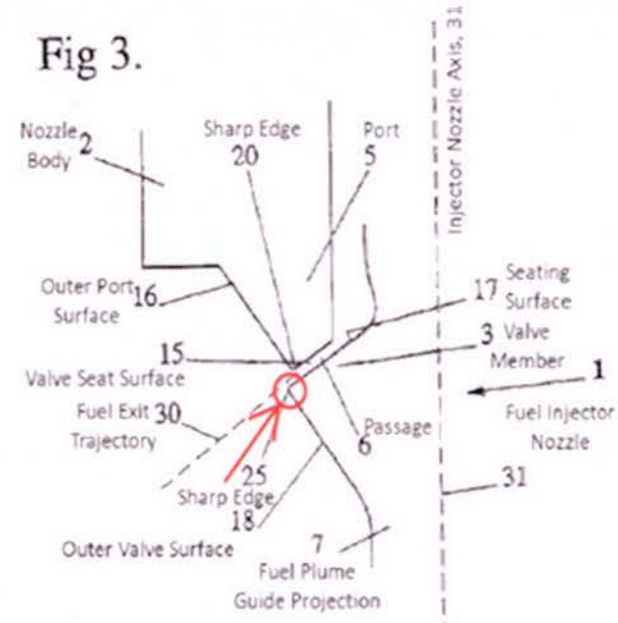
Fig 2.



Asserted Patent – Claim 1

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.

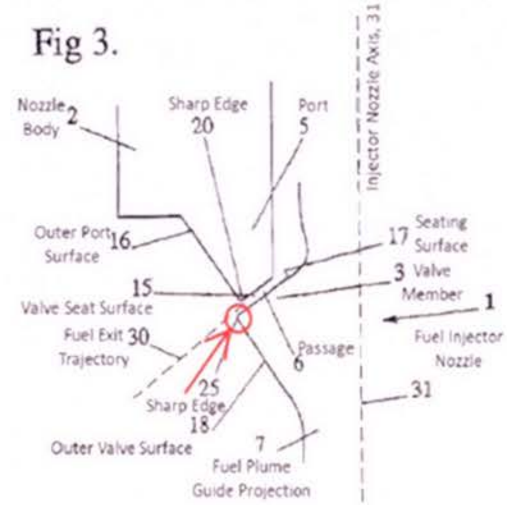
Fig 3.



Asserted Patent – Claim 2

2. An injector nozzle according to claim **1**, wherein the sharp edge acts as a deposit breaking edge to thereby facilitate deposit removal from the injector nozzle.

Fig 3.



Furthermore, the sharp edges act as deposit breaking edges adjacent to the exit of the nozzle passage thus controlling deposit build-up at the nozzle exit by the physical mechanism of deposit shear. That is, any deposits which may form at or adjacent either of the sharp edged transition regions are likely to exhibit increased localised stress characteristics and thus have a fairly weak resistance to fracturing. Accordingly, any deposits which may form at or adjacent these sharp edges are likely to be dislodged by the shearing effect of the fuel issuing from the exit of the nozzle passage. Such a flow of fuel alongside and across any such deposits will typically result in the deposits closest to the nozzle passage exit being broken away. Further, other localised eddies and gas currents present in the combustion chamber, and particularly at or adjacent the nozzle passage exit, may also cause some such deposits to be dislodged from the sharp edged transition regions. Still further, the presence of the sharp edged transition regions on the valve member and the part, together with the mechanical opening and closing movement of the valve member within the part, may also contribute to some physical dislodgement of any deposits which may form at or adjacent the exit of the nozzle passage.

'387 patent at 5:23-45

nozzle leading to improved deposit control. Furthermore, the sharp edges **25**, **20** act as deposit breaking edges adjacent to the exit of the nozzle passage **6** thereby controlling nozzle exit deposit build-up by the physical mechanism of deposit shear. Hence, any deposits that may form at or adjacent the nozzle passage exit and on the trailing edges of the valve member **3** or port **5** will be dislodged or broken away by the shearing action of the fuel issuing from the nozzle passage **6** or the gas dynamics within the combustion chamber of the engine. Accordingly, the formation of any deposits which may impede or otherwise detrimentally effect the flow of fuel from the nozzle **1** can be minimised. Deposits which may form at or adjacent the exit of the nozzle passage **6** may also be dislodged by the mechanical opening and closing action of the valve member **3** within the port **5**, particularly in the case of a toe-seated nozzle arrangement.

'387 patent at 7:41-56

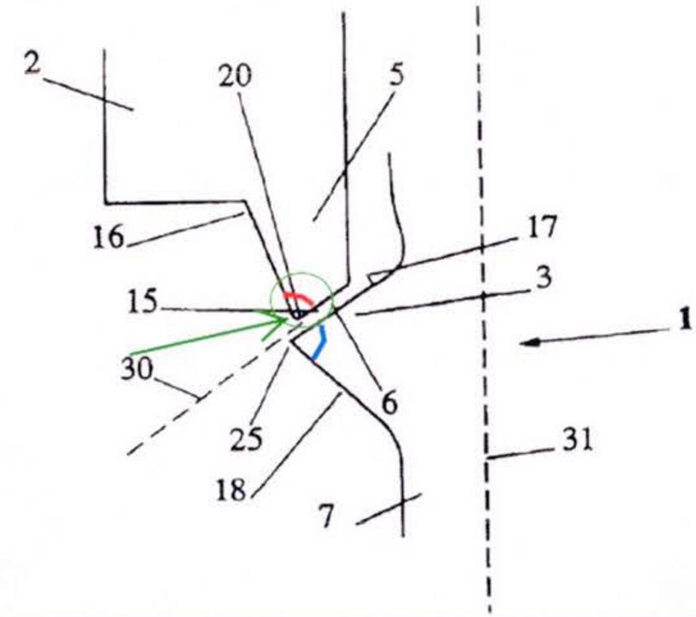
Asserted Patent – Claims 4, 5, 7

4. An injector nozzle according to claim **1**, wherein an acute angle is provided between the seating surface and the outer valve surface of the valve member at the sharp edge transition.

5. An injector nozzle according to claim **1**, wherein the port includes an outer port surface surrounding and located adjacent to the valve seat surface, and a sharp edge is provided at the transition between the valve seat surface and the outer port surface.

7. An injector nozzle according to claim **5**, wherein an acute angle is provided between the valve seat surface and the outer port surface of the port at the sharp edge transition.

Fig 4.

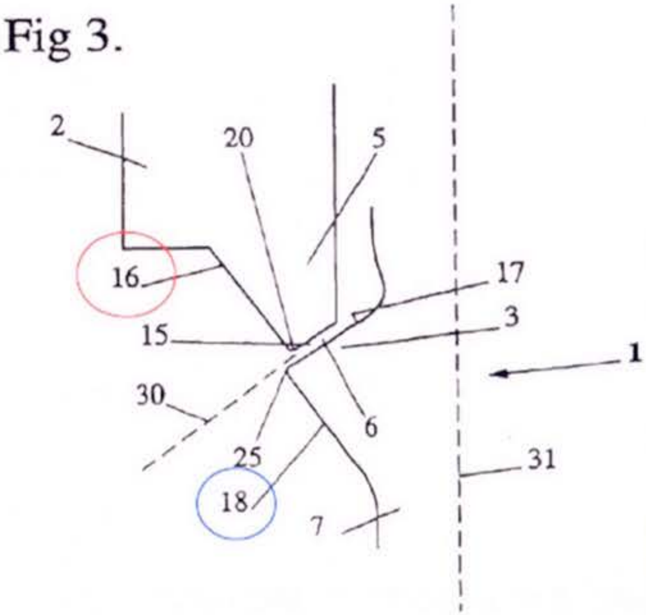


Asserted Patent – Claims 8, 9

8. An injector nozzle according to claim **5**, wherein the outer valve surface and the outer port surface are at least substantially located in an common plane when the valve member is seated in the port.

9. An injector nozzle according to claim **5**, wherein the outer valve surface and the outer port surface are located in at least substantially parallel planes when the valve member is seated in the port.

Fig 3.



In the arrangement shown in FIG. **3**, the outer valve surface **18** and the outer port surface **16** are provided in planes normal to the fuel exit trajectory from the nozzle **1** as indicated by the dashed line **30**. Furthermore, the surfaces **18**, **16** are arranged in the same plane when the valve member **3** is seated within the port **5**. As alluded to hereinbefore, one or each of the surfaces **18**, **16** may of course be arranged to be angled to the fuel exit trajectory **30** by greater than 90 degrees which would result in an acute angle at the transition edges **25**, **20**. For example, as shown in FIG. **4** acute angles may be provided at the transition edges **25**, **20** such that the angle between the outer valve surface **18** and the outer port surface is less than 180 degrees and perhaps of the order of 90 degrees. Still further, the surfaces **18**, **16** may alternatively be arranged such that, whilst being normal to the fuel exit trajectory **30**, they exist in parallel planes when the valve member **3** is seated within the port **5**.

'387 patent at 7:12-29

Asserted Patent – Claims 10, 13

10. An injector nozzle according to claim **5**, wherein the angle between the outer valve surface and the outer port surface is less than 180 degrees.

In the arrangement shown in FIG. **3**, the outer valve surface **18** and the outer port surface **16** are provided in planes normal to the fuel exit trajectory from the nozzle **1** as indicated by the dashed line **30**. Furthermore, the surfaces **18**, **16** are arranged in the same plane when the valve member **3** is seated within the port **5**. As alluded to hereinbefore, one or each of the surfaces **18**, **16** may of course be arranged to be angled to the fuel exit trajectory **30** by greater than 90 degrees which would result in an acute angle at the transition edges **25**, **20**. For example, as shown in FIG. **4** acute angles may be provided at the transition edges **25**, **20** such that the angle between the outer valve surface **18** and the outer port surface is less than 180 degrees and perhaps of the order of 90 degrees. Still further, the surfaces **18**, **16** may alternatively be arranged such that, whilst being normal to the fuel exit trajectory **30**, they exist in parallel planes when the valve member **3** is seated within the port **5**.

'387 patent at 7:12-29

13. An injector nozzle according to claim **5**, wherein the angles between each of the outer valve surface and the outer port surface and a fuel exit trajectory are arranged to be greater than 90 degrees.

Fig 4.

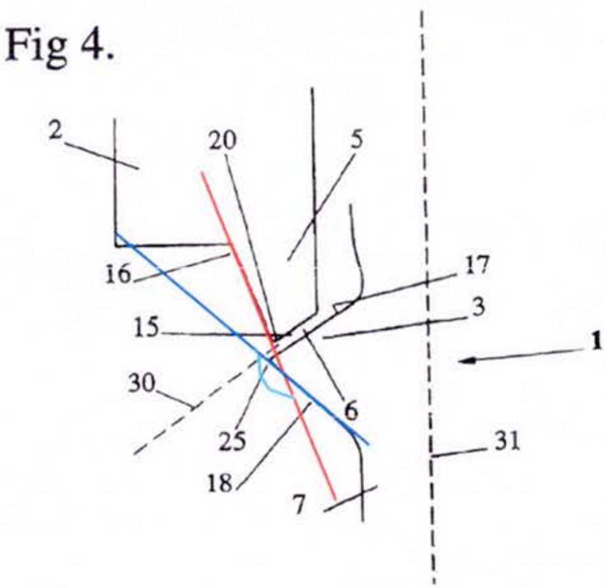
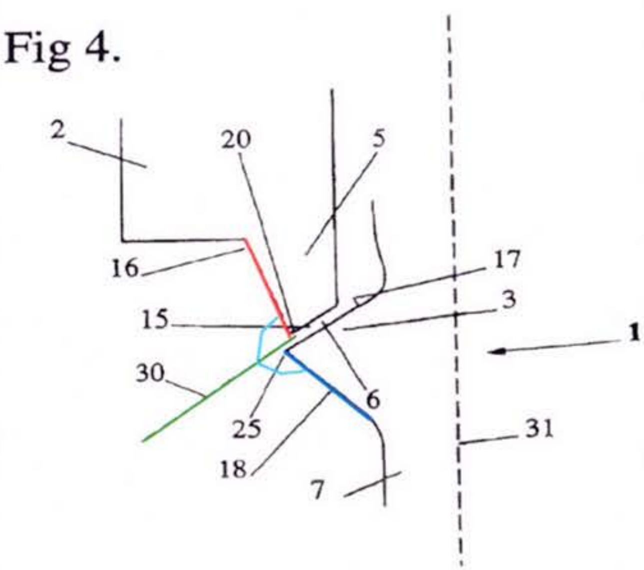


Fig 4.



Asserted Patent – Claims 14, 15, 16

14. An injector nozzle according to claim **1**, the nozzle being of the outwardly opening poppet valve type.

15. An injector nozzle according to claim **1**, the nozzle being arranged to deliver fuel directly into at least one combustion chamber of the engine.

Conveniently, the injector nozzle is of the outwardly opening poppet valve type. However, the present invention may also have applicability to certain designs of inwardly opening pintle valve arrangements.

Preferably, the injector nozzle is arranged to deliver fuel directly into a combustion chamber of the engine. However, whilst the present invention may have particular applicability to direct fuel injection systems, it is also applicable to other types of fuel systems such as manifold or port injection type systems.

'387 patent at 3:35-37

16. An injector nozzle according to claim **5**, wherein the sharp edge on the valve member is formed in a separate step to the sharp edge on the port.

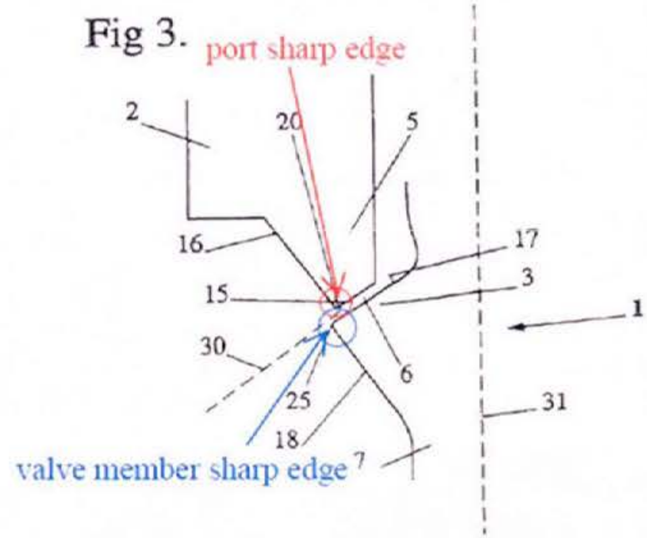
Preferably, the sharp edge on the valve member may be manufactured or provided thereon in a separate step to the provision of the sharp edge on the port. That is, the sharp edges on the port and valve member are preferably not machined in the same machining process and rather the sharp edge on the valve member is machined in a separate machining process to the sharp edge on the port. However, in certain circumstances it may be possible or desirable to machine both of the sharp edges in the same machining process. The machining process may include lapping or grinding of the surfaces.

'387 patent at 3:17-27

Asserted Patent – Claim 18

18. An injector nozzle according to claim **5**, wherein the sharp edges on the valve member and on the port facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage.

Fig 3.



It has been found that the provision of the sharp edge **25** on the valve member **3**, and preferably also the sharp edge **20** on the port **5** facilitates the maintenance of an optimal nozzle exit spray geometry preventing over-expansion of the fuel plume at the exit of the nozzle passage **6** and thereby reducing droplet impingement on the outer surfaces of the nozzle leading to improved deposit control. Furthermore, the

'387 patent at 7:35-41

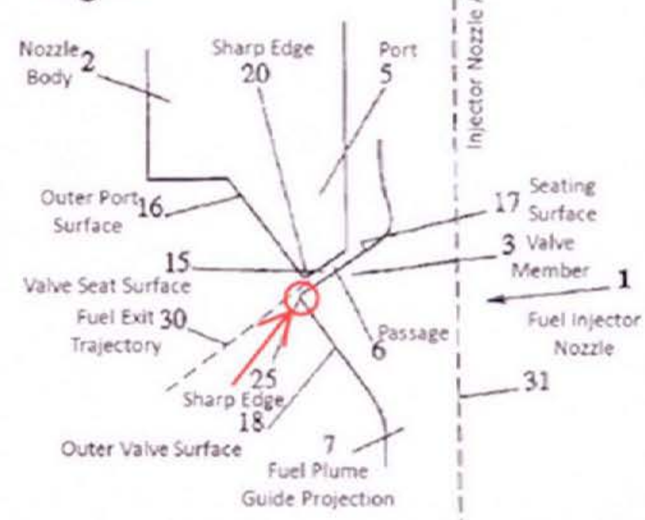
The provision of sharp edges on the valve member and preferably also on the port facilitates the maintenance of an optimal nozzle exit spray geometry preventing over expansion of the fuel plume at the exit of the nozzle passage and thereby reducing droplet impingement on the outer surfaces of the nozzle leading to improved deposit control. That is, the provision of the sharp edged transition on the valve member and preferably also the port minimises the likelihood of a bias being created in the spray direction such that it is towards the external surfaces of the valve member and/or valve port. Impingement of gasoline droplets on the valve member and/or port external surfaces may serve to reduce the temperature of the trailing edges of the valve member or valve port which may support the formation of deposits at or adjacent these regions.

'387 patent at 5:8-22

Asserted Patent – Claim 19

19. An injector nozzle for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel therethrough or sealed contact therebetween to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.

Fig 3.



selection. The injector nozzle of the present invention has applicability to direct injected engines and particularly those operating with a stratified fuel distribution at some point of the engine operating locad range. Furthermore, although the

'387 patent at 7:63-66

Claim Constructions Addressed by the Board

Term	Board Preliminary CC*	Petitioner's Construction**	Patent Owner Construction***
"sharp edge"	"includes, but is not limited to, an edge with a radius of curvature less than 0.2 mm. Further, we agree with Petitioner that additional express construction of 'sharp edge' is not required because the term's ordinary meaning would be understood by a person of ordinary skill in the art."	"a definition is not necessary, because, to the extent that this term has a specific meaning, it would have been understood to those of ordinary skill in the art without additional explanation or restriction."	"An edge having a radius of curvature less than 0.2 mm."
"seating surface"	No need to address proposed construction, but the Board noted: "our analysis does not imply that a 'seating surface' includes only the precise area that contacts a valve seat."	PO's construction improper.	"The surface that is seated against the valve seat surface when the valve member is in the closed position."
"valve seating surface"	No need to address proposed construction.	PO's construction improper.	"The surface against which a valve member is seated."
"acute angle"	No need to address proposed construction.	"An angle measuring less than 90°."	"An angle measuring less than 90°."
"nozzle passage"	No need to address construction, but the Board noted: "Neither the claims nor the plain meaning of 'nozzle passage,' requires that the entire nozzle passage be formed by 'corresponding surface[s]' of the valve seat surface and seating surface."	PO's construction improper.	Did not set forth an express construction, but stated in its arguments concerning Tartrais: "claims 1 and 19 on their face clearly define the 'seating surface' and the 'valve seat surface' as the portions of the valve member and the port that are alternatively separated to define the nozzle passage therebetween when the valve member is open and engaged with one another when the valve member is closed."

* '01254 Institution Decision (ID) at 8-9; '01255 ID at 9; '01256 ID at 8-9.

**'01254, '01255, and '01256 Petitions at 4-11.

***'01254, '01255, and '01256 Preliminary PO response at 13-24.

Claim Construction (cont.)

29. I discuss below what I understand to be Bosch's proposed construction of certain claim terms of the '387 patent.

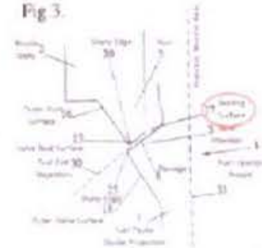
1. "sharp edge" (claims 1, 2, 4-6, 16, 18, and 19)

30. Claims 1, 2, 4-6, 16, and 18-19 recite a "sharp edge" Ex. 1001 at 8:20, 8:26, 8:34, 8:38, 8:43, 9:9-10, 9:16, 10:13. I understand that in the related litigation, Orbital proposed that the term "sharp edge" be construed to mean "an edge having a radius of curvature less than 0.2 mm." I also understand Bosch proposed that such a construction is inappropriately narrow and the construction fails to find support in the intrinsic evidence. *See, e.g.*, Ex. 1001 at 3:4-6, 5:8-45, 6:63-66, 7:4-6, 7:35-56, Figs. 3-4. I agree that no construction is necessary because a POSITA did and does understand the meaning of the term without additional explanation. For example, in my opinion, Figs. 3 and 4 of the '387 show a "sharp edge," as that term would be understood to a POSITA at the relevant time. It is also my opinion that a POSITA would recognize that the fuel injector nozzle prior art confirms that no definition of the term "sharp edge" was or is necessary, as further evidenced by, for example, AT 0093269 to *Tarrrais*, Ex. 1016 at 1 ("sharp-edged machined part 4"); JP H04-30266 to Masubuchi et al. ("*Masubuchi*"), Ex. 1002 at 4 ("knife edge"); U.S. Patent No. 4,693,424 to Sczomak ("*Sczomak*"), Ex. 1003 at 3:14-17, 3:50-53 ("knife edge"); U.S. Patent No. 3,542,293 to Bishop et al. ("*Bishop*"), Ex. 1005 at 2:63-67 ("terminates at a point corresponding to the downstream edge"); U.S. Patent No. 3,105,640 to Allen ("*Allen*"), Ex. 1014 at 3:12-16 ("sharp lip 31"); U.S. Patent No. 3,039,699 to Allen ("*Allen '699*"), Ex. 1019 at 3:54-55 ("sharp annular edge 34"); U.S. Patent No. 3,347,470 to Svoboda ("*Svoboda*"), Ex. 1018 at 2:37-38 ("knife edge"); and U.S. Patent No. 5,516,047 to Kubach et al. ("*Kubach*"), Ex. 1015 at 5:62-66 ("sharp edges").

2. "seating surface" (claims 1, 4, and 19)

31. Claims 1, 4, and 19 recite a "seating surface" Ex. 1001 at 8:13-14, 8:33, 10:6, 10:8. I understand that Orbital proposed in the related litigation that the term be construed to mean "the surface that is seated against the valve seat surface when the valve member is in the closed position." I also understand that Bosch proposed that such a construction is inappropriately narrow in view of the disclosure of the '387 patent. I agree that it is reasonable that such a construction is inappropriate for this term. *See, e.g.*, annotated Fig. 3 (below); Ex. 1001 at 6:1-5, 6:38-41, Figs. 1-4.

Fig 3.



3. "valve seat surface" (claims 1, 5-7, and 19)

32. Claims 1, 5-6, and 19 recite a "valve seat surface" *Id.* at 8:14, 8:39, 8:42, 8:46, 10:5-6. I understand that in the related litigation, Orbital proposed that the term be construed to mean "the surface against which a valve member is seated." I also understand that Bosch proposed that such a construction is inappropriate in view of this term's use in the '387 patent. I agree that it is reasonable that such a construction is inappropriate for this term. *See, e.g.*, Ex. 1001 at 6:1-5, 6:38-41, Figs. 1-4.

Claim Construction (cont.)

4. "acute angle" (Claims 4, 7)

33. Claims 4 and 7 each recite "acute angle." *Id.* at 8:32-35, 8:45-47. I understand that Bosch proposed this term be construed as follows: "an angle measuring less than 90°." I agree that this is a reasonable construction for this term. *See, e.g., id.* at 3:35-37, 7:21-25, Fig. 4; *see also* Ex. 1007 at 3.

Masubuchi

Reference(s)	Basis	Challenged Claim(s)
Masubuchi	§ 102(b)	1, 2, 4, 5, 7, 10, 13–16, 18, 19
Masubuchi	§ 103(a)	1, 2, 4, 5, 7, 10, 13–16, 18, 19
Masubuchi and Breslau	§ 103(a)	16
Masubuchi and Bishop	§ 103(a)	19

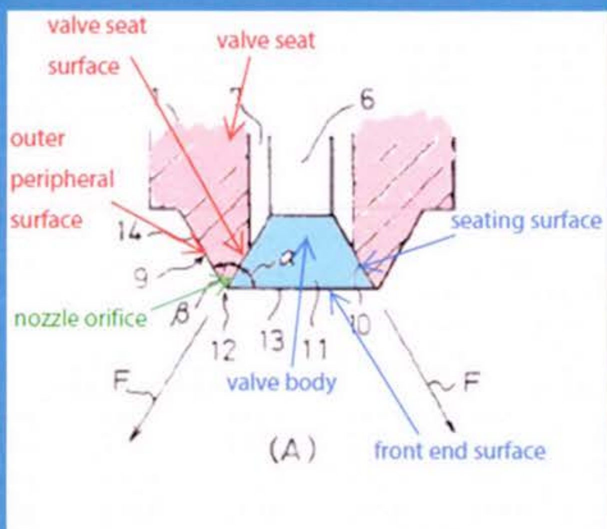


FIG. 2

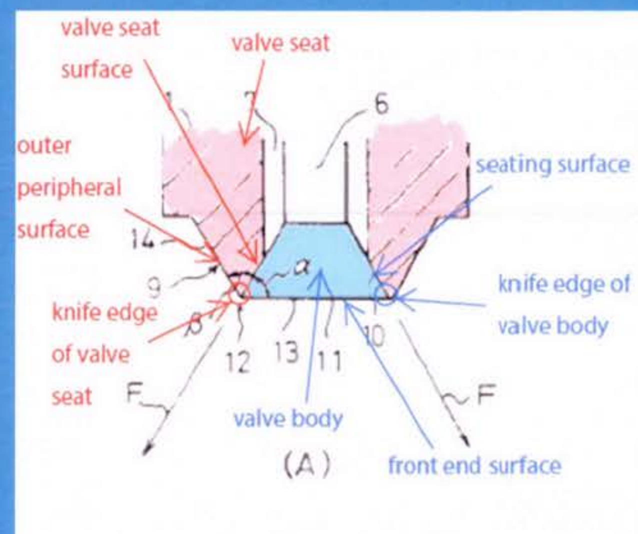


FIG. 2

Masubuchi

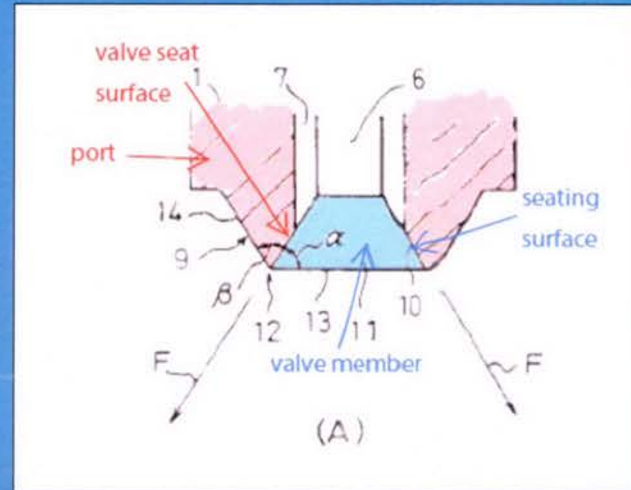
Reference(s)	Basis	Challenged Claim(s)
Masubuchi	§ 102(b)	1, 2, 4, 5, 7, 10, 13–16, 18, 19

Masubuchi Discloses All Elements Of Claims 1, 2, 4-5, 7, 10, 13-16, 18, 19

* '01254, Ex. 1004 at 18-35

Mapping of Masubuchi To Claims 1.0, 1.1

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.

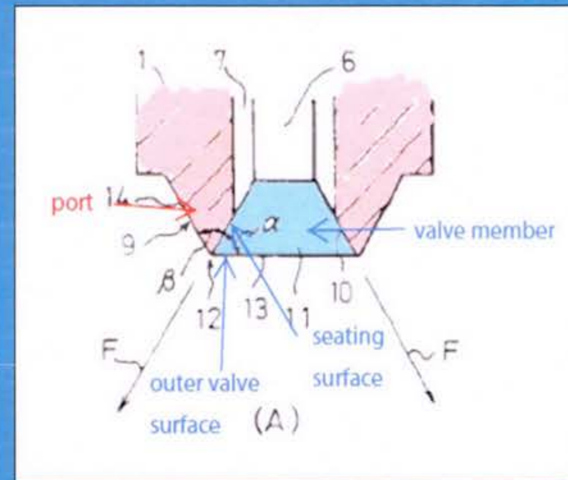


39. *Masubuchi* discloses a fuel injection valve 1 (the claimed "injector nozzle") for a fuel injected internal combustion engine. *Id.* at 4 ("The fuel injection valve 1 is attached to a cylinder head 3 for injecting fuel into a fuel chamber 2 of an internal combustion engine.").

40. *Masubuchi* discloses that the fuel injection valve includes a valve seat 10 (the claimed "port") having a valve seat surface and a valve body 11 (the claimed "valve member") having a seating surface. *Id.* at 4-6, Figs. 1-2. The "port" and corresponding structures including the "valve seat surface" are identified below in red. The "valve member" and corresponding structures including the "seating surface" are identified in blue below in annotated Fig. 2:

Mapping of Masubuchi To Claim 1.1.1

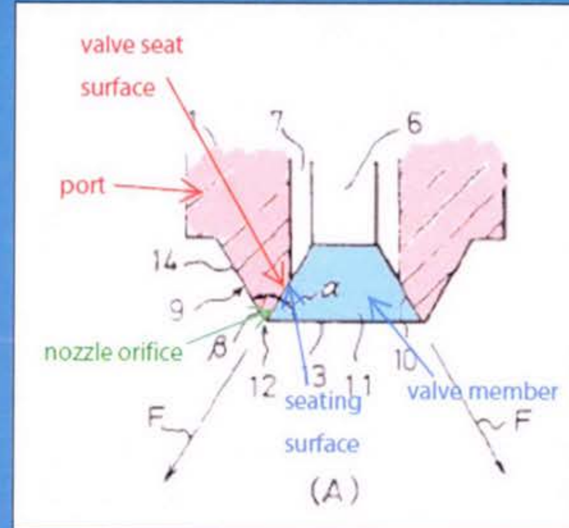
1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.



41. *Masubuchi* discloses that the valve body 11 is movable relative to the valve seat 10 to respectively provide a ring-shaped nozzle orifice (the claimed "nozzle passage") between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel. *Id.* at 4 ("When the needle 6 is caused to descend and the valve body 11 moves away from the valve seat 10, the fuel is sprayed into the combustion chamber 2 from the nozzle orifice formed between the valve body 11 and the valve seat 10. When this happens, the fuel advances along the conical inner wall surface of the valve seat 10 and thus the fuel spreads conically within the combustion chamber 2 in a manner indicated by F in FIG. 2 (A)."). The "nozzle passage" is identified in green below in annotated Figure 2:

Mapping of Masubuchi To Claim 1.1.2

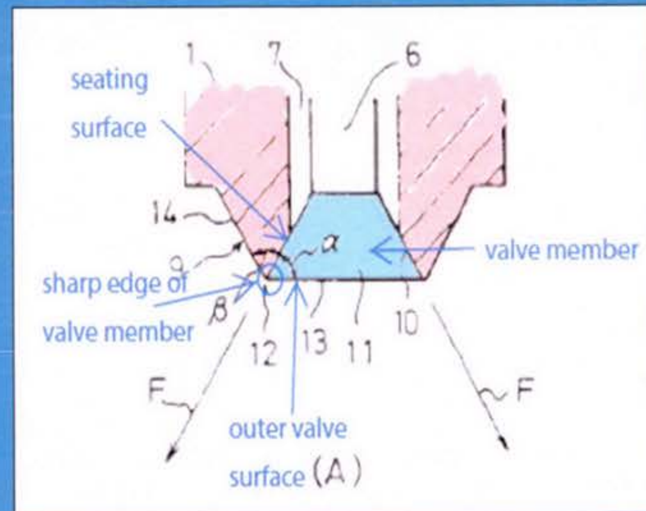
1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.



42. *Masubuchi* discloses that the valve body 11 includes a front end surface 13 (the claimed "outer valve surface") located adjacent the seating surface and external to the valve seat 10. *Id.* at 4-6, Figs. 1-2. The "outer valve surface" is identified below in annotated Fig. 2:

Mapping of Masubuchi To Claim 1.2

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.



43. *Masubuchi* discloses a knife edge (the claimed "sharp edge") provided on the valve body 11 at the transition between the seating surface and the front end surface 13 thereof, for controlling the formation of deposits at or adjacent an exit of the ring-shaped nozzle orifice. *Id.* at 3-5. The "sharp edge of the valve member" is identified below in annotated Figure 2:

Mapping of Masubuchi To Claim 1.2 (Cont.)

44. For example, *Masubuchi* discloses: "[T]he fuel injection valve made by forming a cross-sectional shape of a fuel injection valve front end portion formed in a ring shape to form a conical valve seat formed in a knife-edge shape forming an acute angle, and by forming a cross-sectional shape of a front end rim portion of the valve body formed in a knife-edge shape forming an acute angle, and by forming a tapered edge of the fuel injection valve front end portion formed to be flush with the fuel injection valve body front end surface when the valve body is closed." *Id.* at 3.

45. *Masubuchi* also discloses: "When the cross-sectional shape of the fuel injection valve front end portion is formed in a knife-edge shape, the fuel which is drawn back no longer readily reaches the periphery surface of the fuel injection valve front end portion, so the fuel no longer readily adheres to the fuel injection valve front end portion, and therefore, a deposit no longer readily accumulates. Moreover, due to the fact that the tapered edge of the fuel injection valve front end portion is formed flush with the fuel injection valve body front end surface when the valve body is closed, the fuel does not adhere to the peripheral surface of the valve body nor to the valve seat, and therefore, a deposit also does not adhere." *Id.*

46. *Masubuchi* also discloses: "The front end portion 9 of the fuel injection valve 1 extends in a ring shape around the valve seat 10, and a cross-sectional shape of the front end portion 9 forming a ring shape is formed in a knife-edge shape which forms an acute angle β. Additionally, a cross-sectional shape of the front end rim portion of the valve body 11 is also formed in a knife-edge shape which forms an acute angle α." *Id.* at 4.

47. *Masubuchi* also discloses: "[A]s shown in FIG. 2, when the periphery of the fuel injection valve front end portion 9 is formed from a conical outer peripheral surface 14, the pressure around the front end surface 9 no longer decreases so much, because the quantity of air surrounding the front end surface 9 is greater than when the fuel injection valve front end surface has a broad surface area as in the prior art. As a result, the action of drawing in of the fuel toward the area around the front end surface 9 becomes weaker. Moreover, the distance between the sprayed fuel and the conical outer peripheral surface 14 increases in length, because the periphery of the fuel injection valve front end portion 9 is formed from a conical outer peripheral surface 14, and thus, the injected fuel no longer readily reaches the conical outer peripheral surface 14. As a result, the fuel no longer readily adheres to the conical outer peripheral surface 14, thus making it possible to prevent the formation of large quantities of uncombusted HC and CO. In addition, once the fuel is sprayed, although the fuel adheres to the conical inner wall surface of the valve seat 10, and to the conical outer peripheral surface of the valve body 11, as long as the valve body 11 is closed, as shown in FIG. 2, this adhering fuel is not directly exposed to the combustion gas. Consequently, no uncombusted HC and CO is formed by this adhering fuel, and there is also no change in the spreading angle of the fuel, because deposits do not accumulate on

Mapping of Masubuchi To Claim 1.2 (Cont.)

the conical inner wall surface of the valve seat 10 nor on the conical outer periphery surface of the valve body 11." *Id.* at 4-5.

48. *Masubuchi* also discloses: "It is possible to prevent the formation of uncombusted HC and CO, because fuel adhering to the conical inner wall surface of the valve seat and to the cylindrical outer peripheral surface of the valve body is not directly exposed to the combustion gas. Moreover, there is no change in the spreading angle of the fuel because there is no adhesion of deposits. In addition, the formation of uncombusted HC and CO can be inhibited, because it is possible to inhibit injected fuel from adhering to the outer peripheral surface of the front end portion of the fuel injection valve and from adhering to the front end surface of the valve body." *Id.*

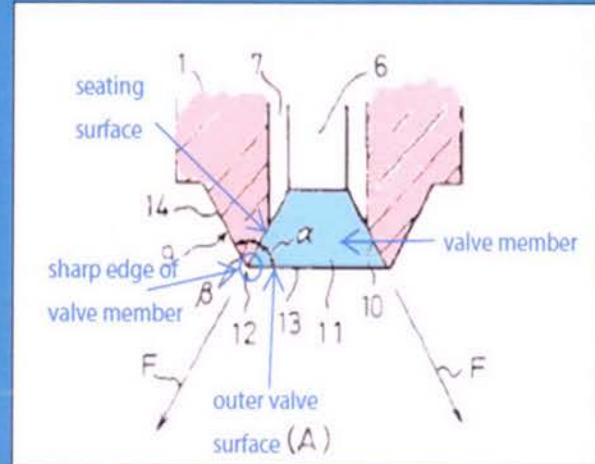
49. As discussed above, *Masubuchi* discloses preventing deposit buildup. In my opinion, a POSITA would recognize that deposits, to the extent deposits do form, will be more susceptible to falling off and thus more easily dislodged by the shearing effect of the fuel issuing from the exit of the orifice passage (as well as the other currents present in the combustion chamber, and at or adjacent the exit of the orifice passage). *Id.* at 3-5. To the extent that *Masubuchi* does not explicitly discuss the shearing effect, it is also my opinion that a POSITA would recognize that the shearing effect would dislodge deposits, as evidenced, *e.g.*, by *Kubach*, Ex. 1015, disclosing a sharp edge 61 preventing "deceleration of the lamella" as well as deposit removal via shearing effect. *Id.* at 2:66-3:3, 3:47-48, 5:62-6:13, 6:58-64, 7:14-65, Figs. 4-5. A POSITA would also recognize, in my opinion, that movement of the knife edge of the valve body 11 away from and then back toward and against the valve seat 10 will further help to break and dislodge deposits at or adjacent an exit of the nozzle orifice. Ex. 1002 at Fig. 2.

61. *Masubuchi* discloses that the knife edges on the valve body 11 and on the valve seat 10 facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the ring-shaped nozzle orifice. *Id.* at 3-5. In my opinion, a POSITA would recognize that because *Masubuchi* discloses that the knife edges of the valve body 11 and valve seat 10 effect the quantity of air surrounding the front end surface 9, thus effecting the pressure and the bias against the drawing in of fuel toward the area around the front end surface 9 during injection, the knife edges "facilitate the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage." *Id.* at 3-5, Fig. 2. It is also my opinion that a POSITA would recognize that over expansion of the fuel spray would also be prevented because deposits do not accumulate on the conical inner wall surface of the valve seat 10 nor on the conical outer periphery surface of the valve body 11. *Id.* at 4-5.

62. For example, *Masubuchi* discloses at 3, "When the cross-sectional shape of the fuel injection valve front end portion is formed in a knife-edge shape, the fuel which is drawn back no longer readily reaches the periphery surface of the fuel injection valve front end portion, so the fuel no longer readily adheres to the fuel injection valve front end portion, and therefore, a deposit no longer readily accumulates." *Id.* at 4-5 ("[A]s shown in FIG. 2, when the periphery of the fuel

Mapping of Masubuchi To Claim 2

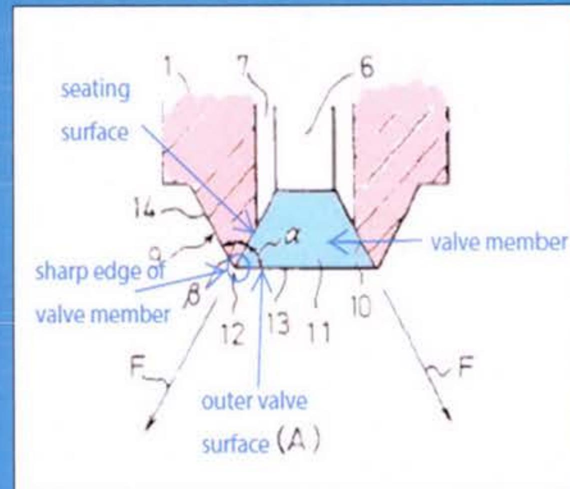
2. An injector nozzle according to claim **1**, wherein the sharp edge acts as a deposit breaking edge to thereby facilitate deposit removal from the injector nozzle.



49. As discussed above, *Masubuchi* discloses preventing deposit buildup. In my opinion, a POSITA would recognize that deposits, to the extent deposits do form, will be more susceptible to falling off and thus more easily dislodged by the shearing effect of the fuel issuing from the exit of the orifice passage (as well as the other currents present in the combustion chamber, and at or adjacent the exit of the orifice passage). *Id.* at 3-5. To the extent that *Masubuchi* does not explicitly discuss the shearing effect, it is also my opinion that a POSITA would recognize that the shearing effect would dislodge deposits, as evidenced, *e.g.*, by *Kubach*, Ex. 1015, disclosing a sharp edge 61 preventing "deceleration of the lamella" as well as deposit removal via shearing effect. *Id.* at 2:66-3:3, 3:47-48, 5:62-6:13, 6:58-64, 7:14-65, Figs. 4-5. A POSITA would also recognize, in my opinion, that movement of the knife edge of the valve body 11 away from and then back toward and against the valve seat 10 will further help to break and dislodge deposits at or adjacent an exit of the nozzle orifice. Ex. 1002 at Fig. 2.

Mapping of Masubuchi To Claim 4

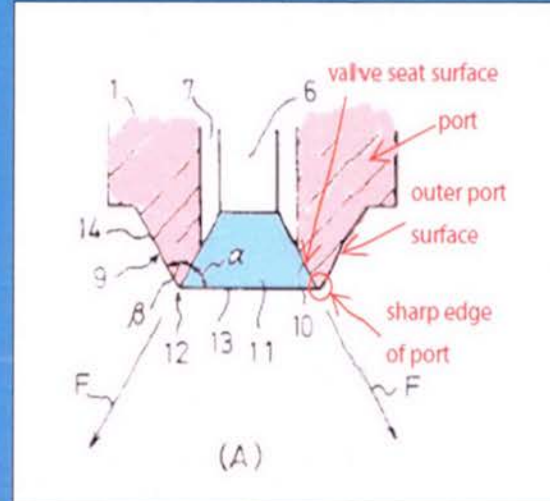
4. An injector nozzle according to claim **1**, wherein an acute angle is provided between the seating surface and the outer valve surface of the valve member at the sharp edge transition.



50. *Masubuchi* discloses that an acute angle is provided between the seating surface and the front end surface 13 of the valve body 11 at the sharp edge transition. *Id.* at 4 ("Additionally, a cross-sectional shape of the front end rim portion of the valve body 11 is also formed in a knife-edge shape which forms an acute angle α."); *id.* at Fig. 2.

Mapping of Masubuchi To Claim 5

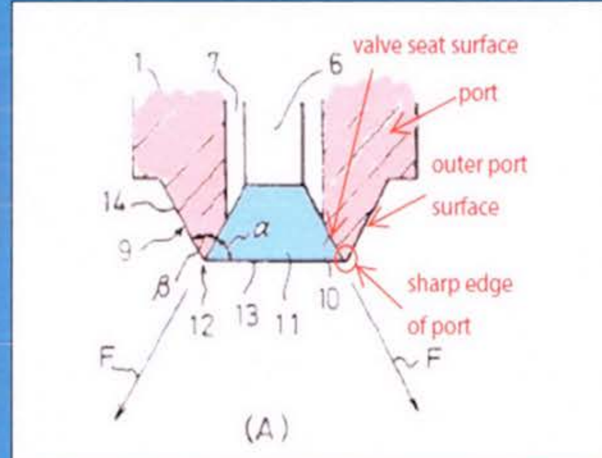
5. An injector nozzle according to claim **1**, wherein the port includes an outer port surface surrounding and located adjacent to the valve seat surface, and a sharp edge is provided at the transition between the valve seat surface and the outer port surface.



51. *Masubuchi* discloses that the valve seat 10 includes an outer peripheral surface 14 (the claimed "outer port surface") surrounding and located adjacent to the valve seat surface, and a knife edge (the claimed "sharp edge of the port") is provided at the transition between the valve seat surface and the outer peripheral surface 14. *Id.* at 4 ("The front end portion 9 of the fuel injection valve 1 extends in a ring shape around the valve seat 10, and a cross-sectional shape of the front end portion 9 forming a ring shape is formed in a knife-edge shape which forms an acute angle β."); *id.* at Fig. 2. The "outer port surface" and the "sharp edge of the port" are identified below in annotated Fig. 2:

Mapping of Masubuchi To Claim 7

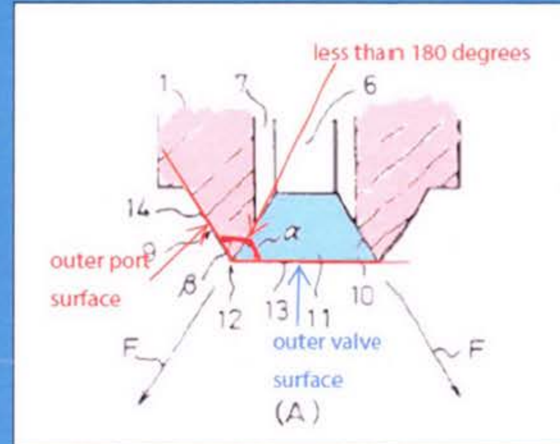
7. An injector nozzle according to claim **5**, wherein an acute angle is provided between the valve seat surface and the outer port surface of the port at the sharp edge transition.



52. *Masubuchi* discloses that an acute angle is provided between the valve seat surface and the outer peripheral surface 14 of the valve seat 10 at the knife edge transition. *Id.* at 4 ("[T]the front end portion 9 forming a ring shape is formed in a knife-edge shape which forms an acute angle β."); *id.* at Fig. 2.

Mapping of Masubuchi To Claim 10

10. An injector nozzle according to claim **5**, wherein the angle between the outer valve surface and the outer port surface is less than 180 degrees.

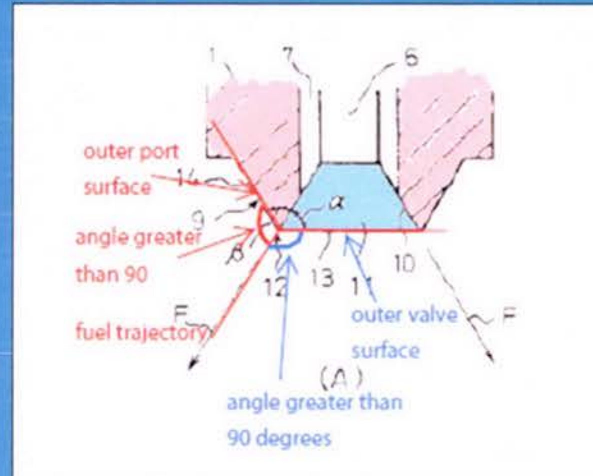


53. As shown below in annotated Figure 2, *Masubuchi* discloses that the angle between the outer peripheral surface 14 and the front end surface 13 is less than 180 degrees. *Id.* at 4 ("[T]he front end rim portion of the valve body 11 is also formed in a knife-edge shape which forms an acute angle α."); *id.* ("[T]he front end portion 9 forming a ring shape is formed in a knife-edge shape which forms an acute angle β."); *id.* at Fig. 2.

54. It is also my opinion that a POSITA would recognize that because the angle between the front end surface 13 and the outer peripheral surface 14 is equal to the sum of angles α and β, which are both acute, the corresponding angle between the outer valve surface and the outer port surface must be less than 180 degrees. *Id.* at 4, Fig. 2.

Mapping of Masubuchi To Claim 13

13. An injector nozzle according to claim **5**, wherein the angles between each of the outer valve surface and the outer port surface and a fuel exit trajectory are arranged to be greater than 90 degrees.

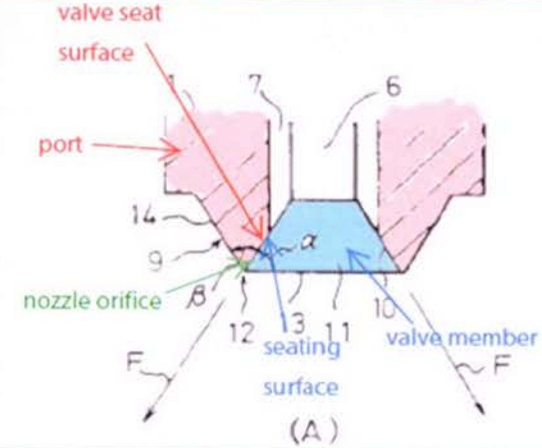


55. As shown below in annotated Figure 2, *Masubuchi* discloses that the angles between each of the front end surface 13 and the outer peripheral surface 14 and the fuel spread F ("the claimed fuel exit trajectory") are arranged to be greater than 90 degrees. *Id.* at 4, Fig. 2.

56. It is also my opinion that a POSITA would recognize that because the angle between the front end surface 13 and the fuel spread F equals 180 degrees minus α, which is acute, the angle between the front end surface 13 and the fuel spread F must be greater than 90 degrees. *Id.* Similarly, because the angle between the outer peripheral surface 14 and the fuel spread F equals 180 degrees minus β, which is also acute, the angle between the outer peripheral surface 14 and F must also be greater than 90 degrees. *Id.*

Mapping of Masubuchi To Claim 14

14. An injector nozzle according to claim **1**, the nozzle being of the outwardly opening poppet valve type.



57. *Masubuchi* discloses that the fuel injection valve is of the outwardly opening poppet valve type. *Id.* at 4 ("When the needle 6 is caused to descend and the valve body 11 moves away from the valve seat 10, the fuel is sprayed into the combustion chamber 2 from the nozzle orifice formed between the valve body 11 and the valve seat 10. When this happens, the fuel advances along the conical inner wall surface of the valve seat 10 and thus the fuel spreads conically within the combustion chamber 2 in a manner indicated by F in FIG. 2 (A)."); *id.* at 3 ("[S]o as to cause fuel to spray from between the valve body and the valve seat by causing the valve body to move in an outward direction."); *id.* at Figs. 1-2.

58. In my opinion, because *Masubuchi* discloses that the valve body 11 "move[s] in an outward direction" away from the valve seat 10, a POSITA would recognize the fuel injection valve of *Masubuchi* is "of the outwardly opening poppet valve type." *Id.* at 3-4, Figs. 1-2.

Mapping of Masubuchi To Claim 15

15. An injector nozzle according to claim 1, the nozzle being arranged to deliver fuel directly into at least one combustion chamber of the engine.

59. *Masubuchi* discloses that the fuel injection valve is arranged to delivery fuel directly into at least one combustion chamber of the engine. *Id.* at 4 ("The fuel injection valve 1 is attached to a cylinder head 3 for injecting fuel into a fuel chamber 2 of an internal combustion engine.").

Mapping of Masubuchi To Claim 16

16. An injector nozzle according to claim **5**, wherein the sharp edge on the valve member is formed in a separate step to the sharp edge on the port.

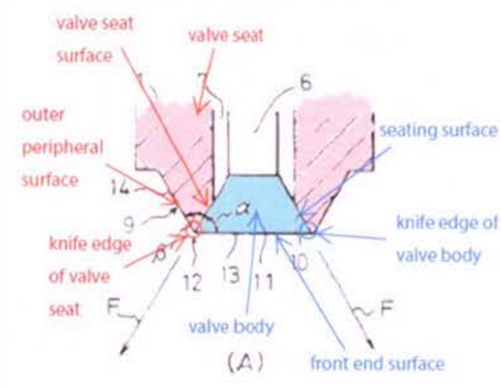


FIG. 2

60. *Masubuchi* discloses that the knife edge on the valve body 11 is formed in a separate step to the knife edge on the valve seat 10. *Id.* at 3 ("[T]he fuel injection valve made by forming a cross-sectional shape of a fuel injection valve front end portion formed in a ring shape to form a conical valve seat formed in a knife-edge shape forming an acute angle, and by forming a cross-sectional shape of a front end rim portion of the valve body formed in a knife-edge shape forming an acute angle, and by forming a tapered edge of the fuel injection valve front end portion formed to be flush with the fuel injection valve body front end surface when the valve body is closed."); *see also id.* at 4-5. In light of at least this disclosure of *Masubuchi*, in my opinion, a POSITA would recognize that *Masubuchi* discloses that the knife edge of the valve body 11 is formed in a separate step to the knife edge of the valve seat 10.

Mapping of Masubuchi To Claim 18

18. An injector nozzle according to claim **5**, wherein the sharp edges on the valve member and on the port facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage.

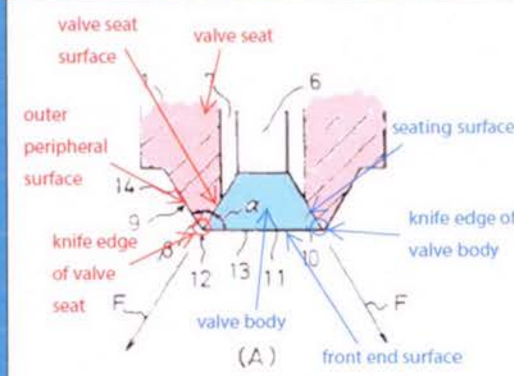


FIG. 2

61. *Masubuchi* discloses that the knife edges on the valve body 11 and on the valve seat 10 facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the ring-shaped nozzle orifice. *Id.* at 3-5. In my opinion, a POSITA would recognize that because *Masubuchi* discloses that the knife edges of the valve body 11 and valve seat 10 effect the quantity of air surrounding the front end surface 9, thus effecting the pressure and the bias against the drawing in of fuel toward the area around the front end surface 9 during injection, the knife edges "facilitate the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage." *Id.* at 3-5, Fig. 2. It is also my opinion that a POSITA would recognize that over expansion of the fuel spray would also be prevented because deposits do not accumulate on the conical inner wall surface of the valve seat 10 nor on the conical outer periphery surface of the valve body 11. *Id.* at 4-5.

62. For example, *Masubuchi* discloses at 3, "When the cross-sectional shape of the fuel injection valve front end portion is formed in a knife-edge shape, the fuel which is drawn back no longer readily reaches the periphery surface of the fuel injection valve front end portion, so the fuel no longer readily adheres to the fuel injection valve front end portion, and therefore, a deposit no longer readily accumulates." *Id.* at 4-5 ("[A]s shown in FIG. 2, when the periphery of the fuel injection valve front end portion 9 is formed from a conical outer peripheral surface 14, the pressure around the front end surface 9 no longer decreases so much, because the quantity of air surrounding the front end surface 9 is greater than when the fuel injection valve front end surface has a broad surface area as in the prior art. As a result, the action of drawing in of the fuel toward the area around the front end surface 9 becomes weaker" (emphasis added).) Moreover, the distance between the sprayed fuel and the conical outer peripheral surface 14 increases in length, because the periphery of the fuel injection valve front end portion 9 is formed from a conical outer peripheral surface 14, and thus, the injected fuel no longer readily reaches the conical outer peripheral surface 14. As a result, the fuel no longer readily adheres to the conical outer peripheral surface 14, thus making it possible to prevent the formation of large quantities of uncombusted HC and CO.

Mapping of Masubuchi To Claim 18 (cont.)

18. An injector nozzle according to claim **5**, wherein the sharp edges on the valve member and on the port facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage.

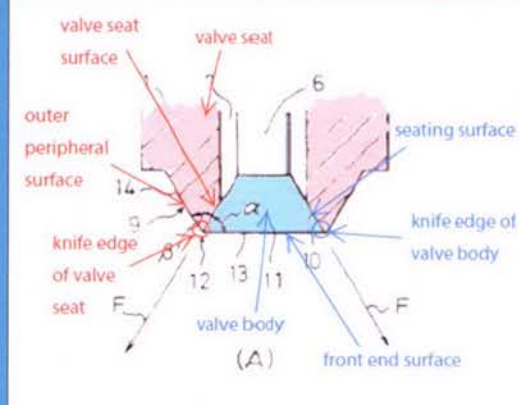


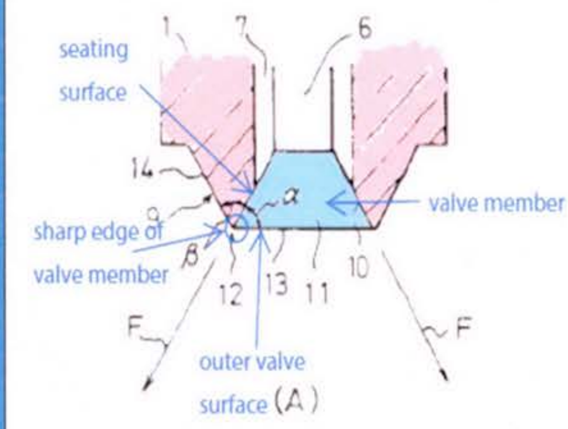
FIG. 2

the conical inner wall surface of the valve seat 10 nor on the conical outer periphery surface of the valve body 11." *Id.* at 4-5.

48. *Masubuchi* also discloses: "It is possible to prevent the formation of uncombusted HC and CO, because fuel adhering to the conical inner wall surface of the valve seat and to the cylindrical outer peripheral surface of the valve body is not directly exposed to the combustion gas. Moreover, there is no change in the spreading angle of the fuel because there is no adhesion of deposits. In addition, the formation of uncombusted HC and CO can be inhibited, because it is possible to inhibit injected fuel from adhering to the outer peripheral surface of the front end portion of the fuel injection valve and from adhering to the front end surface of the valve body." *Id.*

Mapping of Masubuchi To Claim 19

19. An injector nozzle for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel therethrough or sealed contact therebetween to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.



Claim 19

19. **"An injector nozzle for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode, said injector nozzle including"**

63. In my opinion, a POSITA would recognize that the fuel injection valve of *Masubuchi* is capable of being used with a spark-ignited fuel injected internal combustion engine operated in stratified charge mode.

19.1 "a port having a valve seat surface and valve member having a seating surface"

64. *See* Limitation 1.1.

19.1.1"said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel,"

65. *See* Limitation 1.1.1.

19.1.2"the valve member including an outer valve surface located adjacent the seating surface and external to the port"

66. *See* Limitation 1.1.2.

19.2 "wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage"

67. *See* Limitation 1.2.

Masubuchi

Reference(s)	Basis	Challenged Claim(s)
Masubuchi	§ 103(a)	1, 2, 4, 5, 7, 10, 13–16, 18, 19
Masubuchi and Breslau	§ 103(a)	16
Masubuchi and Bishop	§ 103(a)	19

Obviousness of Masubuchi Over Claims 1, 2, 4-5, 7, 10, 13-16, 18, 19

* '01254, Ex. 1004 at 54-63

Obviousness of claims 1, 2, 4-5, 7-10, 13-16, 18, 19 over Masubuchi

98. To the extent that the Board finds that the term "sharp edge" should be construed as "an edge having a radius of curvature less than 0.2 mm" and also finds any of *Masubuchi* and *Sczomak* as not disclosing such an edge, in my opinion, it would have been obvious to a POSITA to implement each knife edge of *Masubuchi* and *Sczomak* with a radius of curvature less than 0.2 mm. In my opinion, a POSITA at the relevant time would have been motivated to form the knife edges of *Masubuchi* and *Sczomak* with a radius of curvature less than 0.2 mm to optimize control of the formation of deposits. It is further my opinion that since *Masubuchi* and *Sczomak* disclose everything else in the claims, discovering the optimum or workable ranges for the radius of curvature to do so would involve only routine skill in the art for a POSITA. In my opinion, a POSITA would recognize that such discovery is not inventive. Here, it is my opinion that a POSITA would recognize and appreciate that because the general conditions of the claim (i.e., knife edges) are disclosed in the prior art of *Masubuchi* and *Sczomak*, discovering the optimum or workable ranges for the radius of curvature of these edges would involve only routine skill in the art. And it is also my opinion that because *Masubuchi* and *Sczomak* each associate knife edges with control and reduction in deposit formation, a POSITA at the relevant time would have appreciated and recognized the knife edges as result-effective variables, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges.

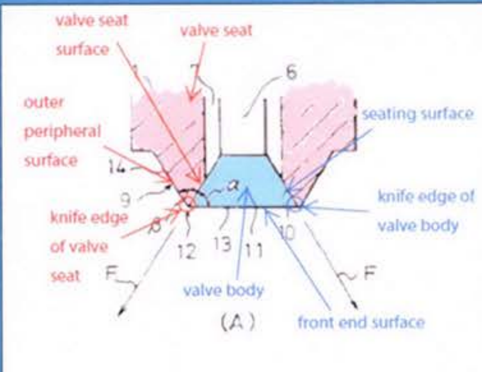


FIG. 2

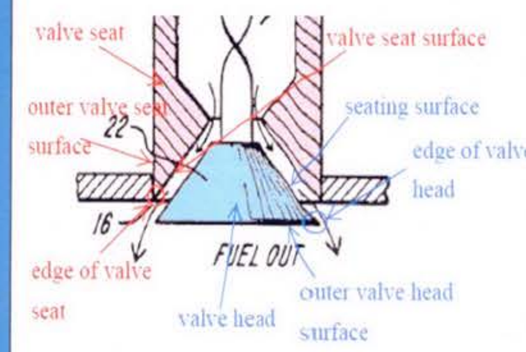
99. It is also my opinion that a POSITA at the relevant time would also have been motivated to implement the knife edges of *Masubuchi* and *Sczomak* with a radius of curvature less than 0.2 mm, in an effort to achieve additional control and reductions in deposit formation. In my opinion, such a modification would constitute no more than an obvious design choice—one of a "finite number of identified, predictable solutions"—to a POSITA at the relevant time. It is also my opinion that a POSITA at the relevant time, and cognizant of the benefits in the control and reduction of deposit formation provided by the knife edges as taught by *Masubuchi* and *Sczomak* would have further appreciated and recognized a design need or market pressure to achieve additional control and reductions in deposit formation. Further, in my opinion, a POSITA would have further recognized that there are a finite and predictable number of potential solutions, such as, for example, making the radius of the sharp edge with a radius of curvature less than 0.2 mm, and with a reasonable expectation of success, would have done so.

Obviousness of claim 16 over Masubuchi and Breslau

100. I have been informed that claim 16 depends from claim 5 and independent claim 1 and thus requires that "the sharp edge on the valve member [be] formed in a separate step to the sharp edge on the port." Ex. 1001 at 9:8-10. As explained below, in my opinion, the teachings of *Masubuchi* in combination with the teachings of *Breslau* would render claim 16 of the '387 patent obvious to a POSITA.

101. As discussed above, *Masubuchi* discloses all features of claims 1 and 5, including, for example, a fuel injection valve including a knife edge provided on the valve body 11 at the transition between the seating surface and the front end surface 13 (per claim 1) thereof as well as a knife edge provided on the valve seat 10 at the transition between the valve seat surface and the outer peripheral surface 14 (per claim 5). In my opinion, it would have been obvious to one of ordinary skill in the art to form the knife edge of the valve body 11 in a separate step to the knife edge on the valve seat 10 of *Masubuchi*.

102. In my opinion, forming an edge of a valve member separate from an edge of a port was well-known in the art. For example, U.S. Patent No. 4,846,217 to *Breslau*, Ex. 1006, issued on July 11, 1989. I have been informed that *Breslau* is prior art under 35 U.S.C. § 102(b). *Breslau* discloses an outwardly opening fuel injection valve 10 arranged to deliver fuel directly into at least one combustion chamber of an internal combustion engine. *Id.* at abstract, Figs. 1-5. As shown in annotated Figure 1B (below), *Breslau* discloses that the injector nozzle includes a valve seat 16 (shown in red) and a valve head 22 (shown in blue). *Id.* at 3:39-49, Figs. 1-4. *Breslau* also discloses that the valve seat 16 has a valve seat surface and



an outer valve seat surface surrounding and adjacent to the valve seat 16, and that the valve head 22 has a seating surface and an outer valve head surface adjacent to the seating surface and external to the valve seat 16. *Id.*

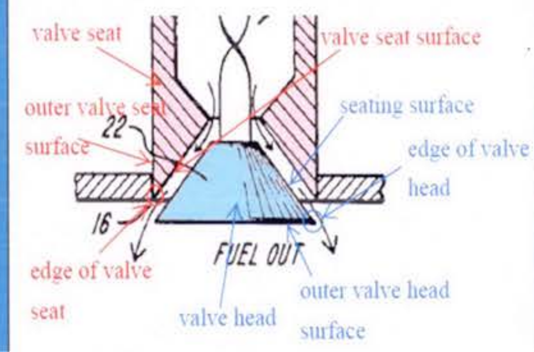
103. *Breslau* further discloses that the valve head 22 is movable relative to the valve seat 16 to respectively provide a nozzle passage between valve seat 16 and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel. *Id.* at 3:43-46. Additionally, *Breslau* depicts a sharp edge at the transition between the seating surface and the outer valve head surface of the valve head 22, as well as a sharp edge at the transition between the valve seat surface and the outer valve seat surface of the valve seat 16. *Id.*

104. *Breslau* further discloses forming the edge of the valve head 22 separately from the edge of the valve seat 16. *Id.* at 3:50-68 ("[A] valve stem 20 is cold formed (forged) from stainless steel alloy 302 (SAE 30 302) to a shape that includes a short conical head portion . . . . The partially-formed valve stem can then be fed into a finishing machine where the tail is held while the valve head is

Obviousness of claim 16 over Masubuchi and Breslau (Cont.)

ground to a final shape."); *id.* at 4:3-16 ("The cylindrical body part [of the valve body] can be cold forged from stainless steel alloy 304 (SAE 30 304). . . . Then a grinding head finishes the valve seat. As shown in FIGS. 1A and 1B the valve seat is preferably formed as a cylindrical beveled surface which is mated with the conical valve head having the same angular shape and dimensions."); *id.* at 4:26-28 ("The nozzle can then be assembled by inserting the valve stem 20 into the valve body 12, such that the valve head 20 and seat 16 mate.").

105. And *Breslau* further explains the advantages of implementing such a separate manufacturing process, which include, for example, reducing the need for precision in forming operations; helping ensure alignment and proper mating of the surfaces of the valve seat with the valve body; helping reduce the risk of alignment problems and maladjustment; and providing a manufacturer the ability to vary the spray pattern of the valves by simply changing the shape of the valve body and/or seat. *Id.* at 2:50-53, 2:57-58 ("Additionally, the valve head and valve seat can be formed by mating beveled surfaces; seating is accomplished with much less need for precision in the forming operations . . . . the valves of the present invention are largely insensitive to alignment problems"); *id.* at 1:60-61 ("which could be cycled with minimal risk of . . . maladjustment."); *id.* at 5:7-9 ("the spray pattern of the valves disclosed herein can be varied by changing the shape of the valve head and/or seat.").



106. In my opinion, a POSITA at the relevant time would have been motivated to form the knife edge of the valve body 11 in a separate step to the knife edge on the valve seat 10 of *Masubuchi*, as in *Breslau*, in order to reduce the need for precision in forming operations; help ensure alignment and proper mating of the surfaces of the valve body 11 with the valve seat 10; and help reduce the risk of alignment problems and maladjustment. *Id.* at 1:60-61, 2:50-53, 2:57-58, 5:7-9. It is also my opinion that a POSITA would have done so to allow the manufacturer to vary the spray pattern of the fuel injector by changing the shape of the valve body 11 with the valve seat 10 of *Masubuchi*. Further, in my opinion, such an implementation of *Masubuchi* would constitute no more than an obvious manufacturing choice—one of a "finite number of identified, predictable solutions" (to either form the two knife edges in a single step or in separate steps)—to a POSITA at the relevant time.

Obviousness of claim 19 over Masubuchi with Bishop

107. I have been informed that the only difference between independent claim 19 and independent claim 1 is the following italicized language from the preamble: "[a]n injector nozzle *for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode*, said injector nozzle including." Ex. 1001 at 10:3-5. As explained below, in my opinion, the teachings of each of *Masubuchi* and *Sczomak* in combination with the teachings of *Bishop* would render claim 19 of the '387 patent obvious to a POSITA.

108. As discussed above, *Masubuchi* and *Sczomak* each disclose an injector valve/nozzle for a fuel injected internal combustion engine. In my opinion, it would have been obvious to a POSITA to implement the fuel injection valve of *Masubuchi* and the fuel injector nozzle of *Sczomak* in a spark-ignited fuel injected internal combustion engine operating in stratified charge mode. In my opinion, the use of an injector nozzle in a spark-ignited fuel injected internal combustion engine operating in stratified charge mode was well-known in the art, as acknowledged, e.g., by the '387 patent. *See* Ex. 1001 at 2:1-13 ("The above discussed disturbances to the delivery of fuel to the combustion chamber of an engine are particularly significant in engines which, for at least part of engine load range, operate with a highly stratified fuel charge *such as is recognized* as highly desirable to control exhaust emissions, particularly during low load operation" (emphasis added).). According to the '387 patent, "An example of such a stratified charge engine is one employing a dual fluid fuel injection system such as that disclosed in the Applicants U.S. Patent Nos. 4,693,224 and RE 36768," both of which are prior art under 35 U.S.C. § 102(b). *Id.* at 2:6-10.

109. As another example, U.S. Patent No. 3,542,293 to Bishop et al. ("*Bishop*"), Ex. 1005, issued on November 24, 1970. I have been informed that *Bishop* is prior art under 35 U.S.C. § 102(b). *Bishop* discloses an injector nozzle in a spark-ignited fuel injected internal combustion engine operated in stratified charge mode. *Id.* at 1:17-21 ("The injector of this invention is particularly useful in a stratified charge type internal combustion engine such as the engine described in Bishop et al., U.S. Patent No. 3,315,650"); *see also Bishop '650*, Ex. 1011, at 1:15-20 ("[This invention] relates to *a stratified charge combustion process for an internal combustion engine of the spark-ignition type* in which fuel is burned in an excess of air at part loads and full utilization of the air is made at maximum loads" (emphasis added.)); *id.* at 4:6-13 ("In a stratified charge engine, only that portion of the air that is adjacent the spark plug is impregnated with gasoline or fuel at the time of ignition. As a result, light-load fuel quantities can be mixed with a small portion of the air so that the local air-fuel ratio around the spark plug is sufficiently high to permit reliable ignition, and yet a quantity of excess air may be present in the cylinder."). *Bishop* explains that doing so helps achieve optimum performance and economy of the engine. Ex. 1005 at 1:19-24 ("Accurate fuel delivery over a wide range of flow rates is essential in such an engine, and this injector performs exceptionally well in achieving the optimum performance and economy of the engine.").

110. In my opinion, a POSITA at the relevant time would have been motivated to implement the fuel injection valve/nozzle of *Masubuchi* and *Sczomak*

Obviousness of claim 19 over Masubuchi with Bishop (Cont.)

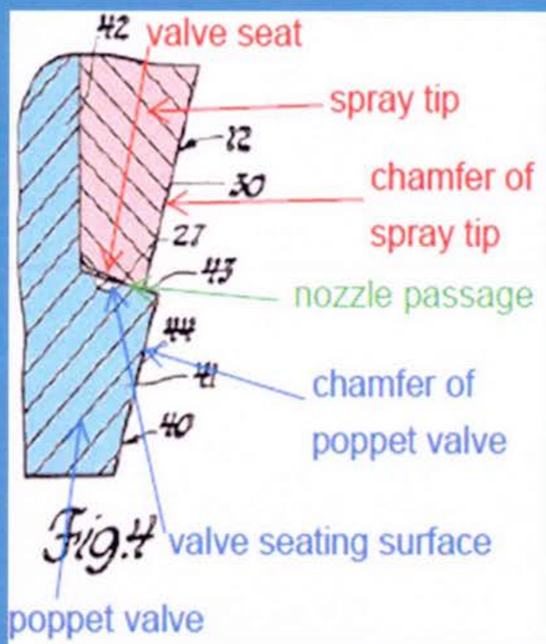
in a spark-ignited fuel injected internal combustion engine operating in stratified charge mode, as in *Bishop*, in order to achieve accurate fuel delivery over a wide range of flow rates and thus help achieve optimum performance and economy of the engine. *Id.* at 1:19-24. It is further my opinion that such an implementation of *Masubuchi* and *Sczomak* would constitute no more than an obvious design choice—one of a "finite number of identified, predictable solutions"—to a POSITA at the relevant time. It is also my opinion that such a modification would simply improve fuel delivery, performance, and economy of the engine disclosed by *Masubuchi* and *Sczomak* in the same way as it improves an engine in *Bishop* (e.g., providing such an engine with accurate fuel delivery over a wide range of flow rates so as to help achieve optimum performance and economy of the engine is essential in such an engine).

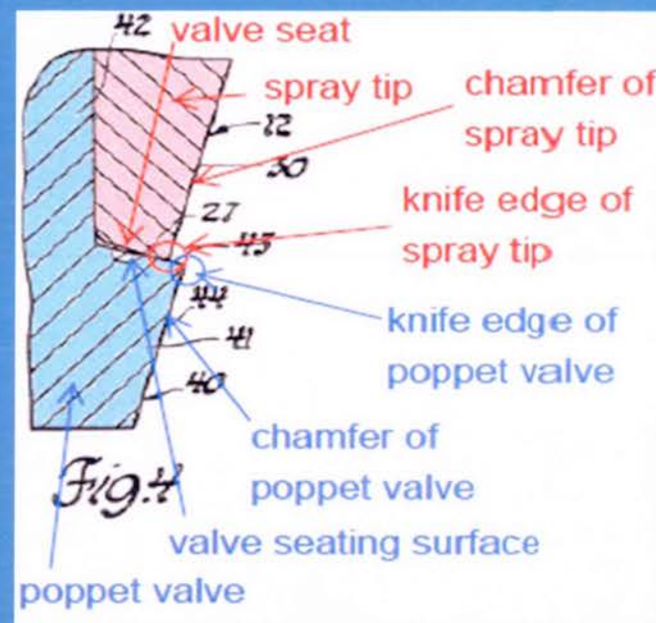
111. It is also my opinion that a POSITA would recognize that direct fuel injectors for both spark ignited and diesel engines (*Sczomak*) share the common problem of injector deposits affecting the spray pattern, fuel delivery, and thus performance and economy of the engine, and a POSITA would have been further motivated to implement the fuel injection nozzle of *Sczomak* in a spark-ignited fuel injected internal combustion engine operating in stratified charge mode so as to take advantage of the deposit formation controlling features of *Sczomak*, discussed above; thus helping improve fuel delivery, and thus performance and economy of the engine. Indeed, known work in one field of endeavor may prompt variations of it for use in the same field or a different one based on design incentives or other market forces. *Id.*

112. In my opinion, a POSITA would recognize that such a modification and improvement could be achieved by simply substituting the engine of *Masubuchi* and *Sczomak* (e.g., internal combustion engines) with another known engine (spark-ignited fuel injected internal combustion engine operating in stratified charge mode) and would yield nothing more than a predictable result. In fact, *Bishop* itself refers to the applicability of his injector for stratified charge engines to conventional engines. Ex. 1005 at 1:19-24 ("[m]any features of the injector also are useful in conventional fuel injected reciprocating-type engines."). Therefore, in my opinion, in further light of *Bishop*'s teaching of the use of its fuel injector with either internal combustions engine operating in stratified charge mode or other conventional engines, it would have been obvious to a POSITA, at the relevant time, to implement the fuel injection valve/nozzles of *Masubuchi* and *Sczomak* in a stratified charge mode internal combustion engine, yielding the predictable advantage of helping achieve optimum performance and economy of the engine, as taught by *Bishop*.

Sczomak

Reference(s)	Basis	Challenged Claim(s)
Sczomak	§ 102(b)	1, 2, 4, 5, 7–9, 14–16, 18, 19
Sczomak	§ 103(a)	1, 2, 4, 5, 7–9, 14–16, 18, 19
Sczomak and Breslau	§ 103(a)	16
Sczomak and Bishop	§ 103(a)	19





Sczomak

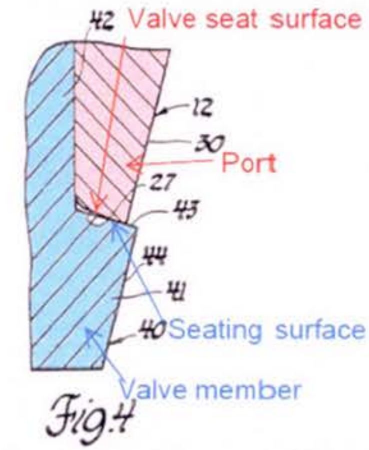
Reference(s)	Basis	Challenged Claim(s)
Sczomak	§ 102(b)	1, 2, 4, 5, 7–9, 14–16, 18, 19

Sczomak Discloses All Elements Of Claims 1, 2, 4-5, 7, 10, 13-16, 18, 19

* '01254, Ex. 1004 at 35-53

Mapping of Sczomak To Claim 1.0, 1.1

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.



73. *Sczomak* discloses an injection nozzle for a fuel injected internal combustion engine. *Id.* at 2:29-35 ("The fuel injection nozzle 5 is of a type that is adapted to . . . discharge fuel into an associated combustion chamber of the engine."); *see also id.* at abstract, 1:44-53, 2:29-35, Fig. 1.

74. *Sczomak* discloses that the injection nozzle includes a spray tip 12 (the claimed "port") having a valve seat 27 (the claimed "valve seat surface") and a poppet valve 40 (the claimed "valve member") having a valve seating surface 43 (the claimed "seating surface"). *Id.* at 3:27-53, Figs. 4-5. The "port" and corresponding structures including the "valve seat surface" are identified below in red. The "valve member" and corresponding structures including the "seating surface" are identified in blue below in annotated Figure 4.

Mapping of Sczomak To Claim 1.1.1

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.

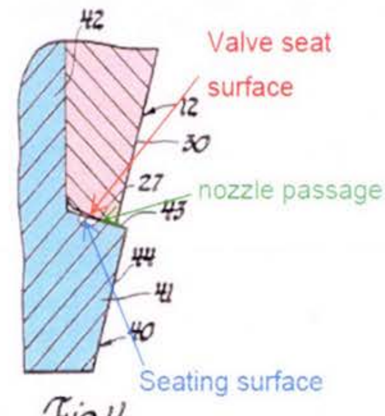


Fig.4

75. *Sczomak* discloses that the poppet valve 40 is movable relative to the spray tip 12 to respectively provide a nozzle passage between the valve seat 27 and the valve seating surface 43 for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel. *Id.* at 1:51-53 ("[W]hereby the spray orifices are covered upon closure of the poppet valve."); *id.* at 5:12-15 ("[T]o insure penetrating fuel sprays as soon as the poppet valve 40 lifts from the valve seat 27."); *id.* at 6:60-63 ("[S]aid poppet valve including an annular head with a frusto-conical valve seat surface positioned for movement between a closed position and an outward open position relative to said valve seat."); *id.* at 1:66-2:2 ("[D]irectly across the frusto-conical seating surface of the head of the poppet valve which in turn is adapted to seat against the outer edge of a frusto-conical valve seat encircling the lower discharge end of the spray tip body of the injection nozzle."); *see also id.* at 1:44-53, 5:13-15, 6:60-7:2, Figs. 4-5. The "nozzle passage" is shown in green below in annotated Figure 4:

Mapping of Sczomak To Claim 1.1.2

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.

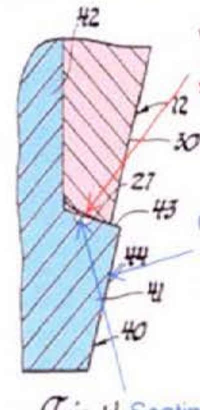
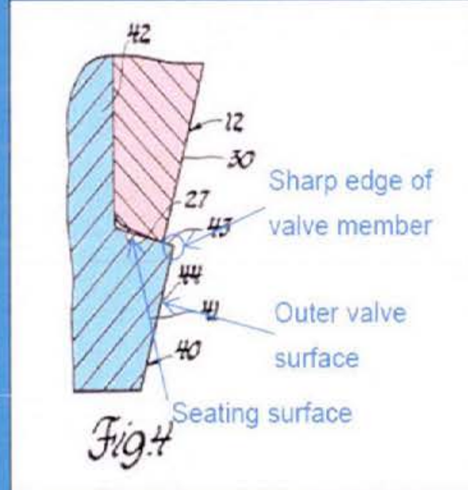


Fig.4

76. *Sczomak* discloses that the poppet valve 40 includes a chamfer 44 (the claimed "outer valve surface") located adjacent the valve seating surface 43 and external to the spray tip 12. *Id* at Figs. 4-5. The "outer valve surface" is identified below in annotated Figure 4.

Mapping of Sczomak To Claim 1.2

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.

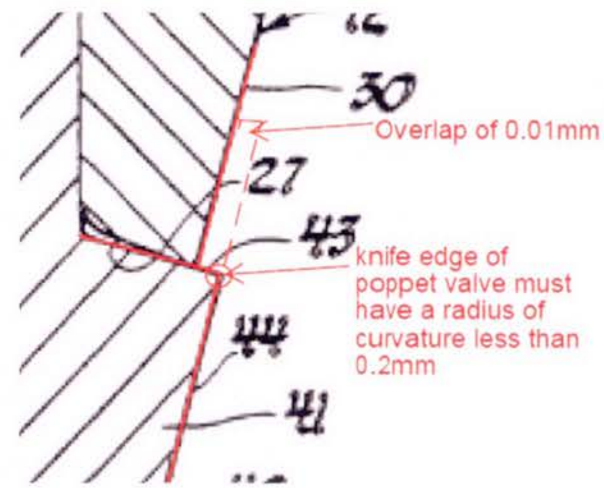


77. *Sczomak* discloses a knife edge (the claimed "sharp edge") is provided on the poppet valve 40 at the transition between the valve seating surface 43 and the chamfer 44 thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage. The "sharp edge" is identified adjacent in annotated Figure 4 below.

78. It is my opinion that a POSITA would recognize that because *Sczomak* discloses that "the head 41 below the valve seat surface 43 is also provided with a chamfer 44 *formed complementary to the chamfered 30* lower end of the spray tip 12." *id.* at 3:50-53, and because the "chamfer 30 [] intersect[s] the valve seat 27 and to define therewith a so-called knife edge." *id.* at 3:14-17, the chamfer 40 intersects the valve seating surface 43 of the poppet valve 40 to also define a knife edge. *Id.* at 3:14-17, 3:50-53, Fig. 4. It is also my opinion that a POSITA would recognize that because *Sczomak* discloses that the poppet valve 40

Mapping of Sczomak To Claim 1.2 (Cont.)

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.



define a knife edge. *Id.* at 3:14-17, 3:50-53, Fig. 4. It is also my opinion that a POSITA would recognize that because *Sczomak* discloses that the poppet valve 40 *is relieved by* a chamfer 44 to intersect the valve seating surface 43 to define a knife edge, *id.* at 3:14-17, 3:50-53, and because *Sczomak* discloses that "the valve seat surface 43 of its head 41 can overhang the valve seat 27 of the spray tip 12 *by a maximum of 0.01 mm*," *id.* at 3:58-65, the knife edge of the poppet valve 40 of *Sczomak* must be less than 0.2 mm (*see* annotated Figure 4 below of *Sczomak*); and thus *Sczomak* meets the definition of "sharp edge," which I understand has been proposed by the patent owner in the related district court litigation (i.e., "an edge having a radius of curvature less than 0.2 mm"). *Id.*

Mapping of Sczomak To Claim 1.2 (Cont.)

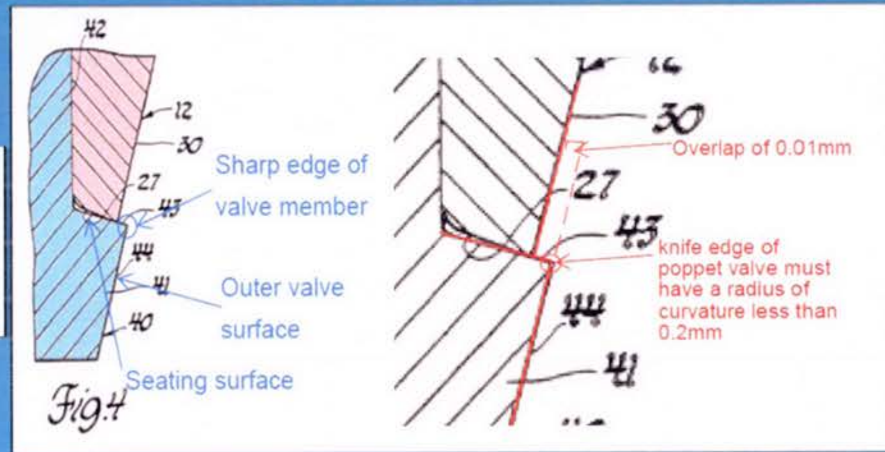
79. For example, *Sczomak* discloses at 1:44-53. ("It is therefore, a primary object of the present invention to provide an improved fuel injection nozzle for use in direct injection type diesel engines that is operable in a manner whereby to substantially eliminate carbon build-up on the cooperating spray discharge elements thereof without affecting the spray pattern of the fuel being discharged therefrom by the use of a poppet valve and an arrangement of spray orifices whereby the spray orifices are covered upon closure of the poppet valve" (emphasis added)); *id.* at 1:69-2:2 ("A further object of the invention is to provide an improved fuel injection nozzle so constructed whereby it will remain substantially free of carbon build-up during extended operation thereof in a direct injection type diesel engine" (emphasis added)); *id.* at 3:14-22 ("As best seen in FIGS. 1, 4 and 5, the lower outer peripheral end of the spray tip 12 is relieved as by a chamfer 30 so as to intersect the valve seat 27 and to define therewith a so-called knife edge ... " (emphasis added)); *id.* at 3:50-53 ("Preferably, as shown, the head 41 below the valve seat surface 43 is also provided with a chamfer 44 formed complementary to the chamfered 30 lower end of the spray tip 12" (emphasis added)); *id.* at 4:8-22 ("The reason for limiting such overhang is due to the fact that any exposed surface radially outward of the actual sealed interface of the valve seat 27 and valve seat surface 43 can and will be wetted by fuel during the injection cycle and fuel thus collected on such exposed wetted surfaces can result in high hydrocarbon emissions during the combustion process then occurring in the associated combustion chamber, not shown. Thus it is desirable to reduce such surface area which can be wetted by fuel to a minimum. In addition, with the chamfered spray tip 12 and head 41 arrangement shown, it appears that any carbon deposit which may engage any exposed valve seating surface either will fall off and/or burn off more readily due to the preferred range of the chamfer angle described hereinabove." (emphasis added)); *id.* at 5:11-15 ("[A]t least one or more of the discharge orifices 46 are still located approximately 0.05 mm above the corner of the valve seat surface 43 to insure penetrating fuel sprays as soon as the poppet valve 40 lifts from the valve seat 27." (emphasis added)); *id.* at 6:24-31 ("Furthermore, the subject fuel injection nozzle can operate at lower peak fuel pressure levels than other known injectors because fuel can flow from the subject injection nozzle in a more efficient manner because of the location of the discharge orifices relative to the valve seat surface 43 of the poppet valve and since larger size discharge orifices 46 can be used without suffering a hydrocarbon penalty." (emphasis added)); *see also id.* at 1:44-53, 1:66-2:2, 2:10-26, 3:27-68, 4:8-35, 5:9-15, 6:24-31, 6:56-64, Figs. 4-5.

Mapping of Sczomak To Claim 1.2 (Cont.)

80. *Sczomak* discloses that the knife edge acts as a deposit breaking edge to thereby facilitate deposit removal from the injection nozzle. *Id.* at 4:8-23, 6:24-31, Figs. 4-5; *see also* disclosure from Limitation 1.2. In my opinion, because *Sczomak* discloses that "any carbon deposit which may engage any exposed valve seating surface either will fall off and/or burn off more readily due to the preferred range of the chamfer angle described hereinabove," a POSITA would recognize that the knife edge of the poppet valve 40 "acts as a deposit breaking edge to thereby facilitate deposit removal from the injector nozzle." Ex. 1003 at 4:8-23, 6:24-31, Figs. 4-5. It is also my opinion that a POSITA would recognize that by decreasing the surface area on which deposits may form, such that they may fall off and/or burn off more readily, deposits that do adhere are more susceptible to falling off, and thus will also be more easily dislodged by the shearing effect of the fuel flow issuing from the exit of the nozzle passage (as well as the other currents present in the combustion chamber, and at or adjacent the nozzle passage exit). *Id.* To the extent that *Sczomak* does not explicitly discuss the shearing effect, it is also my opinion that a POSITA would recognize that the shearing effect would further dislodge deposits, as evidenced, *e.g.*, by U.S. Patent No. 3,347,470 to Svoboda ("*Svoboda*"), Ex. 1018, disclosing "[t]hus in conjunction with the knife edge 42 [[which] minimize[s] the surface available ... for the accumulation of carbon deposits] the wash of fuel flowing through the passages 24 and 36 further reduces the tendency for formation of carbon deposits." *Id.* at 2:38-57, Figs. 2-3. Additionally, movement of the knife edge of the poppet valve 40 away from and then back toward and against the spray tip 12 will also help to break and dislodge deposits (which are more readily due to fall off due to the knife edge) located at or adjacent an exit of the nozzle passage. Ex. 1003 at Fig. 4.

Mapping of Sczomak To Claim 2

2. An injector nozzle according to claim **1**, wherein the sharp edge acts as a deposit breaking edge to thereby facilitate deposit removal from the injector nozzle.



80. *Sczomak* discloses that the knife edge acts as a deposit breaking edge to thereby facilitate deposit removal from the injection nozzle. *Id.* at 4:8-23, 6:24-31, Figs. 4-5; *see also* disclosure from Limitation 1.2. In my opinion, because *Sczomak* discloses that "any carbon deposit which may engage any exposed valve seating surface either will fall off and/or burn off more readily due to the preferred range of the chamfer angle described hereinabove," a POSITA would recognize that the knife edge of the poppet valve 40 "acts as a deposit breaking edge to thereby facilitate deposit removal from the injector nozzle." Ex. 1003 at 4:8-23, 6:24-31, Figs. 4-5. It is also my opinion that a POSITA would recognize that by decreasing the surface area on which deposits may form, such that they may fall off and/or burn off more readily, deposits that do adhere are more susceptible to falling off, and thus will also be more easily dislodged by the shearing effect of the fuel flow issuing from the exit of the nozzle passage (as well as the other currents present in the combustion chamber, and at or adjacent the nozzle passage exit). *Id.* To the extent that *Sczomak* does not explicitly discuss the shearing effect, it is also my opinion that a POSITA would recognize that the shearing effect would further dislodge deposits, as evidenced, *e.g.*, by U.S. Patent No. 3,347,470 to Svoboda ("*Svoboda*"), Ex. 1018, disclosing "[t]hus in conjunction with the knife edge 42 [[which]] minimize[s] the surface available for the accumulation of carbon deposits] the wash of fuel flowing through the passages 24 and 36 further reduces the tendency for formation of carbon deposits." *Id.* at 2:38-57, Figs. 2-3. Additionally, movement of the knife edge of the poppet valve 40 away from and then back toward and against the spray tip 12 will also help to break and dislodge deposits (which are more readily due to fall off due to the knife edge) located at or adjacent an exit of the nozzle passage. Ex. 1003 at Fig. 4.

Mapping of Sczomak To Claim 4

4. An injector nozzle according to claim **1**, wherein an acute angle is provided between the seating surface and the outer valve surface of the valve member at the sharp edge transition.

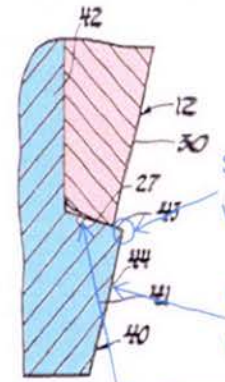


Fig.4

81. *Sczomak* discloses that an acute angle is provided between the valve seat surface 43 and the chamfer 44 at the knife-edge transition. *Id.* at Fig. 4. To the extent that *Sczomak* does not disclose that the angle provided between the valve seat surface 43 and the chamfer 44 at the knife-edge transition of the poppet valve 40 is less than 90 degrees, in my opinion a POSITA would recognize that because *Sczomak* shows in Fig. 4, for example, an angle approximately 90° (which may vary by +/- 0.1°), and because such an angle takes into account usual manufacturing tolerances, the angle may be slightly less than 90° (e.g., 89.99°), and thus an acute angle.

Mapping of Sczomak To Claim 5

5. An injector nozzle according to claim **1**, wherein the port includes an outer port surface surrounding and located adjacent to the valve seat surface, and a sharp edge is provided at the transition between the valve seat surface and the outer port surface.

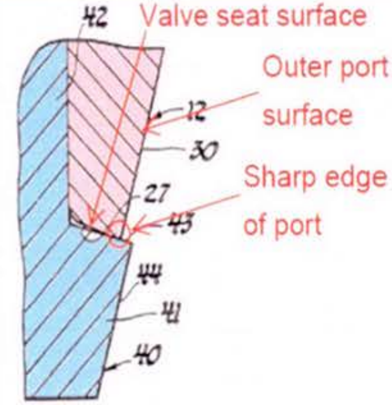


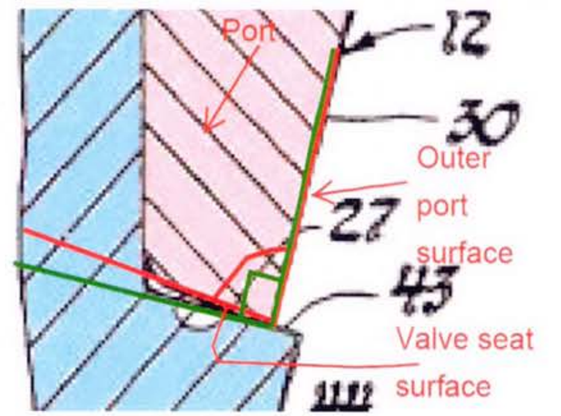
Fig.4

82. *Sczomak* discloses that the spray tip 12 includes a chamfer 30 (the claimed "outer port surface") surrounding and located adjacent to the valve seat 27, and a knife edge (the claimed "sharp edge of the port") provided at the transition between the valve seat 27 and the chamfer 30. *Id.* at 3:14-17, 3:58-65 ("As best seen in FIGS. 1, 4 and 5, the lower outer peripheral end of the spray tip 12 is relieved as by a chamfer 30 so as to intersect the valve seat 27 and to define therewith a so-called knife edge."); *id.* at 3:58-65 ("Accordingly, in a particular injection nozzle application, the poppet valve 40 is selectively mated to a spray tip 12, such that the valve seat surface 43 of its head 41 can overhang the valve seat 27 of the spray tip 12 by a maximum of 0.01 mm as shown in FIG. 4 or the valve seat of the spray tip 12 can overhang the valve seat surface 43 of the poppet valve head 41 by a maximum of 0.01 mm as shown in FIG. 5." (emphasis added)); *id.* at Figs. 4-5. The "outer port surface" and "sharp edge of the port" are identified below in annotated Figure 4.

83. In my opinion, a POSITA would recognize that the knife edge of spray tip 12 would have "a radius of curvature less than 0.2 mm" for at least the same reason that that the knife edge of the poppet valve 40 has a radius of curvature less than 0.2 mm, as discussed above. *Id.*

Mapping of Sczomak To Claim 7

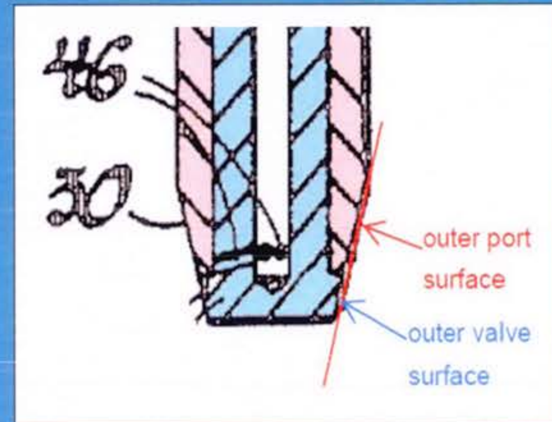
7. An injector nozzle according to claim **5**, wherein an acute angle is provided between the valve seat surface and the outer port surface of the port at the sharp edge transition.



84. As shown in annotated Figure 4 (below), *Sczomak* discloses that an acute angle is provided between the valve seat 27 and the chamfer 30 of the spray tip 12 at the knife edge transition. *Id.* at Fig. 4. In my opinion, a POSITA would recognize that the identified angle (red) in annotated Figure 4 of *Sczomak* is less than 90° (green). *Id.*

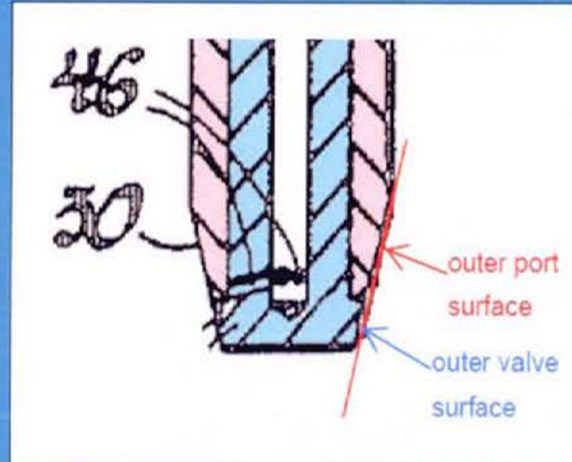
Mapping of Sczomak To Claim 8

8. An injector nozzle according to claim **5**, wherein the outer valve surface and the outer port surface are at least substantially located in an common plane when the valve member is seated in the port.



85. As shown below in annotated Figure 2, *Sczomak* discloses in a similar embodiment that the chamfer 44 and the chamfer 30 are at least substantially located in a common plane when the poppet valve 40 is seated in the spray tip 12. *Id.* at 3:65-4:2 ("However, in another preferred injection nozzle application, the assembly of the poppet valve 40 and spray tip 12 is ground on its outside peripheral surface, as necessary to ensure zero overhang of the poppet valve 40 and spray tip 12 as shown in FIG. 1."); *id.* at Fig. 1.

Mapping of Sczomak To Claim 9

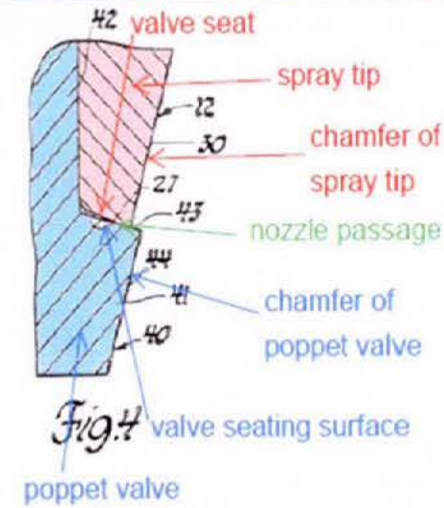


9. An injector nozzle according to claim **5**, wherein the outer valve surface and the outer port surface are located in at least substantially parallel planes when the valve member is seated in the port.

86. *Sczomak* discloses that the chamfer 30 and the chamfer 44 are located in at least substantially parallel planes when the poppet valve 40 is seated in the spray tip 12. *Id.* at 3:58-65, Fig. 4. ("Accordingly, in a particular injection nozzle application, the poppet valve 40 is selectively mated to a spray tip 12, such that the valve seat surface 43 of its head 41 can overhang the valve seat 27 of the spray tip 12 by a maximum of 0.01 mm as shown in FIG. 4.").

Mapping of Sczomak To Claim 14

14. An injector nozzle according to claim **1**, the nozzle being of the outwardly opening poppet valve type.



87. *Sczomak* discloses that the injection nozzle is of the outwardly opening poppet valve type. *Id.* at title, 1:10-14 ("This invention relates to . . . an injection nozzle of the outward opening poppet valve type for use in a direct injection type diesel engine.").

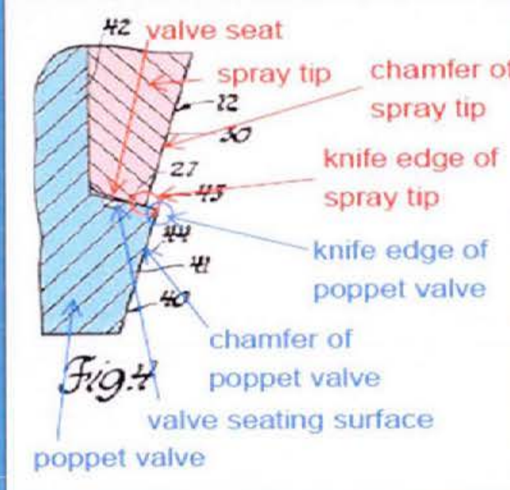
Mapping of Sczomak To Claim 15

15. An injector nozzle according to claim **1**, the nozzle being arranged to deliver fuel directly into at least one combustion chamber of the engine.

88. *Sczomak* discloses that the injection nozzle is arranged to deliver fuel directly into at least one combustion chamber of the engine. *Id.* at 2:29-35 ("The fuel injection nozzle 5 is of a type . . . so as to discharge fuel into an associated combustion chamber of the engine."); *id.* at Fig. 1; *see also id.* at 1:10-14, 44-53.

Mapping of Sczomak To Claim 16

16. An injector nozzle according to claim **5**, wherein the sharp edge on the valve member is formed in a separate step to the sharp edge on the port.

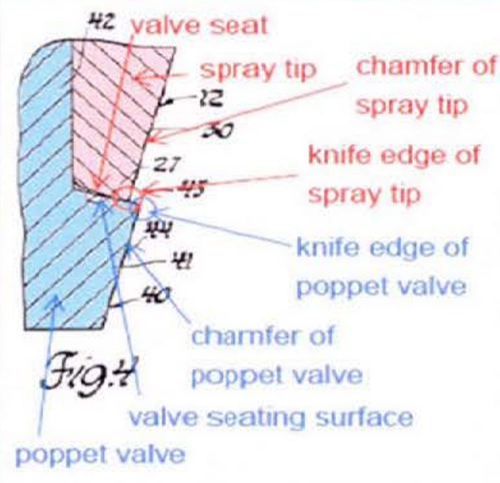


89. *Sczomak* discloses that the knife edge on the poppet valve 40 is formed in a separate step to the knife edge on the spray tip 12. *See id.* at 3:54-62 ("However, because of the usual manufacturing tolerance encountered in mass production of injection nozzles, some overlap of the valve seat surface 43 of the poppet valve 40 relative to the valve seat 27 can be tolerated. Accordingly, in a particular injection nozzle application, the poppet valve 40 is selectively mated to a spray tip 12, such that the valve seat surface 43 of its head 41 can overhang the valve seat 27 of the spray tip 12 by a maximum of 0.01 mm as shown in FIG. 4."); *id.* at 3:14-17 ("As best seen in FIGS. 1, 4 and 5, the lower outer peripheral end of the spray tip 12 is relieved as by a chamfer 30 so as to intersect the valve seat 27 and to define therewith a so-called knife edge . . . ."); *id.* at 3:50-53 ("Preferably, as shown, the head 41 below the valve seat surface 43 is also provided with a chamfer 44 formed complementary to the chamfered 30 lower end of the spray tip 12."); *id.* at Figs. 1, 4-5.

90. In my opinion, a POSITA would recognize that because *Sczomak* discloses the mass production of injection nozzles, and because *Sczomak* further recognizes, appreciates, and accounts for the "usual manufacturing tolerance encountered" in such mass production of injection nozzles by setting "some overlap" or "overhang" of the valve seat surface 43 of the head 41 of the poppet valve 40 over the valve seat 27 of the spray tip 12 "by a maximum of 0.01 mm." *Sczomak* teaches the claimed process. *Id.* at 3:54-68, 4:1-7, Figs. 1, 4-5. In my opinion, if the sharp edges were actually formed in one step (such as grinding), there would be no overlap of the outer port and the outer valve surface.

Mapping of Sczomak To Claim 18

18. An injector nozzle according to claim **5**, wherein the sharp edges on the valve member and on the port facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage.

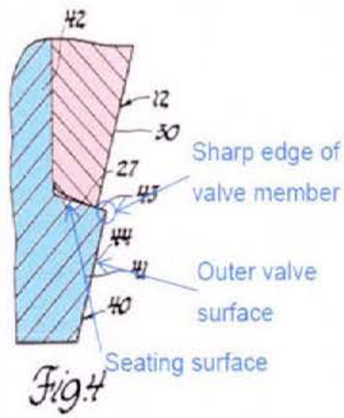


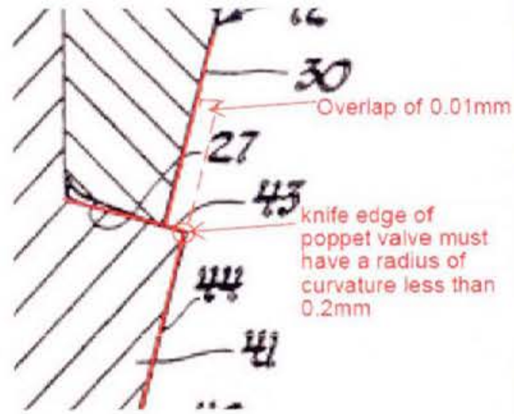
91. *Sczomak* discloses that the knife edges on the poppet valve 40 and the spray tip 12 facilitate the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage. *Id.* at 1:44-53, 5:9-15, 6:24-31, Figs. 4-5; *see also* disclosure in Limitation 1.2. For example, *Sczomak* discloses: "Furthermore, the subject fuel injection nozzle can operate at lower peak fuel pressure levels than other known injectors because fuel can flow from the subject injection nozzle in a more efficient manner because of the location of the discharge orifices relative to the valve seat surface 43 of the poppet valve and since larger size discharge orifices 46 can be used without suffering a hydrocarbon penalty." Ex. 1003 at 6:24-31. *Sczomak* further discloses a "fuel injection nozzle . . . that is operable in a manner whereby to substantially eliminate carbon build-up on the cooperating spray discharge elements thereof without affecting the spray pattern of the fuel being discharged therefrom." *Id.* at 1:69-2:2.

92. In my opinion, a POSITA would recognize that by preventing deposit buildup at or adjacent the nozzle passage, or hydrocarbon penalty (which is associated with over-expansion of the spray), allowing for a "more efficient" fuel flow from the injection nozzle, the knife edges "facilitate the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage." *Id.* at 1:44-53, 5:9-15, 6:24-31, Figs. 4-5.

Mapping of Sczomak To Claim 19

19. An injector nozzle for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel therethrough or sealed contact therebetween to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.





19.1 "An injector nozzle for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode, said injector nozzle including"

93. In my opinion, a POSITA would recognize that the injection nozzle of *Sczomak* is capable of being used with a spark-ignited fuel injected internal combustion engine operated in stratified charge mode.

19.2 "a port having a valve seat surface and valve member having a seating surface"

94. *See* Limitation 1.1.

19.3 "said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel,"

95. *See* Limitation 1.1.1.

19.4 "the valve member including an outer valve surface located adjacent the seating surface and external to the port"

96. *See* Limitation 1.1.2.

19.5 "wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage"

97. *See* Limitation 1.2.

Sczomak

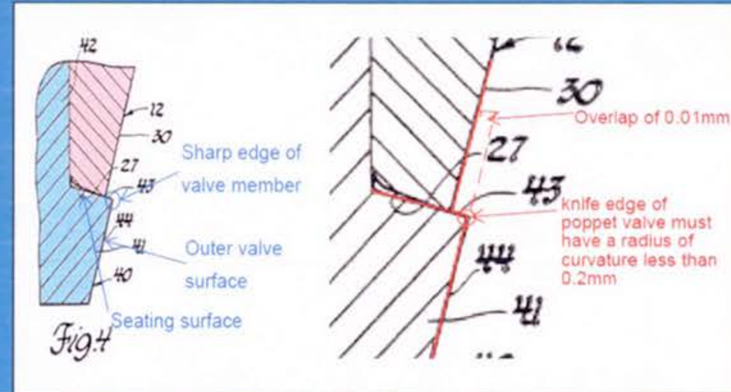
Reference(s)	Basis	Challenged Claim(s)
Sczomak	§ 103(a)	1, 2, 4, 5, 7–9, 14–16, 18, 19
Sczomak and Breslau	§ 103(a)	16
Sczomak and Bishop	§ 103(a)	19

Obviousness of Sczomak Over Claims 1, 2, 4-5, 7, 10, 13-16, 18, 19

* '01254, Ex. 1004 at 54-55, 59-65

Obviousness of claims 1, 2, 4-5, 7-10, 13-16, 18, 19 over Sczomak

98. To the extent that the Board finds that the term "sharp edge" should be construed as "an edge having a radius of curvature less than 0.2 mm" and also finds any of *Masubuchi* and *Sczomak* as not disclosing such an edge, in my opinion, it would have been obvious to a POSITA to implement each knife edge of *Masubuchi* and *Sczomak* with a radius of curvature less than 0.2 mm. In my opinion, a POSITA at the relevant time would have been motivated to form the knife edges of *Masubuchi* and *Sczomak* with a radius of curvature less than 0.2 mm to optimize control of the formation of deposits. It is further my opinion that since *Masubuchi* and *Sczomak* disclose everything else in the claims, discovering the optimum or workable ranges for the radius of curvature to do so would involve only routine skill in the art for a POSITA. In my opinion, a POSITA would recognize that such discovery is not inventive. Here, it is my opinion that a POSITA would recognize and appreciate that because the general conditions of the claim (i.e., knife edges) are disclosed in the prior art of *Masubuchi* and *Sczomak*, discovering the optimum or workable ranges for the radius of curvature of these edges would involve only routine skill in the art. And it is also my opinion that because *Masubuchi* and *Sczomak* each associate knife edges with control and reduction in deposit formation, a POSITA at the relevant time would have appreciated and recognized the knife edges as result-effective variables, i.e., a



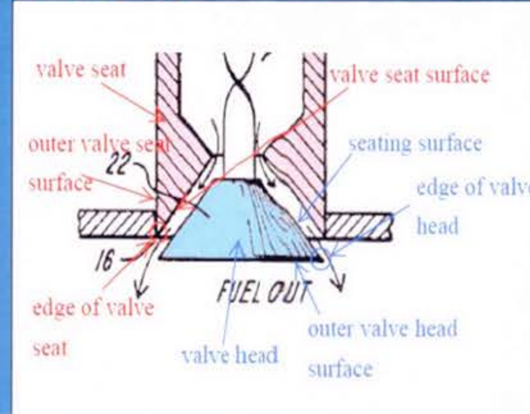
variable which achieves a recognized result, before the determination of the optimum or workable ranges.

99. It is also my opinion that a POSITA at the relevant time would also have been motivated to implement the knife edges of *Masubuchi* and *Sczomak* with a radius of curvature less than 0.2 mm, in an effort to achieve additional control and reductions in deposit formation. In my opinion, such a modification would constitute no more than an obvious design choice—one of a "finite number of identified, predictable solutions"—to a POSITA at the relevant time. It is also my opinion that a POSITA at the relevant time, and cognizant of the benefits in the control and reduction of deposit formation provided by the knife edges as taught by *Masubuchi* and *Sczomak* would have further appreciated and recognized a design need or market pressure to achieve additional control and reductions in deposit formation. Further, in my opinion, a POSITA would have further recognized that there are a finite and predictable number of potential solutions, such as, for example, making the radius of the sharp edge with a radius of curvature less than 0.2 mm, and with a reasonable expectation of success, would have done so.

Obviousness of claim 16 over Sczomak and Breslau

113. I have been informed that claim 16 depends from claim 5 and independent claim 1 and thus requires that "the sharp edge on the valve member [be] formed in a separate step to the sharp edge on the port." Ex. 1001 at 9:8-10. As explained below, in my opinion, the teachings of *Sczomak* in combination with the teachings of *Breslau* would render claim 16 of the '387 patent obvious to a POSITA. As discussed above, *Sczomak* discloses all features of claims 1 and 5. In my opinion, it would have been obvious to a POSITA to form the knife edge of the poppet valve 40 of *Sczomak* in a separate step to the knife edge on the spray tip 20 of *Sczomak*. As discussed above in Section D, in my opinion, forming an edge of a valve member separate from an edge of a port was well-known in the art, as evidenced by *Breslau*. For example, as discussed above, *Breslau* depicts sharp edges and discloses forming the sharp edge of the valve head 22 separately from the sharp edge of the valve seat 16 and several advantages of doing so: reducing the need for precision in forming operations; helping ensure alignment and proper mating of the surfaces of the valve seat with the valve body; helping reduce the risk of alignment problems and maladjustment; and providing a manufacturer the ability to vary the spray pattern of the valves by simply changing the shape of the valve body and/or seat.

114. It is also my opinion that a POSITA at the relevant time would have been motivated to form the knife edge of the poppet valve 40 of *Sczomak* in a separate step to the knife edge on the spray tip 20 of *Sczomak*, as in *Breslau*, in



order to reduce the need for precision in forming operations; help ensure alignment and proper mating of the surfaces of the spray tip 20 with the poppet valve 40; and help reduce the risk of alignment problems and maladjustment. Ex. 1006 at 1:60-61, 2:50-53, 2:57-58, 5:7-9. It is further my opinion that a POSITA would have done so to allow the manufacturer to vary the spray pattern of the fuel injector by changing the shape of the spray tip 20 with the poppet valve 40 of *Sczomak*. Indeed, such an implementation of *Sczomak* would constitute no more than an obvious manufacturing choice—one of a "finite number of identified, predictable solutions"—to a POSITA at the relevant time.

Obviousness of claim 19 over Sczomak with Bishop

107. I have been informed that the only difference between independent claim 19 and independent claim 1 is the following italicized language from the preamble: "[a]n injector nozzle *for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode*, said injector nozzle including." Ex. 1001 at 10:3-5. As explained below, in my opinion, the teachings of each of *Masubuchi* and *Sczomak* in combination with the teachings of *Bishop* would render claim 19 of the '387 patent obvious to a POSITA.

108. As discussed above, *Masubuchi* and *Sczomak* each disclose an injector valve/nozzle for a fuel injected internal combustion engine. In my opinion, it would have been obvious to a POSITA to implement the fuel injection valve of *Masubuchi* and the fuel injector nozzle of *Sczomak* in a spark-ignited fuel injected internal combustion engine operating in stratified charge mode. In my opinion, the use of an injector nozzle in a spark-ignited fuel injected internal combustion engine operating in stratified charge mode was well-known in the art, as acknowledged, e.g., by the '387 patent. *See* Ex. 1001 at 2:1-13 ("The above discussed disturbances to the delivery of fuel to the combustion chamber of an engine are particularly significant in engines which, for at least part of engine load range, operate with a highly stratified fuel charge *such as is recognized* as highly desirable to control exhaust emissions, particularly during low load operation" (emphasis added).). According to the '387 patent, "An example of such a stratified charge engine is one employing a dual fluid fuel injection system such as that disclosed in the Applicants U.S. Patent Nos. 4,693,224 and RE 36768," both of which are prior art under 35 U.S.C. § 102(b). *Id.* at 2:6-10.

109. As another example, U.S. Patent No. 3,542,293 to Bishop et al. ("*Bishop*"), Ex. 1005, issued on November 24, 1970. I have been informed that *Bishop* is prior art under 35 U.S.C. § 102(b). *Bishop* discloses an injector nozzle in a spark-ignited fuel injected internal combustion engine operated in stratified charge mode. *Id.* at 1:17-21 ("The injector of this invention is particularly useful in a stratified charge type internal combustion engine such as the engine described in Bishop et al., U.S. Patent No. 3,315,650"); *see also Bishop '650*, Ex. 1011, at 1:15-20 ("[This invention] relates to *a stratified charge combustion process for an internal combustion engine of the spark-ignition type* in which fuel is burned in an excess of air at part loads and full utilization of the air is made at maximum loads" (emphasis added)); *id.* at 4:6-13 ("In a stratified charge engine, only that portion of the air that is adjacent the spark plug is impregnated with gasoline or fuel at the time of ignition. As a result, light-load fuel quantities can be mixed with a small portion of the air so that the local air-fuel ratio around the spark plug is sufficiently high to permit reliable ignition, and yet a quantity of excess air may be present in the cylinder."). *Bishop* explains that doing so helps achieve optimum performance and economy of the engine. Ex. 1005 at 1:19-24 ("Accurate fuel delivery over a wide range of flow rates is essential in such an engine, and this injector performs exceptionally well in achieving the optimum performance and economy of the engine.").

110. In my opinion, a POSITA at the relevant time would have been motivated to implement the fuel injection valve/nozzle of *Masubuchi* and *Sczomak*

Obviousness of claim 19 over Sczomak with Bishop (Cont.)

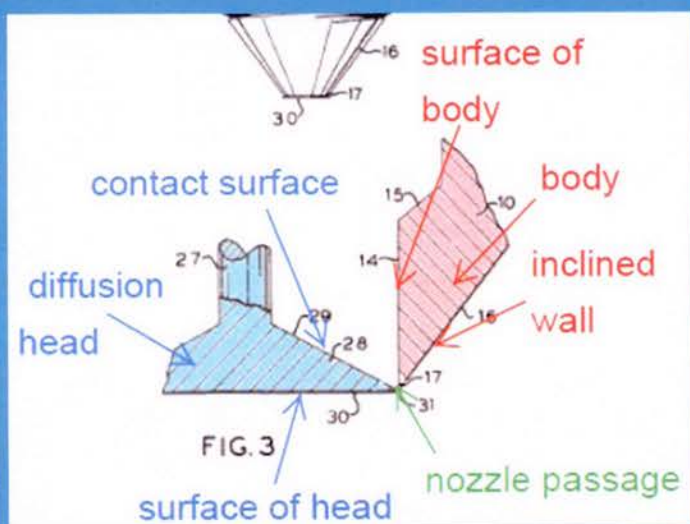
in a spark-ignited fuel injected internal combustion engine operating in stratified charge mode, as in *Bishop*, in order to achieve accurate fuel delivery over a wide range of flow rates and thus help achieve optimum performance and economy of the engine. *Id.* at 1:19-24. It is further my opinion that such an implementation of *Masubuchi* and *Sczomak* would constitute no more than an obvious design choice—one of a "finite number of identified, predictable solutions"—to a POSITA at the relevant time. It is also my opinion that such a modification would simply improve fuel delivery, performance, and economy of the engine disclosed by *Masubuchi* and *Sczomak* in the same way as it improves an engine in *Bishop* (e.g., providing such an engine with accurate fuel delivery over a wide range of flow rates so as to help achieve optimum performance and economy of the engine is essential in such an engine).

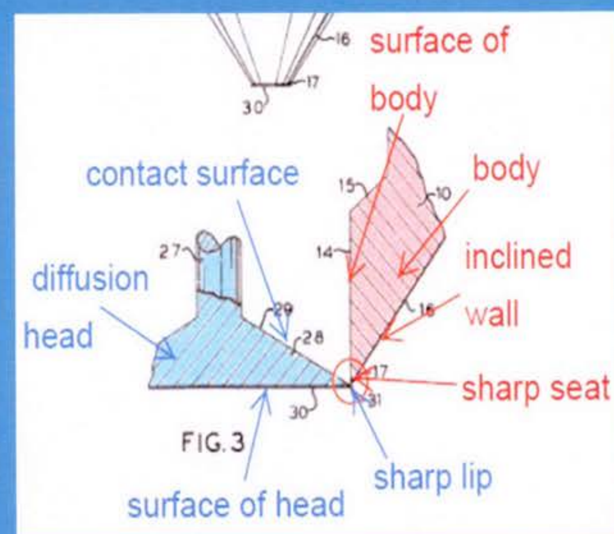
111. It is also my opinion that a POSITA would recognize that direct fuel injectors for both spark ignited and diesel engines (*Sczomak*) share the common problem of injector deposits affecting the spray pattern, fuel delivery, and thus performance and economy of the engine, and a POSITA would have been further motivated to implement the fuel injection nozzle of *Sczomak* in a spark-ignited fuel injected internal combustion engine operating in stratified charge mode so as to take advantage of the deposit formation controlling features of *Sczomak*, discussed above; thus helping improve fuel delivery, and thus performance and economy of the engine. Indeed, known work in one field of endeavor may prompt variations of it for use in the same field or a different one based on design incentives or other market forces. *Id.*

112. In my opinion, a POSITA would recognize that such a modification and improvement could be achieved by simply substituting the engine of *Masubuchi* and *Sczomak* (e.g., internal combustion engines) with another known engine (spark-ignited fuel injected internal combustion engine operating in stratified charge mode) and would yield nothing more than a predictable result. In fact, *Bishop* itself refers to the applicability of his injector for stratified charge engines to conventional engines. Ex. 1005 at 1:19-24 ("[m]any features of the injector also are useful in conventional fuel injected reciprocating-type engines."). Therefore, in my opinion, in further light of *Bishop*'s teaching of the use of its fuel injector with either internal combustions engine operating in stratified charge mode or other conventional engines, it would have been obvious to a POSITA, at the relevant time, to implement the fuel injection valve/nozzles of *Masubuchi* and *Sczomak* in a stratified charge mode internal combustion engine, yielding the predictable advantage of helping achieve optimum performance and economy of the engine, as taught by *Bishop*.

Allen

Reference(s)	Basis	Challenged Claim(s)
Allen	§ 102(b)	1, 2, 4, 5, 7, 10, 14–16, 18, 19
Allen	§ 103(a)	1, 2, 4, 5, 7, 10, 14–16, 18, 19
Allen and Breslau	§ 103(a)	16
Allen and Bishop	§ 103(a)	1, 15, 19





Allen

Reference(s)	Basis	Challenged Claim(s)
Allen	§ 102(b)	1, 2, 4, 5, 7, 10, 14–16, 18, 19

Allen Discloses All Elements Of Claims 1, 2, 4-5, 7, 10, 13-16, 18, 19

* '01255, Ex. 1004 at 18-35

Mapping of Allen To Claim 1.0, 1.1

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.

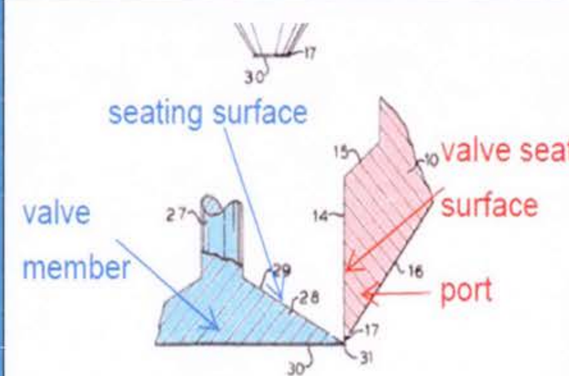


FIG. 3

38. *Allen* discloses a fuel injector nozzle. *Id.* at title. To the extent that *Allen* does not explicitly discuss application of its "fuel injection nozzle" for a fuel injected internal combustion engine, in my opinion, one having ordinary skill in the art would recognize that *Allen's* fuel injection nozzle is indeed for use with an internal combustion engine. Such use is further evidenced, *e.g.*, by U.S. Patent No. 3,039,699 to *Allen '699*, Ex. 1018 (which I have been informed is prior art), sharing the same inventor and file date as *Allen*, in addition to a similar fuel injection nozzle (with a sharp edge 34), as well as disclosing, "While the invention is in no way limited to any specific use . . . the nozzle of the present invention finds successful adaptation . . . in the injection of fuel into the combustion supporting gases of high speed, spark-ignition type, internal combustion engines.") Ex. 1018 at 2:24-31, Figs. 1-4.

39. *Allen* discloses that the injector nozzle includes a body 10 (the claimed "port") having a surface 14 (the claimed "valve seat surface") and a diffusion head 28 (the outer portion of the claimed "valve member") having a fluid contact surface 29 (the claimed "seating surface"). The "port" and corresponding structures including the "valve seat surface" are identified in red below in annotated Fig. 3. The "valve member" and corresponding structures including the "seating surface" are identified in blue below in annotated Fig. 3.

Mapping of Allen To Claim 1.1.1

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.

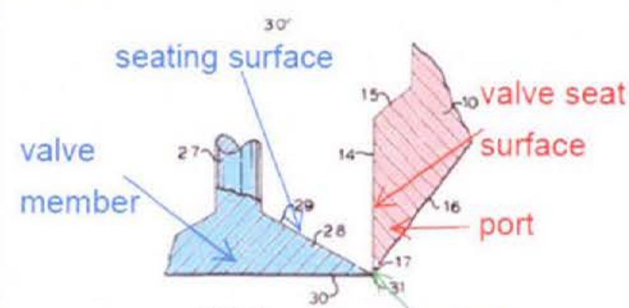


FIG. 3

40. *Allen* discloses that diffusion head 28 is movable relative to the body 10 to respectively provide a flow orifice (the claimed "nozzle passage") between the surface 14 and the fluid contact surface 29 for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel. Ex. 1002 at 1:50-62, 3:4-8, 3:30-40, 4:8-10, Figs. 1-3. The "nozzle passage" is identified below in green in annotated Figure 3.

Mapping of Allen To Claim 1.1.1 (Cont.)

41. For example, *Allen* discloses: "The head 28 is of minimum radius capable of providing sealing contact with the sharp circular seat 17." *Id.* at 3:6-8; "In the present form of the invention, the body is formed with a uniformly cylindrical outlet bore, insuring free direct passage of liquid, terminating in a circular flow orifice forming a companion seat for the diffusion element. The outer wall of the body adjoining the seat is formed as a frusto-conical surface meeting the orifice periphery at a sharp, acute angle, the apex of which defines the seat as a sharp circular edge. Since the acute angle between inner and outer body walls at the orifice provides a sharp edge confronting the smooth tip edge surface of the inwardly facing conical surface of the diffusion head, a sharp circular line contact between the element and its seat is achieved." *Id.* at 1:50-62. "[S]aid suspending means providing yieldable contact of said inner surface [of said diffusion head] with said seat." *Id.* at 4:8-10; "It will further be noted that since the diffusion element is retained in position merely by the relatively light spring 24 which is fully flexible, both laterally as well as longitudinally, the element is free floating and may move rapidly and fully from its seat 17 . . . . It will also be noted that the conical configuration of the surface will insure proper seating of the element against the seat, such conical formation providing a guiding action for the seating of the element under spring tension when fluid pressure is terminated. *Id.* at 3:30-40.

Mapping of Allen To Claim 1.1.2

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.

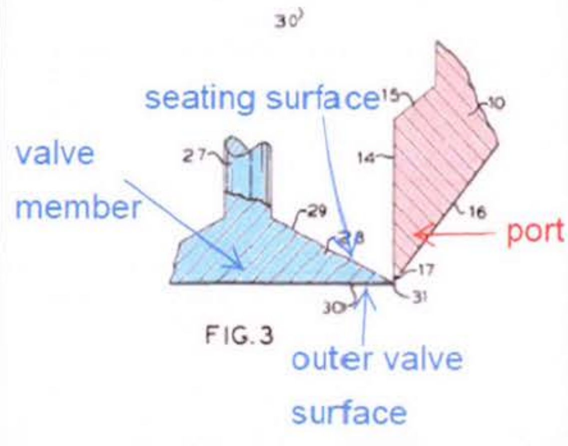


FIG. 3

42. *Allen* discloses that the diffusion head 28 includes a surface 30 (the claimed "outer valve surface") located adjacent the fluid contact surface 29 and external to the body 10. *Id.* at Figs. 1-3. The "outer valve surface" is identified below in annotated Figure 3:

Mapping of Allen To Claim 1.2

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.

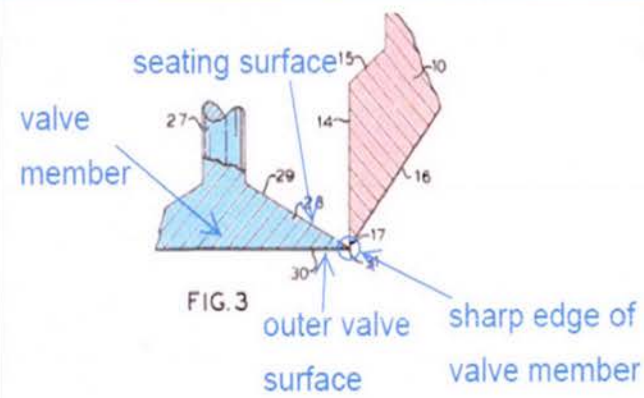


FIG. 3

43. *Allen* discloses a sharp and acutely angled lip 31 (the claimed "sharp edge") is provided on the diffusion head 28 at the transition between the fluid contact surface 29 and the surface 30 thereof, for controlling the formation of deposits at or adjacent an exit of the ring-shaped nozzle orifice. *Id.* at 1:23-27, 1:39-49, 1:50-62; 2:3-6, 2:43-49, 2:50-55, 3:4-30, 3:41-54, and Figs. 1-3. The "sharp edge of the valve member" is shown adjacent in annotated Figure 3:

44. In my opinion, a POSITA would recognize that because *Allen* discloses that the sharp and acutely angled lip 31 "insure[s] a quick and complete discharge of fluid, eliminating the danger of fluid drag or adherence and insuring rapid decrease of fluid pressure reduces," and because it is well-known and recognized by one having ordinary skill in the art that fuel on the surface of the valve member or port leads to deposits, the sharp lip 31 "control[s] the formation of deposits at or adjacent an exit of the nozzle passage." *Id.* at 1:23-27, 1:39-49, 1:50-62, 2:2-6, 2:43-49, 2:50-55, 3:4-30, 3:41-54, and Figs. 1-3.

Mapping of Allen To Claim 1.2 (Cont.)

45. For example, *Allen* discloses: "A further problem which has not been solved to the extent of complete satisfaction is that of minimizing efficiency losses due to drag friction and the adherence of fluid to the nozzle element." *Id.* at 1:23-27; "This diffusion element presents a frusto-conical surface facing the direction of fluid flow, and terminating in a sharp circular edge, characterized by a radius slightly exceeding but closely approaching that of the radius of the outlet orifice with which it is associated to minimize the length of the path of travel of fluid in a restricted zone. Hence, drag, skin friction and turbulence are avoided as well as the formation of a self-perpetuating consolidated stream. Since pressure drop is almost instantaneous as the fluid passes from the nozzle, diffusion inherently follows almost immediately." *Id.* at 1:39-49; "In the present form of the invention, the body is formed with a uniformly cylindrical outlet bore, insuring free direct passage of liquid, terminating in a circular flow orifice forming a companion seat for the diffusion element. The outer wall of the body adjoining the seat is formed as a frusto-conical surface meeting the orifice periphery at a sharp, acute angle, the apex of which defines the seat as a sharp circular edge. Since the acute angle between inner and outer body walls at the orifice provides a sharp edge confronting the smooth tip edge surface of the inwardly facing conical surface of the diffusion head, a sharp circular line contact between the element and its seat is achieved." *Id.* at 1:50-62.

46. *Allen* also discloses: "Another object of the invention is to provide a nozzle of the type referred to so constructed and arranged as to minimize turbulence, frictional drag, retardation of fluid flow and the clinging of fluid to nozzle components." *Id.* at 2:3-6; "The opposite outer end of the bore 14 terminates in an orifice formed as a sharp knife-like circular seat 17 at the apex between the inner perpendicular walls of the bore 14 and the outer downwardly and inwardly tapering frusto-conical wall 16 of the body below the threads 11." *Id.* at 2:43-49; "As here shown, the wall of the bore 14 is concentric with the wall 15 of the cylindrical cavity 12, and thus axial with respect to the body. The inward and downward taper of the frusto-conical outer surface 16 of the body meets the wall of the base at an acute angle to form the sharp smooth circular seat 17." *Id.* at 2:50-55.

47. *Allen* further discloses: "The head 28 comprises a disc-like member having an upper frusto-conical fluid contact surface 29 facing the direction of fluid flow from the bore 14. The head 28 is of minimum radius capable of providing sealing contact with the sharp circular seat 17. The under or outer side of the head 28 is here shown as a flat circular surface 30 disposed in a plane normal to the axis

Mapping of Allen To Claim 1.2 (Cont.)

of the head and joining the outer periphery of the surface 29 at an acute angle to provide a short, thin, sharp and acutely angled lip 31 of minimum overhang. As more clearly illustrated in FIG. 3, the sharp lip 31 when seated, will contact the sharp seat 17 to provide a thin circular line contact. While, as indicated with respect to angularity forming the seat 17, the angle between the surfaces 29 and 30 may not be critical; it is, however, preferable that this angle be acute to provide a sharp edge for the lip to insure a quick and complete discharge of fluid, eliminating the danger of fluid drag or adherence and insuring rapid decrease of fluid pressure. It will be noted that the substantially equal diameter of the head 28 with respect to the diameter of the seat 17 at the end of the fluid outlet passage 14 provides a minimum marginal lip 31 extending outwardly and downwardly from the seat 17. The frusto-conical surface including the lip will insure a radial spread of fluid discharged and the desired degree of atomization and diffusion." *Id.* at 3:4-30 (emphasis added); "From the foregoing, it will be seen that the present nozzle structure may be characterized as including a discharge orifice bounded by a sharp smooth circular seat from which the fluid may be rapidly discharged with minimum drag friction and without the retention of moisture or liquid droplets. This sharp terminus, externally bounded by the reversely inclined walls 16, gives a substantially instantaneous pressure drop insuring rapid diffusion. The conical diffusion head with its minimum overhang of peripheral edge, also formed at an acute angle, similarly precludes adhesion and insures rapid atomization. Such minimum overhang also diminishes the length of restrictive passage of fluid between head and seat, effectively maintaining friction at a minimum." *Id.* at 3:41-54 (emphasis added).

48. *Allen* discloses that the sharp and acutely angled lip 31 acts as a deposit breaking edge to thereby facilitate deposit removal from the injector nozzle. *Id.* at 1:23-27, 1:39-49, 1:50-62, 2:3-6, 2:43-49, 2:50-55; 3:4-30, 2:41-54, and Figs. 1-3; *see also* disclosure from Limitation 1.2.

49. It is also my opinion that a POSITA would recognize that by "minimiz[ing] turbulence, frictional drag, retardation of fluid flow and the clinging of fluid to nozzle components," "insur[ing] a radial spread of fluid discharged and the desired degree of atomization and diffusion," and "insur[ing] a quick and complete discharge of fluid, eliminating the danger of fluid drag or adherence and insuring rapid decrease of fluid pressure," to the extent fluid adheres and deposits form, such deposits will be more susceptible to falling off and thus more easily dislodged by the shearing effect of the fuel issuing from the exit of the nozzle passage (as well as the other swirls and currents present in the combustion

Mapping of Allen To Claim 1.2 (Cont.)

chamber, and at or adjacent the nozzle passage exit) Ex. 1002 at 1:23-27, 1:39-49, 1:50-62, 2:3-6, 2:43-49, 2:50-55; 3:4-30, 2:41-54, and Figs. 1-3. To the extent that *Allen* does not explicitly discuss the shearing effect, it is also my opinion that a POSITA would recognize that the shearing effect would further dislodge deposits, as evidenced, *e.g.*, by *Kubach*, Ex. 1003, which discloses a sharp edge 61 preventing "deceleration of the lamella" as well as deposit removal via shearing effect. *Id.* at 2:66-3:2, 3:47-48, 5:67-6:12, 6:58-64, 7:13-65, Figs. 4-5. *Id.* Additionally, movement of sharp and acutely angled lip 31 away from and then back toward and against the body 10 will further help to break and dislodge deposits located at or adjacent an exit of the nozzle passage. Ex. 1002 at Figs. 1-3.

59. *Allen* discloses that the sharp and acutely angled lip 31 on the diffusion head 28 and the sharp circular seat 14 on the body 10 facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the ring-shaped nozzle orifice. *Id.* at 3:4-30, 3:41-54, Figs. 1-3; *see also* recited disclosure in Limitation 1.2.

60. In my opinion, a POSITA would recognize that because *Allen* discloses that the sharp lip 31 and the sharp seat 14 "minimize turbulence, frictional drag, retardation of fluid flow and the clinging of fluid to nozzle components," "insure a radial spread of fluid discharged and the desired degree of atomization and diffusion," and "insure a quick and complete discharge of fluid, eliminating the danger of fluid drag or adherence and insuring rapid decrease of fluid pressure," the sharp lip 31 and the sharp seat 14 "facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage," as recited by claim 18. Ex. 1002 at 3:4-30, 3:41-54, Figs. 1-3.

Mapping of Allen To Claim 2

2. An injector nozzle according to claim **1**, wherein the sharp edge acts as a deposit breaking edge to thereby facilitate deposit removal from the injector nozzle.

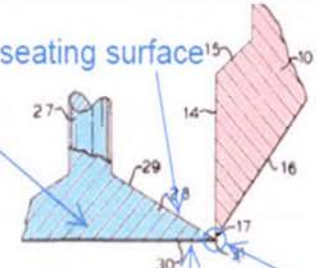


FIG.3

48. *Allen* discloses that the sharp and acutely angled lip 31 acts as a deposit breaking edge to thereby facilitate deposit removal from the injector nozzle. *Id.* at 1:23-27, 1:39-49, 1:50-62, 2:3-6, 2:43-49, 2:50-55; 3:4-30, 2:41-54, and Figs. 1-3; *see also* disclosure from Limitation 1.2.

49. It is also my opinion that a POSITA would recognize that by "minimiz[ing] turbulence, frictional drag, retardation of fluid flow and the clinging of fluid to nozzle components," "insur[ing] a radial spread of fluid discharged and the desired degree of atomization and diffusion," and "insur[ing] a quick and complete discharge of fluid, eliminating the danger of fluid drag or adherence and insuring rapid decrease of fluid pressure," to the extent fluid adheres and deposits form, such deposits will be more susceptible to falling off and thus more easily dislodged by the shearing effect of the fuel issuing from the exit of the nozzle passage (as well as the other swirls and currents present in the combustion chamber, and at or adjacent the nozzle passage exit). Ex. 1002 at 1:23-27, 1:39-49, 1:50-62, 2:3-6, 2:43-49, 2:50-55; 3:4-30, 2:41-54, and Figs. 1-3. To the extent that *Allen* does not explicitly discuss the shearing effect, it is also my opinion that a POSITA would recognize that the shearing effect would further dislodge deposits, as evidenced, *e.g.*, by *Kubach*, Ex. 1003, which discloses a sharp edge 61 preventing "deceleration of the lamella" as well as deposit removal via shearing effect. *Id.* at 2:66-3:2, 3:47-48, 5:67-6:12, 6:58-64, 7:13-65, Figs. 4-5. *Id.* Additionally, movement of sharp and acutely angled lip 31 away from and then back toward and against the body 10 will further help to break and dislodge deposits located at or adjacent an exit of the nozzle passage. Ex. 1002 at Figs. 1-3.

Mapping of Allen To Claim 4

4. An injector nozzle according to claim **1**, wherein an acute angle is provided between the seating surface and the outer valve surface of the valve member at the sharp edge transition.

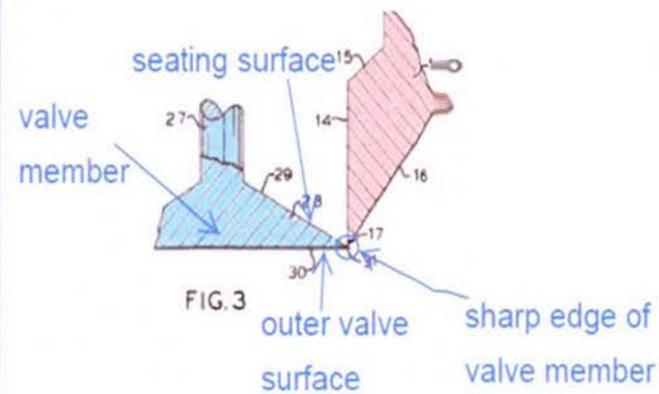


FIG. 3

50. *Allen* discloses that an acute angle is provided between the fluid contact surface 29 and the surface 30 of diffusion head 28 at the sharp and acutely angled lip 31 transition. *Id.* at 3:6-13 ("The under or outer side of the head 28 is here shown as a flat circular surface 30 disposed in a plane normal to the axis of the head and joining the outer periphery of the surface 29 at an acute angle to provide a short, thin, sharp and acutely angled lip 31 of minimum overhang."); *id.* at Fig. 3.

Mapping of Allen To Claim 5

5. An injector nozzle according to claim **1**, wherein the port includes an outer port surface surrounding and located adjacent to the valve seat surface, and a sharp edge is provided at the transition between the valve seat surface and the outer port surface.

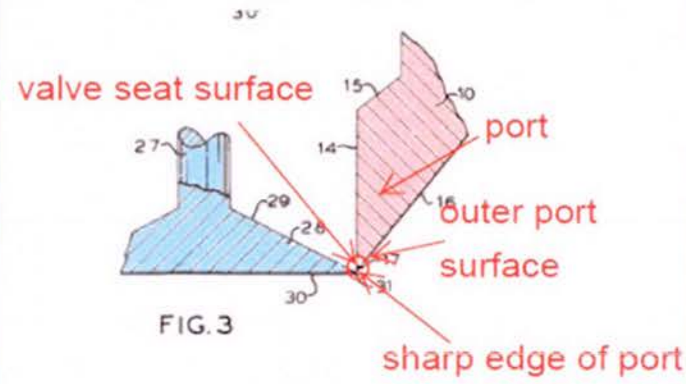


FIG. 3

51. *Allen* discloses that the body 10 includes an inclined wall 16 (the claimed "outer port surface") surrounding and located adjacent to the surface 14, and a sharp circular seat 17 (the claimed "sharp edge of the port") is provided at the transition between the surface 14 and the inclined wall 16. *Id.* at 2:43-55, Figs. 1-3. The "outer port surface" and the "sharp edge of the port" are identified below in annotated Figure 3:

52. For example, Allen discloses: "The opposite outer end of the bore 14 terminates in an orifice formed as a sharp knife-like circular seat 17 at the apex between the inner perpendicular walls of the bore 14 and the outer downwardly and inwardly tapering frusto-conical wall 16 of the body below the threads 11." *Id.* at 2:43-49; "The inward and downward taper of the frusto-conical outer surface 16 of the body meets the wall of the base at an acute angle to form the sharp smooth circular seat 17." *Id.* at 2:53-55.

Mapping of Allen To Claim 7

7. An injector nozzle according to claim **5**, wherein an acute angle is provided between the valve seat surface and the outer port surface of the port at the sharp edge transition.

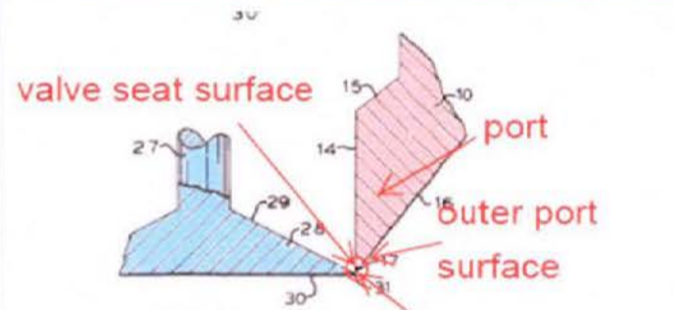


FIG. 3

53. *Allen* discloses that an acute angle is provided between the surface 14 and the inclined wall 16 of the body 10 at the sharp edge transition. *Id.* at 2:50-55, ("[T]he frusto-conical outer surface 16 of the body meets the wall of the base at an acute angle to forming 5 the sharp smooth circular seat 17."); *id.* at Fig. 3.

Mapping of Allen To Claim 10

10. An injector nozzle according to claim **5**, wherein the angle between the outer valve surface and the outer port surface is less than 180 degrees.

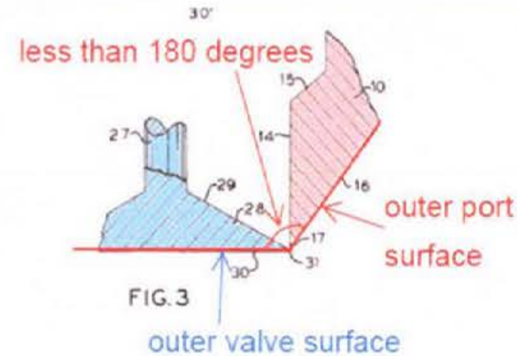


FIG.3

54. As shown below in annotated Figure 2, Allen discloses that the angle between the surface 30 and the inclined wall 16 is less than 180 degrees. *Id.* at Figs. 1-3.

Mapping of Allen To Claim 14

14. An injector nozzle according to claim **1**, the nozzle being of the outwardly opening poppet valve type.

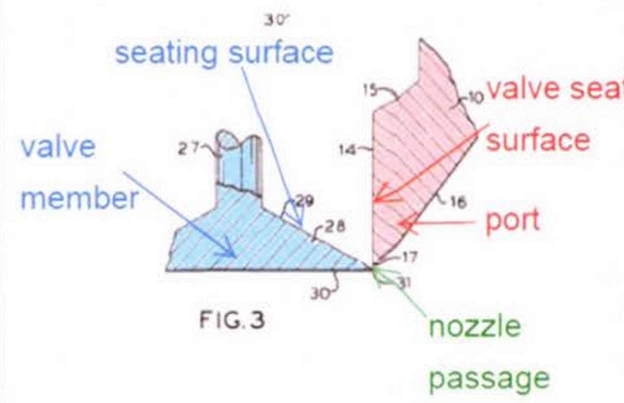


FIG. 3

55. *Allen* discloses that the injector nozzle is of the outwardly opening poppet valve type. *Id.* at 1:50-62, 2:24-31, 3:4-8, 3:30-40, Figs. 1-3. In my opinion, a POSITA would recognize that because *Allen* discloses that the diffusion head 28 "may move rapidly and fully from its seat 17" in an outward direction, one having ordinary skill in the art would recognize the fuel injector nozzle of *Allen* is "of the outwardly opening poppet valve type." *Id.*

Mapping of Allen To Claim 15

15. An injector nozzle according to claim **1**, the nozzle being arranged to deliver fuel directly into at least one combustion chamber of the engine.

56. To the extent that *Allen* does not explicitly discuss application of its "fuel injection nozzle" for a fuel injected internal combustion engine and being arranged to deliver fuel directly into at least one combustion chamber of the engine, one having ordinary skill in the art would recognize that *Allen's* fuel injection nozzle is indeed for use with an internal combustion engine and being arranged to deliver fuel directly into at least one combustion chamber of the engine. Such use is further evidenced, *e.g.*, by U.S. Patent No. 3,039,699 to Allen ("*Allen '699*"), Ex. 1018, sharing the same inventor and file date (and a similar fuel injection nozzle) as *Allen*, and further disclosing: "[T]he nozzle of the present invention finds successful adaptation . . . in the injection of fuel into the combustion supporting gases of high speed, spark-ignition type, internal combustion engines."). Ex. 1018 at 2:24-3.

57. In my opinion, a POSITA would recognize that the fuel injection valve of *Allen* is capable of being arranged to deliver fuel directly into at least one combustion chamber of the engine.

Mapping of Allen To Claim 16

16. An injector nozzle according to claim **5**, wherein the sharp edge on the valve member is formed in a separate step to the sharp edge on the port.

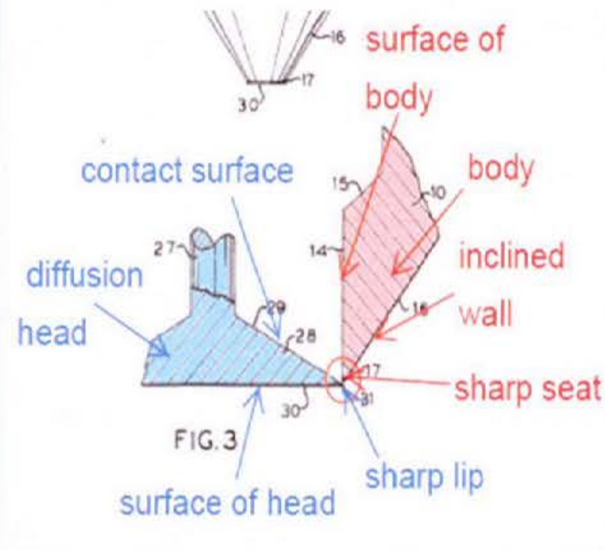
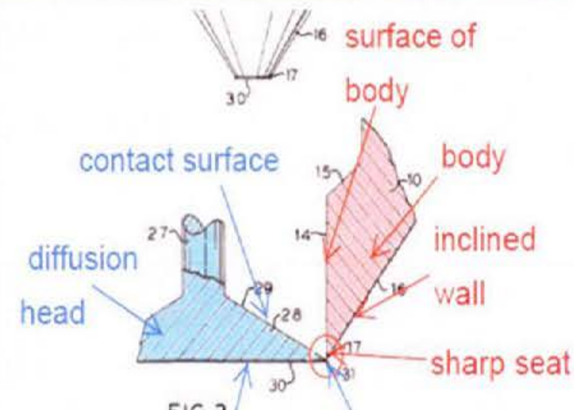


FIG.3

58. *Allen* discloses that the sharp and acutely angled lip 31 on the shank 27 is formed in a separate step from the sharp circular seat 14 on the body 10. *Id.* at 1:23-27, 1:39-49, 1:50-62, 2:2-6, 2:43-49, 2:50-55, 3:4-30, 3:41-54, and Figs. 1-3. In my opinion, a POSITA would recognize that because *Allen* discloses that "[t]he under or outer side of the head 28 . . . provide[s] a short, thin, sharp and acutely angled lip 31 of minimum overhang." *id.* at 3:4-9, one having ordinary skill in the art would recognize that the sharp and acutely angled lip 31 on diffusion head 28 is formed in a separate step from the sharp circular seat 14 on the body 10. *Id.*

Mapping of Allen To Claim 18

18. An injector nozzle according to claim **5**, wherein the sharp edges on the valve member and on the port facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage.

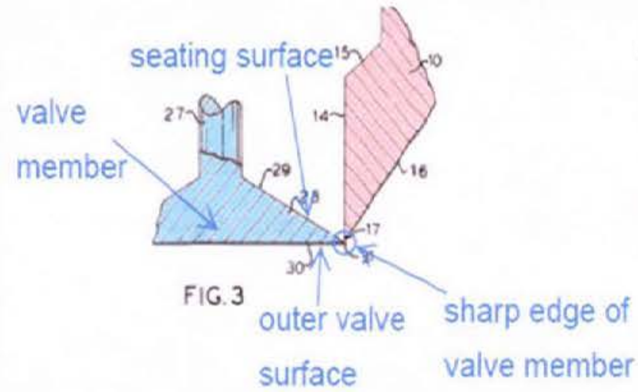


59. *Allen* discloses that the sharp and acutely angled lip 31 on the diffusion head 28 and the sharp circular seat 14 on the body 10 facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the ring-shaped nozzle orifice. *Id.* at 3:4-30, 3:41-54, Figs. 1-3; *see also* recited disclosure in Limitation 1.2.

60. In my opinion, a POSITA would recognize that because *Allen* discloses that the sharp lip 31 and the sharp seat 14 "minimize turbulence, frictional drag, retardation of fluid flow and the clinging of fluid to nozzle components," "insure a radial spread of fluid discharged and the desired degree of atomization and diffusion," and "insure a quick and complete discharge of fluid, eliminating the danger of fluid drag or adherence and insuring rapid decrease of fluid pressure," the sharp lip 31 and the sharp seat 14 "facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage," as recited by claim 18. Ex. 1002 at 3:4-30, 3:41-54, Figs. 1-3.

Mapping of Allen To Claim 19

19. An injector nozzle for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel therethrough or sealed contact therebetween to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.



19. "An injector nozzle for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode, said injector nozzle including"

61. In my opinion, a POSITA would recognize that the fuel injection nozzle of *Allen* is capable of being used with a spark-ignited fuel injected internal combustion engine operated in stratified charge mode.

19.1 "a port having a valve seat surface and valve member having a seating surface"

62. *See* Limitation 1.1.

19.1.1 "said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel,"

63. *See* Limitation 1.1.1.

19.1.2 "the valve member including an outer valve surface located adjacent the seating surface and external to the port"

64. *See* Limitation 1.1.2.

19.2 "wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage"

65. *See* Limitation 1.2.

Allen

Reference(s)	Basis	Challenged Claim(s)
Allen	§ 103(a)	1, 2, 4, 5, 7, 10, 14–16, 18, 19
Allen and Breslau	§ 103(a)	16
Allen and Bishop	§ 103(a)	1, 15, 19

Obviousness of Allen Over Claims 1, 2, 4-5, 7, 10, 13-16, 18, 19

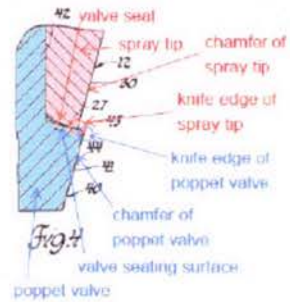
* '01255, Ex. 1004 at 49-51, 53-63

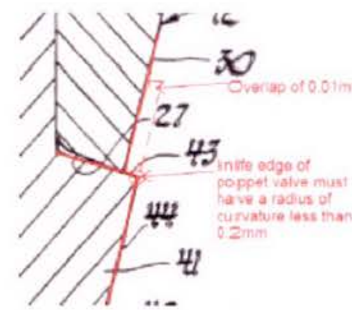
Obviousness of claims 1, 2, 4-5, 7-10, 13-16, 18, 19 over Allen

94. To the extent that the Board finds that the term "sharp edge" should be construed as "an edge having a radius of curvature less than 0.2 mm" and also finds any of *Allen* and *Kubach* as not disclosing such an edge, it is also my opinion that it would have been obvious to a POSITA in the art to implement the sharp edges of *Allen* and *Kubach* with a radius of curvature less than 0.2 mm.

95. In my opinion, forming a sharp edge with a radius of curvature less than 0.2 mm is well-known in the art. For example, U.S. Patent No. 4,693,424 to *Sczomak*, Ex. 1015, issued on September 15, 1987. I have been informed that *Sczomak* is prior art under 35 U.S.C. § 102(b).

96. *Sczomak* discloses an injector nozzle including a spray tip 12 (shown in red) and a poppet valve 40 (shown in blue), as shown in annotated Figure 4 (below left). *Id.* at 1:66-2:2, 3:27-53, Figs. 4-5.





97. *Sczomak* further discloses a knife edge provided on the poppet valve 40 at the transition between a valve seating surface 43 and a chamfer 44 thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage. *Id.* at 3:14-23, 3:50-53, 4:19-22, Figs. 4-5. In my opinion, a POSITA would recognize that because *Sczomak* discloses that the poppet valve 40 is relieved by a chamfer 44 to intersect the valve seating surface 43 to define the knife edge, *id.* at 3:14-17, 3:50-53, and that "the valve seat surface 43 of its head 41 can overhang the valve seat 27 of the spray tip 12 *by a maximum of 0.01 mm*," *id.* at 3:58-65, one having ordinary skill in the art would recognize that the knife edge of the poppet valve 40 of *Sczomak* must be less than 0.2 mm, as shown in annotated Figure 4 (above right). *Sczomak* further explains the advantages of implementing such a sharp edge. *Id.* at 4:8-22 ("In addition, with the chamfered spray tip 12 and head 41 arrangement shown, it appears that any carbon deposit which may engage any exposed valve seating surface either will fall off and/or burn off more readily due to the preferred range of the chamfer angle described hereinabove.").

Obviousness of claims 1, 2, 4-5, 7-10, 13-16, 18, 19 over Allen (Cont.)

103. It is also my opinion that a POSITA at the relevant time would have been motivated to implement the sharp edges of *Allen* and *Kubach* with a radius of curvature less than 0.2 mm, such as in *Sczomak* or *Bishop* so as to optimize control and reduction of the formation of deposits, as taught by *Sczomak* (via decreasing the surface by which deposits may form, such that they may fall off and/or burn off more readily) and *Bishop* (via preventing asymmetrical spray as well as providing a nominal surface area by which deposits may form). In my opinion, a POSITA would recognize that such an implementation of *Allen* and *Kubach* would constitute no more than an obvious design choice—one of a "finite number of identified, predictable solutions"—to one skilled in the art at the relevant time.

104. It is my opinion that a POSITA at the relevant time would have been motivated to form the sharp edges of *Allen* and *Kubach* with a radius of curvature less than 0.2 mm to optimize control and reduction of the formation of deposits. Since *Allen* and *Kubach* disclose everything else in the claims, discovering the optimum or workable ranges for the radius of curvature to do so would involve only routine skill in the art. Such discovery to a POSITA, in my opinion, is not inventive. Here, a POSITA would further recognize and appreciate that because the general conditions of the claim (i.e., sharp edges) are disclosed in the prior art of *Allen* and *Kubach*, discovering the optimum or workable ranges for the radius of curvature of these sharp edges would involve only routine skill in the art. Furthermore, it is also my opinion that since *Allen* and *Kubach* each associate the structure of their respective sharp edges with controlling the formation of deposits, a POSITA at the relevant time would have appreciated and recognized the sharp edges as result-effective variables, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges.

105. It is also my opinion that a POSITA at the relevant time would also have been motivated to implement the sharp edges of *Allen* and *Kubach* with a radius of curvature less than 0.2 mm, in an effort to achieve further control and reductions in deposit formation. In my opinion, such a modification would constitute no more than an obvious design choice—one of a "finite number of identified, predictable solutions"—to a POSITA at the relevant time. Here, in my opinion, a POSITA at the relevant time, and cognizant of the benefits in the control and reduction of deposit formation provided by the sharp edges of *Allen* and *Kubach* would have further appreciated and recognized a design need or market pressure to achieve further control and reductions in deposit formation. Also, a POSITA would have further recognized that there are a finite and predictable number of potential solutions, such as, for example, making the radius of the sharp edge with a radius of curvature less than 0.2 mm, and with a reasonable expectation of success, would have done so.

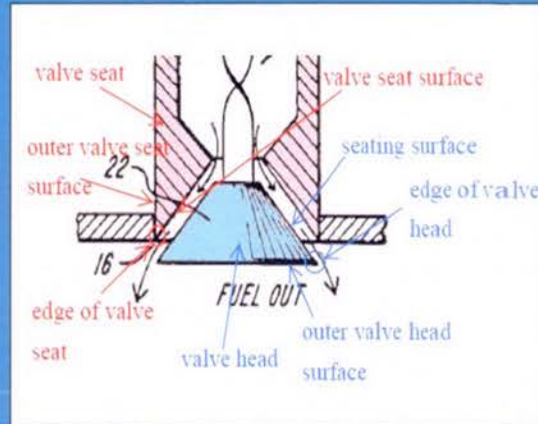
Obviousness of claim 16 over Allen and Breslau

106. I have been informed that claim 16 depends from claim 5 and independent claim 1 and thus requires that "the sharp edge on the valve member [be] formed in a separate step to the sharp edge on the port." Ex. 1001 at 9:8-10. As explained below, in my opinion, the teachings of *Allen* in combination with the teachings of *Breslau* would render claim 16 of the '387 patent obvious to a POSITA.

107. As discussed above, *Allen* discloses all the features of claims 1 and 5, including, for example, an injector nozzle including a sharp and acutely angled lip 31 provided on the diffusion head 28 at the transition between a fluid contact surface 29 and the surface 30 thereof (per claim 1) as well as a sharp circular seat 17 provided on the body 10 at the transition between the surface 14 and the inclined wall 16 (per claim 5).

108. To the extent that the Board finds claim 16 patentable over *Allen* based on claim 16's formation in a separate step limitation, in my opinion it would have been obvious to a POSITA to form the sharp and acutely angled lip 31 on the diffusion head 28 in a separate step to the sharp circular seat 17 on the body 10 of *Allen*.

109. In my opinion, forming an edge of a valve member separate from an edge of a port was well-known in the art. For example, U.S. Patent No. 4,846,217 to Breslau ("*Breslau*"), Ex. 1006, which issued on July 11, 1989. I have been informed that *Breslau* is prior art under 35 U.S.C. § 102(b).

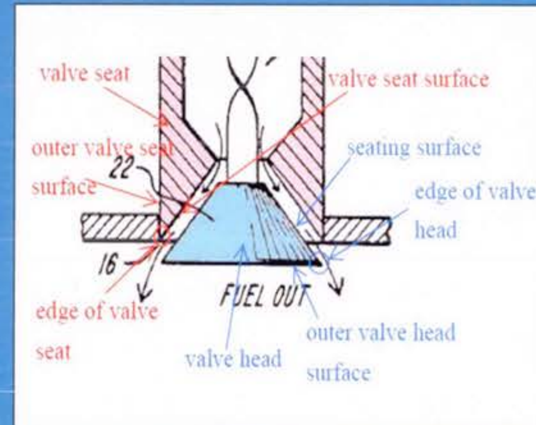


110. *Breslau* discloses an outwardly opening fuel injection valve 10 arranged to deliver fuel directly into at least one combustion chamber of an internal combustion engine. *Id.* at Abstract, Figs. 1-5. As shown adjacent in annotated Figure 1B (below), *Breslau* discloses that the injector nozzle includes a valve seat 16 (shown in red) and a valve head 22 (shown in blue). *Id.* at 3:39-49, Figs. 1-4.

Obviousness of claim 16 over Allen and Breslau (Cont.)

111. *Breslau* also discloses that the valve seat 16 has a valve seat surface and an outer valve seat surface surrounding and adjacent to the valve seat 16 and that the valve head 22 has a seating surface and an outer valve head surface adjacent to the seating surface and external to the valve seat 16. *Id.* *Breslau* further discloses that the valve head 22 is movable relative to the valve seat 16 to respectively provide a nozzle passage between valve seat 16 and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel. *Id.* Additionally, *Breslau* depicts a sharp edge at the transition between the seating surface and the outer valve head surface of the valve head 22, as well as a sharp edge at the transition between the valve seat surface and the outer valve seat surface of the valve seat 16. *Id.*

112. *Breslau* further discloses forming the sharp edge of the valve head 22 separately from the sharp edge of the valve seat 16. *Id.* at 3:50-68 ("[A] valve stem 20 is cold formed (forged) from stainless steel alloy 302 (SAE 30 302) to a shape that includes a short conical head portion . . . . The partially-formed valve stem can then be fed into a finishing machine where the tail is held while the valve head is ground to a final shape."); *id.* at 4:3-16 ("The cylindrical body part [of the valve body] can be cold forged from stainless steel alloy 304 (SAE 30 304). . . . Then a grinding head finishes the valve seat. As shown in FIGS. 1A and 1B the valve seat is preferably formed as a cylindrical beveled surface which is mated with the conical valve head having the same angular shape and dimensions."); *id.* at 4:26-28

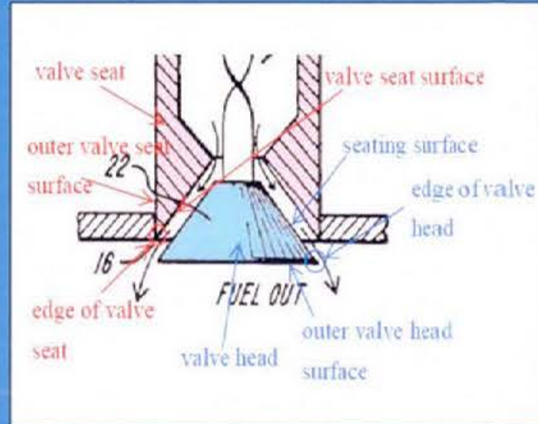


("The nozzle can then be assembled by inserting the valve stem 20 into the valve body 12, such that the valve head 20 and seat 16 mate.").

113. And *Breslau* further explains the advantages of implementing such a separate manufacturing process, which include, for example, reducing the need for precision in forming operations; helping ensure alignment and proper mating of the surfaces of the diffusion head with the body; helping to reduce the risk of alignment problems and maladjustment, and providing a manufacturer the ability to vary the spray pattern of the valves by simply changing the shape of the diffusion head and/or the body. *Id.* at 2:50-53, 2:57-58 ("Additionally, the valve head and valve seat can be formed by mating beveled surfaces; seating is accomplished with much less need for precision in the forming operations . . . the valves of the present invention are largely insensitive to alignment problems"); *id.* at 1:60-61, and which ("could be cycled with minimal risk of . . . maladjustment"); *id.* at 5:7-9 ("the spray pattern of the valves disclosed herein can be varied by changing the shape of the valve head and/or seat.").

Obviousness of claim 16 over Allen and Breslau (Cont.)

114. In my opinion, a POSITA at the relevant time would have been motivated to form the sharp and acutely angled lip 31 on the diffusion head 28 in a separate step to the sharp circular seat 17 on the body 10 of *Allen*, as in *Breslau* in order to reduce the need for precision in forming operations; help ensure alignment and proper mating of the surfaces of the body 10 with the diffusion head 28; helping to reduce the risk of alignment problems and maladjustment. *Id.* at 1:60-61; 2:50-53, 2:57-58; 5:7-9. It is also my opinion that a POSITA would have done so to allow the manufacturer to vary the spray pattern of the fuel injector by changing the shape of the diffusion head 28 with the body 10 of *Allen*. It is further my opinion that such an implementation of *Allen* would constitute no more than an obvious manufacturing choice—one of a "finite number of identified, predictable solutions"—to a POSITA at the relevant time.



Obviousness of claims 1, 15, 19 over Allen with Bishop

115. Independent claim 1 recites "for a fuel injected internal combustion engine." Ex. 1001 at 8:12-13. Claim 15, which I have been informed depends from claim 1 recites, "the nozzle being arranged to deliver fuel directly into at least one combustion chamber of the engine." *Id.* at 9:5-7. I have also been informed that the only difference between independent claim 19 and independent claim 1 is the following italicized language from the preamble: "[a]n injector nozzle *for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode*, said injector nozzle including." Ex. 1001 at 10:3-5. As explained below, in my opinion, the teachings of *Allen* in combination with the teachings of *Bishop* would render claims 1, 15, and 19 of the '387 patent obvious to a POSITA and the teachings of *Kubach* in combination with the teachings of *Bishop* would render claims 15 and 19 of the '387 patent obvious to a POSITA.

116. As discussed above, *Allen* discloses a fuel injection nozzle and *Kubach* discloses an injection valve for a fuel injected internal combustion engine. In my opinion, the use of an injector nozzle in a spark-ignited fuel injected internal combustions engine operating in stratified charge mode was well-known in the art, as acknowledged, e.g., by the '387 patent. *See id.* at 2:1-13 ("The above discussed disturbances to the delivery of fuel to the combustion chamber of an engine are particularly significant in engines which, for at least part of engine load range, operate with a highly stratified fuel charge *such as is recognized* as highly desirable to control exhaust emissions, particularly during low load operation" (emphasis added).). According to the '387 patent, "An example of such a stratified charge engine is one employing a dual fluid fuel injection system such as that disclosed in the Applicants U.S. Patent Nos. 4,693,224 and RE 36768," both of which are prior art under 35 U.S.C. § 102(b). *Id.* at 2:6-10.

117. As another example, as discussed above, *Bishop* discloses an injector nozzle with a sharp edge provided on a valve member 26 at the transition between the surface 64 and the exterior surface 61, thereof and a sharp edge provided at the transition of a tip portion 20 between the valve seat 62 and the exterior surface 60. Ex. 1005 at 2:57-64, 2:72-3:8; 4:13-19, Fig. 2. *Bishop* further discloses that the injector nozzle is for an internal combustion engine operated in stratified charge mode. *Id.* at 1:17-21 ("The injector of this invention is particularly useful in a stratified charge type internal combustion engine such as the engine described in Bishop et al., U.S. Patent No. 3,315,650"); *see also Bishop '650*, Ex. 1011, at 1:15-20 ("[This invention] relates to *a stratified charge combustion process for an internal combustion engine of the spark-ignition type* in which fuel is burned in an excess of air at part loads and full utilization of the air is made at maximum loads" (emphasis added)); *id.* at 4:6-13 ("In a stratified charge engine, only that portion of the air that is adjacent the spark plug is impregnated with gasoline or fuel at the time of ignition. As a result, light-load fuel quantities can be mixed with a small portion of the air so that the local air-fuel ratio around the spark plug is sufficiently high to permit reliable ignition, and yet a quantity of excess air may be present in the cylinder.").

Obviousness of claim 19 over Allen with Bishop (Cont.)

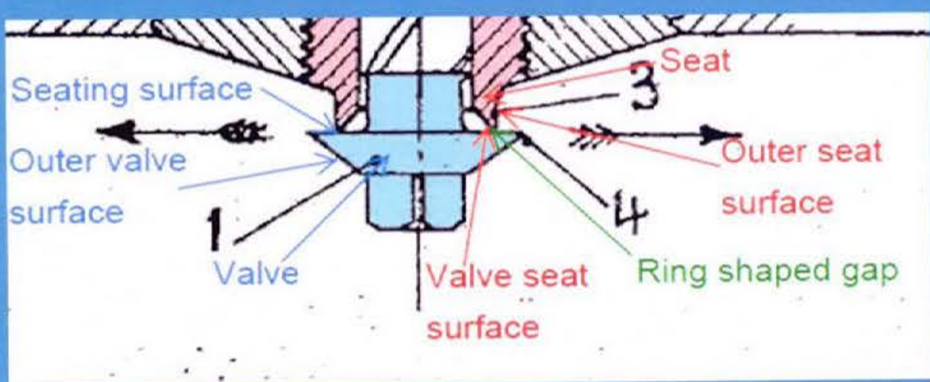
118. *Bishop* explains that doing so helps achieve optimum performance and economy of the engine. Ex. 1005 at 1:19-24 ("Accurate fuel delivery over a wide range of flow rates is essential in such an engine, and this injector performs exceptionally well in achieving the optimum performance and economy of the engine.").

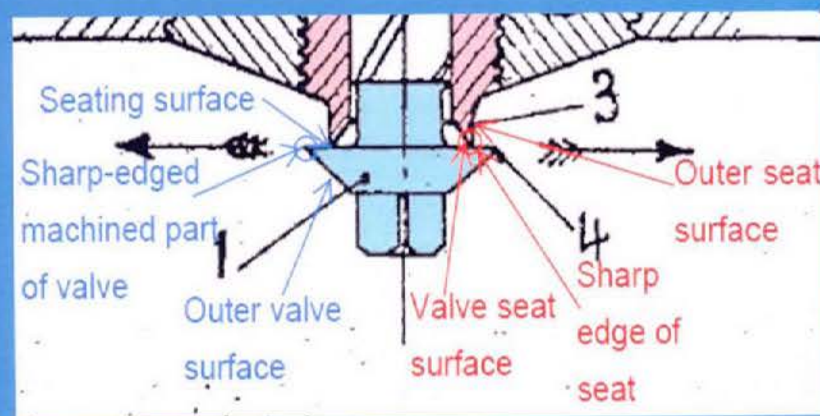
119. In my opinion, a POSITA at the relevant time would have been motivated to implement the fuel injection nozzle/valve of *Allen* and *Kubach* in a spark-ignited fuel injected internal combustion engine operating in stratified charge mode, as in *Bishop*, in order to achieve accurate fuel delivery over a wide range of flow rates and thus help achieve optimum performance and economy of the engine. *Id.* at 1:17-24. Indeed, in my opinion, such an implementation of *Allen* and *Kubach* would constitute no more than an obvious design choice—one of a "finite number of identified, predictable solutions"—to a POSITA at the relevant time. It is further my opinion that such an implementation of *Allen* and *Kubach* would constitute no more than an obvious design choice—one of a "finite number of identified, predictable solutions"—to a POSITA at the relevant time. It is also my opinion that such a modification would simply improve fuel delivery, performance, and economy of the engine disclosed by *Allen* and *Kubach* in the same way as it improves an engine in *Bishop* (e.g., providing such an engine with accurate fuel delivery over a wide range of flow rates so as to help achieve optimum performance and economy of the engine is essential in such an engine).

120. It is also my opinion that a POSITA would recognize that such a modification would simply improve fuel delivery, performance, and economy of the engine disclosed by *Kubach* in the same way as it improves an engine in *Bishop* (e.g., by providing a such an engine with accurate fuel delivery over a wide range of flow rates so as to help achieve optimum performance and economy of the engine is essential in such an engine). Further, it is my opinion that such a modification and improvement could be achieved by simply substituting the engine of *Kubach* (e.g., fuel injected internal combustion engine) with another known engine (spark-ignited fuel injected internal combustion engine operating in stratified charge mode), and would yield nothing more than a predictable result. Further, *Bishop* itself refers to the applicability of his injector for stratified charge engines to conventional engines. Ex. 1005 at 1:19-24 ("[m]any features of the injector also are useful in conventional fuel injected reciprocating-type engines."). Therefore, it is also my opinion, in further light of *Bishop*'s teaching of the use of its fuel injector with either internal combustion engines operating in stratified charge mode or other conventional engines, that it would have been obvious to a POSITA at the relevant time, to implement the fuel injection valve of *Kubach* in a stratified charge mode internal combustion engine, yielding the predictable advantages of helping achieve optimum performance and economy of the engine, as taught by *Bishop*. *Id.* at 1:17-24.

Tartrais

Reference(s)	Basis	Challenged Claim(s)
Tartrais	§ 102(b)	1, 2, 4, 5, 7, 10, 14–16, 18, 19
Tartrais	§ 103(a)	1, 2, 4, 5, 7, 10, 14–16, 18, 19
Tartrais and Breslau	§ 103(a)	16
Tartrais and Bishop	§ 103(a)	19





Tartrais

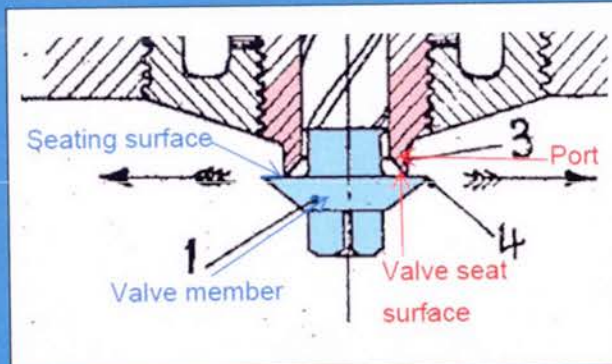
Reference(s)	Basis	Challenged Claim(s)
Tartrais	§ 102(b)	1, 2, 4, 5, 7, 10, 14–16, 18, 19

Tartrais Discloses All Elements Of Claims 1, 2, 4-5, 7, 10, 13-16, 18, 19

* '01256, Ex. 1004 at 38-52

Mapping of Tartrais To Claim 1.0, 1.1

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.



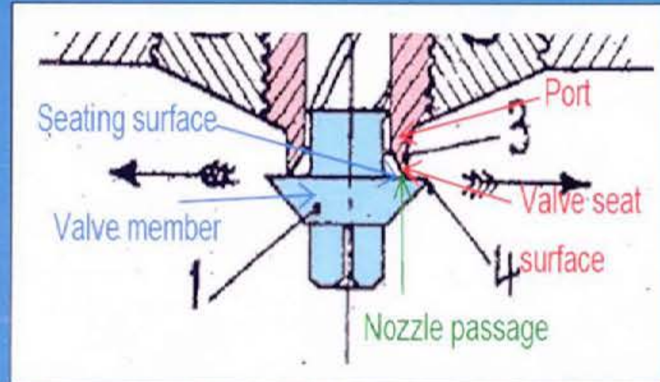
75. *Tartrais* discloses a fuel injection valve for a fuel injected internal combustion engine. *Id.* at Title, 1.

76. *Tartrais* discloses that the injector nozzle includes a seat 3 (the claimed "port") having a valve seat surface and a valve 1 (the claimed "valve member") having a seating surface. *Id.* at 1, Fig. 1. The "port" and corresponding structures including the "valve seat surface" are identified below in red. The "valve member" and corresponding structures including the "seating surface" are identified in blue below in the annotated figure:

77. *Tartrais* discloses: "[t]he diffuser is comprised of a valve 1 which has a rod that is set in the body or housing 2 without play, with said housing having a seat 3 in form of a cutting edge. The actual valve has a planar surface that is delimited by an acutely angled part 4. The spring 5 holds the valve on its seat, and the valve is equipped with channels 6." *Id. Tartrais* further discloses that "[t]he object of the invention is a fuel injection valve that is characterized in that the ring-shaped gap is formed between two elements, which are on the one hand a planar surface delimited by an acutely angled edge, and on the other side have a sharp edge, with one of said elements being stationary and the other (preferably the planar surface) being carried by the valve." *Id.*

Mapping of Tartrais To Claim 1.1.1

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.



78. *Tartrais* discloses that the valve 1 is movable relative to the seat 3 to respectively provide a ring-shaped gap (the claimed "nozzle passage") between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel. *Id.*, Fig. 1. The "nozzle passage" is identified in green below in annotated Figure 1:

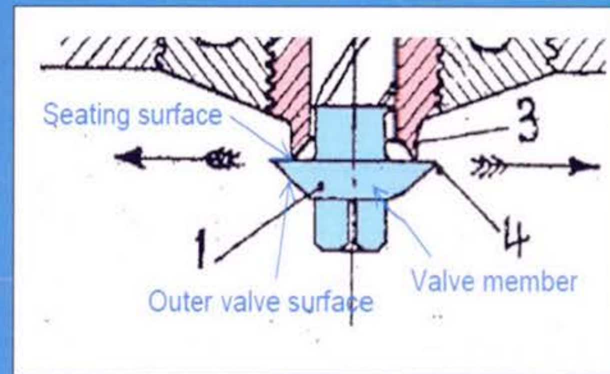
79. For example, *Tartrais* discloses that "[t]he invention relates to an injection valve, in particular for combustion engines, where the fuel is spread onto a large surface and injected through a ring-shaped gap." *Id.* *Tartrais* further discloses: "The mode of operation is as follows: At the given point in time of the operating cycle, a pump of any design presses a specific quantity of fuel into the device, with said liquid having to lift up the valve 1 after flowing through the filter 7, so as to be able to enter into the cylinder. The spring force, in addition to the pressure of the gases in the cylinder, effects that the valve is lifted only very insignificantly. The liquid escapes in the rather thin spurt." *Id.*

Mapping of Tartrais To Claim 1.1.1 (Cont.)

80. *Tartrais* discloses: "The diffuser is comprised of a valve 1 which has a rod that is set in the body or housing 2 without play, with said housing having a seat 3 in form of a cutting edge. The actual valve has a planar surface that is delimited by an acutely angled part 4. The spring 5 holds the valve on its seat." *Id.* *Tartrais* further discloses a "[f]uel injection valve for combustion engines, with the injection taking place in form of a wide surface through a ring-shaped gap, characterized in that said ring-shaped gap is formed between two parts of which one (1) consists of a planar surface delimited by an acute angle (4), and the other (2) by a sharp edge (3), with one of the two parts being stationary and the other (usefully the planar surface) being carried by the valve." *Id.*

Mapping of Tartrais To Claim 1.1.2

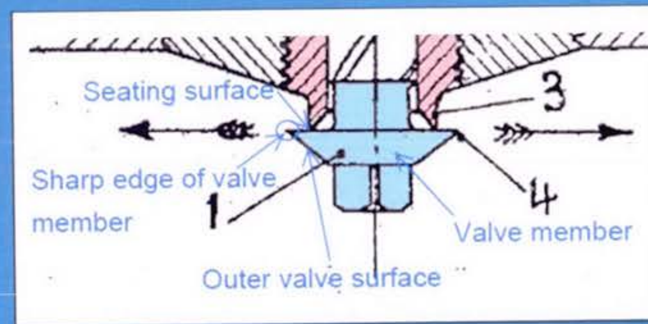
1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.



81. *Tartrais* discloses that the valve 1 includes an outer valve surface located adjacent the seating surface and external to the seat 3. *Id.* at Fig. 1. The "outer valve surface" is identified adjacent to the seating surface in annotated Fig. 1:

Mapping of Tartrais To Claim 1.2

1. An injector nozzle for a fuel injected internal combustion engine, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.



82. *Tartrais* discloses a sharp-edged machined part 4 (the claimed "sharp edge") provided on the valve 1 at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the ring-shaped gap. *Id.* at 1, Fig. 1. The "sharp edge of the valve member" is identified adjacent in annotated Figure 1:

83. In my opinion, a POSITA would recognize that because *Tartrais* discloses that the sharp edge 4 "facilitat[es] a fine, widely spread, horizontal liquid surface that is completely even around the valve" and "prevent[s] liquid from flowing down the wall" such that "liquid squirts out evenly all around and diffuses in the ambient air that it encounters"), *id.* at 1, and because it is well-known and recognized by one having ordinary skill in the art that fuel on nozzle surfaces leads to deposits, the sharp edge 4 "control[s] the formation of deposits at or adjacent an exit of the nozzle passage." *Id.*

Mapping of Tartrais To Claim 1.2 (Cont.)

84. For example, *Tartrais* discloses: "The object of the invention is a fuel injection valve that is characterized in that the ring-shaped gap is formed between two elements, which are on the one hand a planar surface delimited by an acutely angled edge, and on the other side have a sharp edge, with one of said elements being stationary and the other (preferably the planar surface) being carried by the valve. Said arrangement facilitates obtaining a fine, widely spread, horizontal liquid surface that is completely even around the valve." *Id.* (emphasis added); "The diffuser is comprised of a valve 1 which has a rod that is set in the body or housing 2 without play, with said housing having a seat 3 in form of a cutting edge. The actual valve has a planar surface that is delimited by an acutely angled part 4." *Id.* (emphasis added); "The mode of operation is as follows: At the given point in time of the operating cycle, a pump of any design presses a specific quantity of fuel into the device, with said liquid having to lift up the valve 1 after flowing through the filter 7, so as to be able to enter into the cylinder. The spring force, in addition to the pressure of the gases in the cylinder, effects that the valve is lifted only very insignificantly. The liquid escapes in the rather thin spurt. The **sharp-edged machined part 4** prevents the liquid from flowing down the wall. Therefore, the liquid squirts out evenly all around, and diffuses in the ambient air that it encounters." *Id.* (emphasis added); "Fuel injection valve for combustion engines, with the injection taking place in form of a wide surface through a ring-shaped gap, characterized in that said ring-shaped gap is formed between two parts of which one (1) consists of a planar surface delimited by an acute angle (4), and the other (2) by a sharp edge (3), with one of the two parts being stationary and the other (usefully the planar surface) being carried by the valve." *Id.* (emphasis added).

Mapping of Tartrais To Claim 1.2 (Cont.)

85. *Tartrais* discloses that the sharp edge 4 acts as a deposit breaking edge to thereby facilitate deposit removal from the injector nozzle. *Id*; *see also* disclosure from Limitation 1.2.

86. In my opinion, a POSITA would recognize that by preventing deposit buildup, (via "facilitat[ing] . . . a fine, widely spread, horizontal liquid surface that is completely even around the valve" and "prevent[ing] . . . liquid from flowing down the wall" such that "liquid squirts out evenly all around and diffuses in the ambient air that it encounters"). Ex. 1003 at 1, to the extent deposits do form, they will be more susceptible to falling off and thus more easily dislodged by the shearing effect of the fuel issuing from the exit of the orifice passage. To the extent that *Tartrais* does not explicitly discuss the shearing effect, in my opinion, a POSITA would recognize that the shearing effect would dislodge deposits, as evidenced, *e.g.*, by *Kubach*, Ex. 1017, disclosing a sharp edge 61 preventing "deceleration of the lamella" as well as deposit removal via shearing effect. *Id.* at 2:66-67-3:2, 3:47-48, 5:67-6:12, 6:58-64, 7:13-65, Figs. 4-5. *See also Svoboda*, disclosing "[t]hus in conjunction with the knife edge 42 [[which] minimize[s] the surface available . . . for the accumulation of carbon deposits] the wash of fuel flowing through the passages 24 and 36 further reduces the tendency for formation of carbon deposits." Ex. 1020 at 2:38-57, Figs. 2-3.

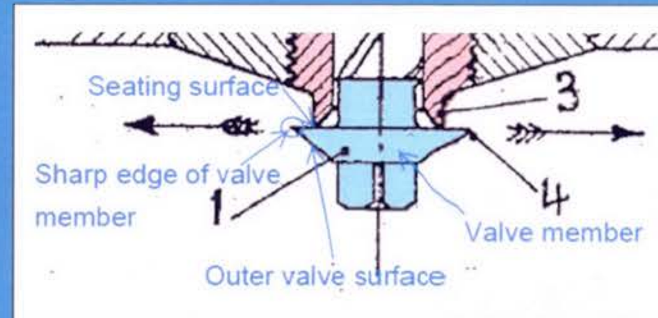
95. *Tartrais* discloses that the sharp edges on the valve 1 and the seat 3 facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the ring-shaped gap. *See* Limitation 1.2.

96. In my opinion, a POSITA would recognize that because *Tartrais* discloses that "the arrangement" of the sharp edges on the valve 1 and the seat 3 "<u>facilitates</u> obtaining a fine, widely spread, horizontal liquid surface that is completely even around the valve," "prevents the liquid from flowing down the wall," such that "the liquid squirts out evenly all around, and diffuses in the ambient air that it encounters," the sharp edges "facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage." Ex. 1003 at 1, Fig. 1.

97. For example, *Tartrais* discloses at *id.*, "The object of the invention is a fuel injection valve that is characterized in that the ring-shaped gap is formed between two elements, which are on the one hand a planar surface delimited by an acutely angled edge, and on the other side have a sharp edge, with one of said elements being stationary and the other (preferably the planar surface) being carried by the valve. <u>Said arrangement facilitates obtaining a fine, widely spread, horizontal liquid surface that is completely even around the valve.</u>" *Id.* at 1; "The liquid escapes in the rather thin spurt. The sharp-edged machined part 4 <u>prevents the liquid from flowing down the wall. Therefore, the liquid squirts out evenly all around, and diffuses in the ambient air that it encounters.</u>" *Id.* (emphasis added).

Mapping of Tartrais To Claim 2

2. An injector nozzle according to claim **1**, wherein the sharp edge acts as a deposit breaking edge to thereby facilitate deposit removal from the injector nozzle.

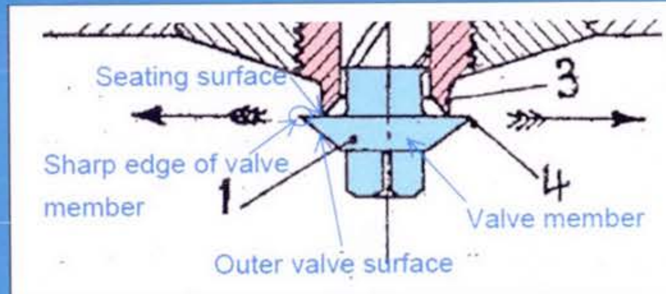


85. *Tartrais* discloses that the sharp edge 4 acts as a deposit breaking edge to thereby facilitate deposit removal from the injector nozzle. *Id*; *see also* disclosure from Limitation 1.2.

86. In my opinion, a POSITA would recognize that by preventing deposit buildup, (via "facilitat[ing] . . . a fine, widely spread, horizontal liquid surface that is completely even around the valve" and "prevent[ing] . . . liquid from flowing down the wall" such that "liquid squirts out evenly all around and diffuses in the ambient air that it encounters"). Ex. 1003 at 1, to the extent deposits do form, they will be more susceptible to falling off and thus more easily dislodged by the shearing effect of the fuel issuing from the exit of the orifice passage. To the extent that *Tartrais* does not explicitly discuss the shearing effect, in my opinion, a POSITA would recognize that the shearing effect would dislodge deposits, as evidenced, *e.g.*, by *Kubach*, Ex. 1017, disclosing a sharp edge 61 preventing "deceleration of the lamella" as well as deposit removal via shearing effect. *Id.* at 2:66-67-3:2, 3:47-48, 5:67-6:12, 6:58-64, 7:13-65, Figs. 4-5. *See also Svoboda*, disclosing "[t]hus in conjunction with the knife edge 42 [[which] minimize[s] the surface available . . . for the accumulation of carbon deposits] the wash of fuel flowing through the passages 24 and 36 further reduces the tendency for formation of carbon deposits." Ex. 1020 at 2:38-57, Figs. 2-3.

Mapping of Tartrais To Claim 4

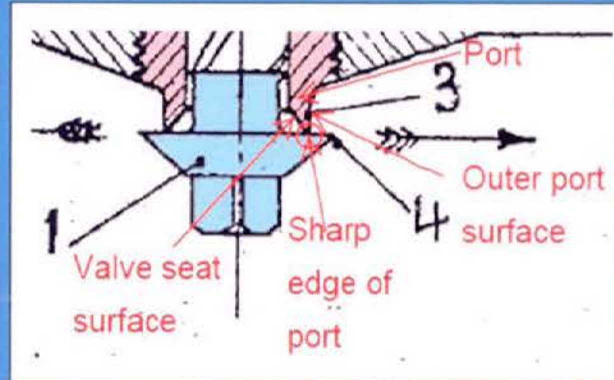
4. An injector nozzle according to claim **1**, wherein an acute angle is provided between the seating surface and the outer valve surface of the valve member at the sharp edge transition.



87. *Tartrais* discloses that an acute angle is provided between the seating surface and the outer valve surface at the sharp edge 4 transition. Ex. 1003 at 1, Fig 1. ("The object of the invention is a fuel injection valve that is characterized in that the ring-shaped gap is formed between two elements, which are on the one hand a planar surface delimited by an acutely angled edge, and on the other side have a sharp edge" (emphasis added).).

Mapping of Tartrais To Claim 5

5. An injector nozzle according to claim **1**, wherein the port includes an outer port surface surrounding and located adjacent to the valve seat surface, and a sharp edge is provided at the transition between the valve seat surface and the outer port surface.

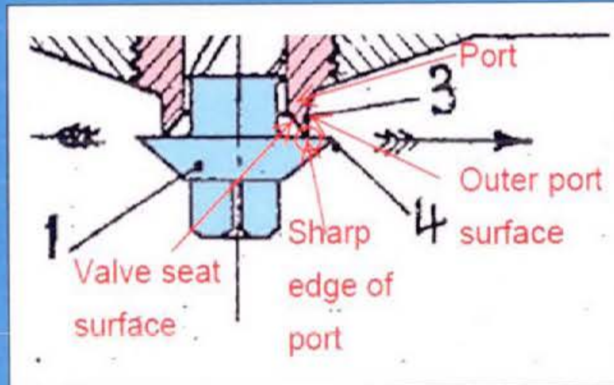


88. *Tartrais* discloses that the seat 3 includes an outer port surface surrounding and located adjacent to the valve seat surface, and a sharp edge is provided at the transition between the valve seat surface and the outer port surface. *Id.* The "outer port surface" and the "sharp edge of the port" are identified adjacent to each other in annotated Fig. 1:

89. For example, *Tartrais* discloses: "The object of the invention is a fuel injection valve that is characterized in that the ring-shaped gap is formed between two elements, which are on the one hand a planar surface delimited by an acutely angled edge, and on the other side have a sharp edge, with one of said elements being stationary and the other (preferably the planar surface) being carried by the valve. Said arrangement facilitates obtaining a fine, widely spread, horizontal liquid surface that is completely even around the valve." *Id.* (emphasis added). *Tartrais* further discloses: "The diffuser is comprised of a valve 1 which has a rod that is set in the body or housing 2 without play, with said housing having a seat 3 in form of a cutting edge. The actual valve has a planar surface that is delimited by an acutely angled part 4." *Id.*

Mapping of Tartrais To Claim 7

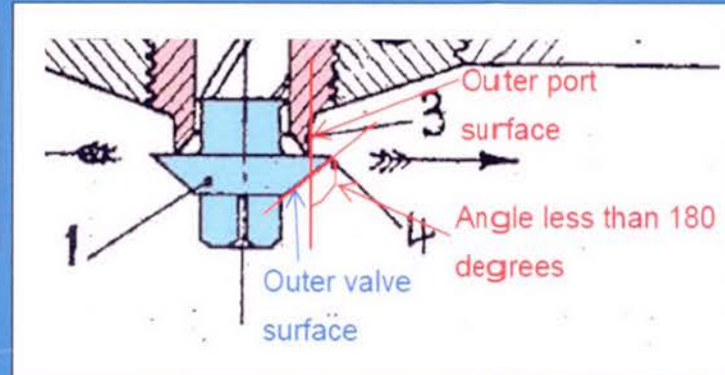
7. An injector nozzle according to claim **5**, wherein an acute angle is provided between the valve seat surface and the outer port surface of the port at the sharp edge transition.



90. *Tartrais* discloses that an acute angle is provided between the valve seat surface and the outer port surface of the seat 3 at the sharp edge transition. *Id.* at Fig. 1.

Mapping of Tartrais To Claim 10

10. An injector nozzle according to claim **5**, wherein the angle between the outer valve surface and the outer port surface is less than 180 degrees.

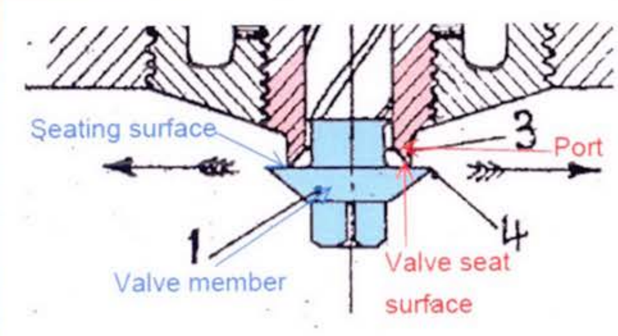


91. As shown below in annotated Figure, *Tartrais* discloses that the angle between the outer valve surface and the outer port surface is less than 180 degrees.

Id. at Fig. 1.

Mapping of Tartrais To Claim 14

14. An injector nozzle according to claim **1**, the nozzle being of the outwardly opening poppet valve type.



92. *Tartrais* discloses that the nozzle is of the outwardly opening poppet valve type. *Id.* at 1, Fig. 1. In my opinion, a POSITA would recognize that because *Tartrais* discloses that the valve 1 lifts up away from the seat 3, the fuel injection valve of *Tartrais* is "of the outwardly opening poppet valve type."

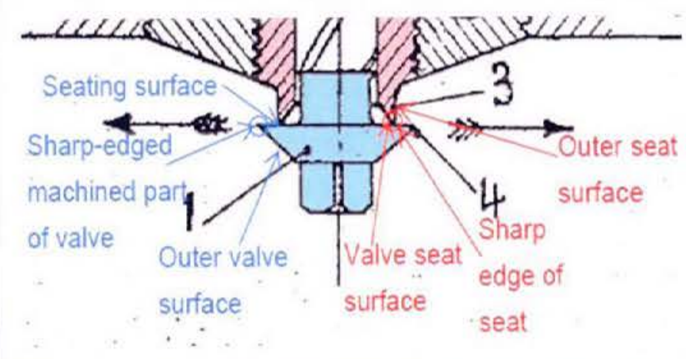
Mapping of Tartrais To Claim 15

15. An injector nozzle according to claim **1**, the nozzle being arranged to deliver fuel directly into at least one combustion chamber of the engine.

93. *Tartrais* discloses that the nozzle is arranged to delivery fuel directly into at least one combustion chamber of the engine. *Id.* at title, 1 ("[A] specific quantity of fuel into the device, with said liquid having to lift up the valve 1 after flowing through the filter 7, so as to be able to enter into the cylinder" (emphasis added).).

Mapping of Tartrais To Claim 16

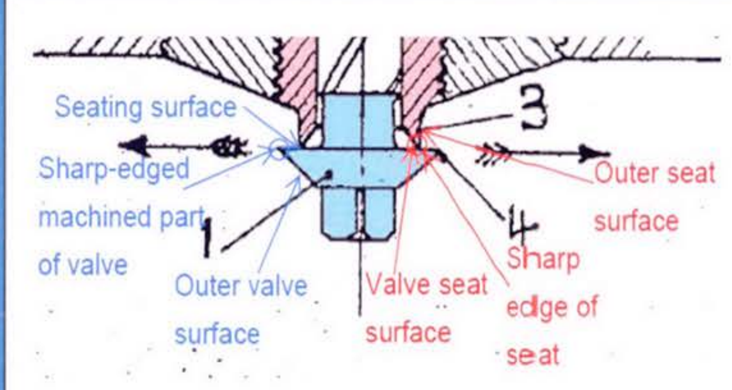
16. An injector nozzle according to claim **5**, wherein the sharp edge on the valve member is formed in a separate step to the sharp edge on the port.



94. *Tartrais* discloses that the sharp edge 4 on the valve 1 is formed in a separate step to the sharp edge 3 on the seat 3. *See id.* In my opinion, a POSITA would recognize that based on at least this disclosure, including disclosure that the sharp edge 4 is a "sharp-edged *machined* part," the sharp edge of the valve 1 of *Tartrais* must be formed in a separate step to the sharp edge of the seat 3.

Mapping of Tartrais To Claim 18

18. An injector nozzle according to claim **5**, wherein the sharp edges on the valve member and on the port facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage.



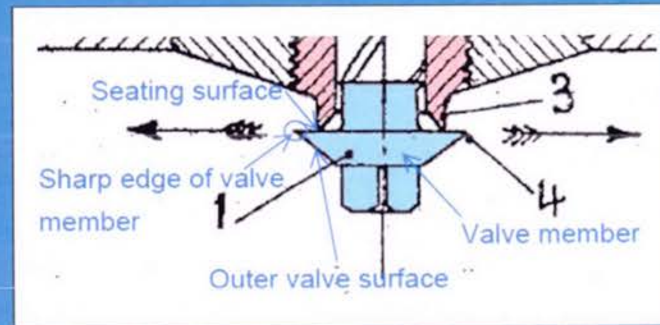
95. *Tartrais* discloses that the sharp edges on the valve 1 and the seat 3 facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the ring-shaped gap. *See* Limitation 1.2.

96. In my opinion, a POSITA would recognize that because *Tartrais* discloses that "the arrangement" of the sharp edges on the valve 1 and the seat 3 "facilitates obtaining a fine, widely spread, horizontal liquid surface that is completely even around the valve," "prevents the liquid from flowing down the wall," such that "the liquid squirts out evenly all around, and diffuses in the ambient air that it encounters," the sharp edges "facilitates the maintenance of an optimal nozzle exit spray geometry thereby preventing over expansion of the fuel spray at the exit of the nozzle passage." Ex. 1003 at 1, Fig. 1.

97. For example, *Tartrais* discloses at *id.*, "The object of the invention is a fuel injection valve that is characterized in that the ring-shaped gap is formed between two elements, which are on the one hand a planar surface delimited by an acutely angled edge, and on the other side have a sharp edge, with one of said elements being stationary and the other (preferably the planar surface) being carried by the valve. Said arrangement facilitates obtaining a fine, widely spread, horizontal liquid surface that is completely even around the valve." *Id.* at 1; "The liquid escapes in the rather thin spurt. The sharp-edged machined part 4 prevents the liquid from flowing down the wall. Therefore, the liquid squirts out evenly all around, and diffuses in the ambient air that it encounters." *Id.* (emphasis added).

Mapping of Tartrais To Claim 19

19. An injector nozzle for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode, said injector nozzle including a port having a valve seat surface and valve member having a seating surface, said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel therethrough or sealed contact therebetween to prevent said delivery of fuel, the valve member including an outer valve surface located adjacent the seating surface and external to the port, wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage.



19. "An injector nozzle for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode, said injector nozzle including"

98. In my opinion, a POSITA would recognize that the fuel injection valve of *Tartrais* is capable of being used within a spark-ignited fuel injected internal combustion engine operating in stratified charge mode. *Id.*

19.1 "said injector nozzle including a port having a valve seat surface and valve member having a seating surface"

99. *See* Limitation 1.1.

19.1.1"said valve member being movable relative to the port to respectively provide a nozzle passage between the valve seat surface and the seating surface for the delivery of fuel there-through or sealed contact there-between to prevent said delivery of fuel,"

100. *See* Limitation 1.1.1.

19.1.2"the valve member including an outer valve surface located adjacent the seating surface and external to the port"

101. *See* Limitation 1.1.2.

19.2 "wherein a sharp edge is provided on the valve member at the transition between the seating surface and the outer valve surface thereof, for controlling the formation of deposits at or adjacent an exit of the nozzle passage"

102. *See* Limitation 1.2.

Tartrais

Reference(s)	Basis	Challenged Claim(s)
Tartrais	§ 103(a)	1, 2, 4, 5, 7, 10, 14–16, 18, 19
Tartrais and Breslau	§ 103(a)	16
Tartrais and Bishop	§ 103(a)	19

Obviousness of Tartrais Over Claims 1, 2, 4-5, 7, 10, 13-16, 18, 19

* '01256, Ex. 1004 at 52-54,60-64

Obviousness of claims 1, 2, 4-5, 7-10, 13-16, 18, 19 over Tartrais

103. To the extent that the Board finds that the term "sharp edge" should be construed as "an edge having a radius of curvature less than 0.2 mm" and also finds any of *Bishop* and *Tartrais* as not disclosing such an edge, in my opinion, it would have been obvious to one of ordinary skill in the art to implement the edges terminating at a point of *Bishop* and the sharp edges of *Tartrais* with a radius of curvature less than 0.2 mm. In my opinion, a POSITA at the relevant time would have been motivated to implement the edges terminating at a point of *Bishop* and the sharp edges *Tartrais* with a radius of curvature less than 0.2 mm to optimize control of the formation of deposits. Since *Bishop* and *Tartrais* disclose everything else in the claims, discovering the optimum or workable ranges for the radius of curvature to do so would involve only routine skill in the art. Such discovery to a POSITA, in my opinion, is not inventive.

104. Here, a POSITA would recognize that because the general conditions of the claim (i.e., edges terminating at a point and sharp edges) are disclosed in the prior art of *Bishop* and *Tartrais*, discovering the optimum or workable ranges for the radius of curvature of these edges would involve only routine skill in the art. Furthermore, it is also my opinion that since *Bishop* and *Tartrais* each associate their respective edges with control and reduction in deposit formation, a POSITA at the relevant time would have appreciated and recognized the edges terminating at a point of *Bishop* and the sharp edges *Tartrais* as result-effective variables, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges.

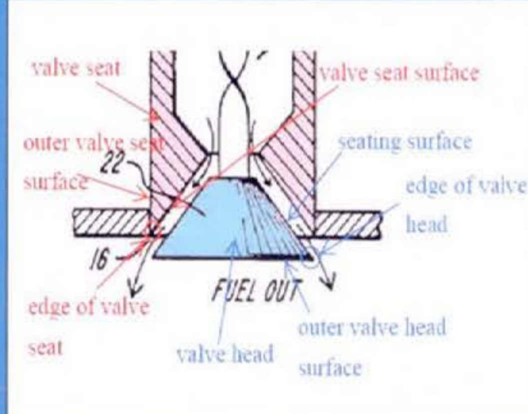
105. It is also my opinion that a POSITA at the relevant time would also have been motivated to implement the edges terminating at a point of *Bishop* and the sharp edges *Tartrais* with a radius of curvature less than 0.2 mm, in an effort to achieve further control and reductions in deposit formation. Indeed, such a modification would constitute no more than an obvious design choice—one of a "finite number of identified, predictable solutions"—to a POSITA at the relevant time. Here, it is also my opinion that a POSITA at the relevant time, and cognizant of the benefits in the control and reduction of deposit formation provided by the edges terminating at a point and the sharp edges as taught by *Bishop* and *Tartrais* would have further appreciated and recognized a design need or market pressure to achieve further control and reductions in deposit formation. Also, it is also my opinion that a POSITA would have further recognized that there are a finite and predictable number of potential solutions, such as, for example, making the radius of the sharp edge with a radius of curvature less than 0.2 mm, and with a reasonable expectation of success, would have done so.

Obviousness of claim 16 over Tartrais and Breslau

124. I have been informed that claim 16 depends from claim 5 and independent claim 1 and thus requires that "the sharp edge on the valve member [be] formed in a separate step to the sharp edge on the port." Ex. 1001 at 9:8-10. As explained below, in my opinion, the teachings of *Tartrais* in combination with the teachings of *Breslau* would render claim 16 of the '387 patent obvious to a POSITA.

125. As discussed *supra*, *Tartrais* discloses all features of claims 1 and 5, including, for example, a fuel injection valve including a sharp edged machined part 4 provided on the valve 1 at the transition between a seating surface and an outer valve surface (per claim 1) thereof as well as a sharp edge provided on the seat 3 at the transition between the valve seat surface and the outer seat surface (per claim 5). In my opinion, it would have been obvious to a POSITA to form the sharp edge of the valve 1 in a separate step to the sharp edge on the seat 3 of *Tartrais*.

126. As discussed above in Section D, in my opinion, forming an edge of a valve member separate from an edge of a port was well-known in the art, as evidenced by *Breslau*. For example, as discussed above, *Breslau* depicts sharp edges and discloses forming the sharp edge of the valve head 22 separately from the sharp edge of the valve seat 16 and several advantages of doing so: reducing the need for precision in forming operations; helping ensure alignment and proper mating of the surfaces of the valve seat with the valve body; helping reduce the risk of alignment problems and maladjustment; and providing a manufacturer the ability to vary the spray pattern of the valves by simply changing the shape of the valve body and/or seat.



127. In my opinion, a POSITA at the relevant time would have been motivated to form the sharp edged machined part 4 of the valve 1 in a separate step to the sharp edge on the seat 3 of *Tartrais*, as in *Breslau*, in order to reduce the need for precision in forming operations; help ensure alignment and proper mating of the surfaces of the valve 1 with the seat 3; and help reduce the risk of alignment problems and maladjustment. Ex. 1006 at 1:60-61, 2:50-53, 2:57-58, 5:7-9. It is also my opinion that a POSITA would have done so to allow the manufacturer to vary the spray pattern of the fuel injector by changing the shape of the valve 1 with the seat 3 of *Tartrais*. It is further my opinion that such an implementation of *Tartrais* would constitute no more than an obvious manufacturing choice—one of a "finite number of identified, predictable solutions"—to a POSITA at the relevant time.

Obviousness of claim 19 over Tartrais with Bishop

118. I have been informed that the only difference between independent claim 19 and independent claim 1 is the following italicized language from the preamble: "[a]n injector nozzle *for a spark-ignited fuel injected internal combustion engine operated in stratified charge mode*, said injector nozzle including." Ex. 1001 at 10:3-5. As explained below, in my opinion, the teachings of *Tartrais* in combination with the teachings of *Bishop* would render claim 19 of the '387 patent obvious to a POSITA.

119. As discussed above, *Tartrais* discloses a fuel injection valve for use in a fuel injected internal combustion engine. In my opinion, it would have been obvious to a POSITA to implement the fuel injection valve of *Tartrais* in a spark-ignited fuel injected internal combustion engine operating in stratified charge mode.

120. In my opinion, the use of an injector nozzle in a spark-ignited fuel injected internal combustion engine operating in stratified charge mode was well-known in the art, as acknowledged, e.g., by the '387 patent. *See Id.* at 2:1-13 ("The above discussed disturbances to the delivery of fuel to the combustion chamber of an engine are particularly significant in engines which, for at least part of engine load range, operate with a highly stratified fuel charge *such as is recognized* as highly desirable to control exhaust emissions, particularly during low load operation"(emphasis added).). According to the '387 patent, "An example of such a stratified charge engine is one employing a dual fluid fuel injection system such as that disclosed in the Applicants U.S. Patent Nos. 4,693,224 and RE 36768," both of which are prior art under 35 U.S.C. § 102(b). Ex. 1001 at 2:6-9.

121. As another example, and as discussed *supra*, *Bishop* discloses using an injector nozzle in a spark-ignited fuel injected internal combustion engine operated in stratified charge mode. Ex. 1002 at 1:17-21 ("The injector of this invention is particularly useful in a stratified charge type internal combustion engine such as the engine described in Bishop et al., U.S. Patent No. 3,315,650"); *see also Bishop '650*, Ex. 1011 at 1:14-19 ("[This invention] relates to *a stratified charge combustion process for an internal combustion engine of the spark-ignition type* in which fuel is burned in an excess of air at part loads and full utilization of the air is made at maximum loads" (emphasis added.)); *id.* at 4:6-13 ("In a stratified charge engine, only that portion of the air that is adjacent the spark plug is impregnated with gasoline or fuel at the time of ignition. As a result, light-load fuel quantities can be mixed with a small portion of the air so that the local air-fuel ratio around the spark plug is sufficiently high to permit reliable ignition, and yet a quantity of excess air may be present in the cylinder.").

122. In my opinion, such an implementation of *Tartrais* would constitute no more than an obvious design choice—one of a "finite number of identified, predictable solutions"—to a POSITA at the relevant time.

123. It is further my opinion that such a modification and improvement could be achieved by simply substituting the engines of *Tartrais* (e.g., internal combustion engine) with another known engine (spark-ignited fuel injected internal combustion engine operating in stratified charge mode) and would yield nothing more than a predictable result. In fact, *Bishop* itself refers to the applicability of his injector for stratified charge engines to conventional engines. Ex. 1002 at 1:23-24 ("[m]any features of the injector also are useful in conventional fuel injected reciprocating-type engines.").

Claims 1, 19 - Patent Owner Arguments to Masubuchi

In response to argument that Masubuchi discloses a sharp edge, PO says:

1. **Petitioner's construction of sharp edge is wrong**

"Petitioner's (non)-construction does not reflect the broadest reasonable construction of the term "sharp edge" within the meaning of the '387 Patent."

My response:

I disagree.

As stated in my declaration, in my opinion, a POSITA would recognize that express construction of "sharp edge" is not needed. *See* , *e.g.*, slides 15-17.

Claims 1, 19 - Patent Owner Arguments to Masubuchi

In response to argument that Masubuchi discloses a sharp edge, PO says (cont.):

2. Masubuchi discloses a macro geometric angle, not sharp edge transition

"[t]he '387 Patent distinguishes between the macro-level, geometric angle between two surfaces described by Masubuchi and the claimed micro-level sharp edge 'discontinuity' provided at the transition between two adjacent surfaces."

My response:

I disagree:

- Masubuchi provides reference to the characteristics of the sharp edge transition by at least describing the edges of valve body 11 (the claimed "valve member") and the valve seat 10 (the claimed "port") as each having "a knife-edge shape." *See, e.g.*, slides 24-26, 29.
- That Masubuchi also describes angle α, formed at the juncture of the seating surface and outer valve surface 13, does not detract from Masubuchi's explicit description of the edge itself as "a knife-edge." It is not the angle formed at the juncture of the seating surface and the outer valve surface 13 which delineates the "knife-edge shape," but rather, the "knife-edge" which defines the "knife-edge shape."

Claims 1, 19 - Patent Owner Arguments to Masubuchi

In response to argument that Masubuchi discloses a sharp edge, PO says (Cont.):

3. Masubuchi is shaped to normal tolerances

PO argues that the "figures of Masubuchi likewise fail to shed light as to the sharpness of Masubuchi's edge features,"; "there is nothing in Masubuchi that would indicate that the rim portion of the valve body . . . is machined, created, or shaped other than to normal tolerances,"; and it cannot be determined if Masubuchi's valve member includes a sharp edge "without a specific reference to the shape of the transition."

My response:

I disagree:

- Masubuchi explicitly provides a "specific reference to the shape of the transition" by at least describing the edges of valve body 11 (the claimed "valve member") and the valve seat 10 (the claimed "port") as each having "a knife-edge shape." *See, e.g.*, slides 24-26, 29.
- Masubuchi explicitly specifies that the valve body 11 and the valve seat 10 are formed to include a knife-edge.

Claims 1, 19 - Patent Owner Arguments to Masubuchi

In response to argument that Masubuchi's knife edges control the formation of deposits at or adjacent an exit of the nozzle passage, PO says:

"to the extent that Masubuchi discloses that any of its features is a variable that results in reduced deposit formation, it is the provision of an acute angle (β) formed between the conical valve seat (10) and a front end portion (9) of the valve body (11) . . . [Masubuchi] associates control of carbon deposit formation only because of the acute angle formed between the valve seat (10) and the outer, lower surface of the valve body (11), rather than by the provision of a certain radius of curvature of the transition between the surfaces as disclosed in the '387 patent."

My response:

I disagree. Masubuchi discloses that each of the valve body 11 and the valve seat 10 include knife edges. Masubuchi further discloses that the knife edges of the valve body 11 and the valve seat 10 control the formation of deposits at or adjacent an exit of the nozzle passage. For example:

1. The knife edges of the valve body 11 and the valve seat 10 effect the quantity of air surrounding the front end surface 9, thus effecting the pressure and the bias against the drawing in of fuel toward the area around the front end surface 9 during injection. Less fuel adhesion to the area around the front end surface 9 = less fuel adhesion to the nozzle surfaces at or adjacent an exit of the nozzle passage = less deposit formation at the nozzles surfaces at or adjacent an exit of the nozzle passage. *See, e.g.*, slides 24-27, 36-37.

2. The knife edges of the valve body 11 and the valve seat 10 each minimize the surface available for fuel to adhere – and thus for deposits to form – as opposed to that of a non-sharp edge. There will also be less surface area available for fuel to adhere at the knife edge mating surfaces of the valve body 11 and the valve 10, at or adjacent an exit of the nozzle passage (i.e., smaller crevices for fuel adhesion, and thus deposit formation). Masubuchi at 3 ("Moreover, due to the fact that the tapered edge of the fuel injection valve front end portion is formed flush with the fuel injection valve body front end surface when the valve body is closed, the fuel does not adhere to the peripheral surface of the valve body nor to the valve seat, and therefore, a deposit also does not adhere."). ("In addition, it is possible to inhibit injected fuel . . . from adhering to the front end surface of the valve body."). *See id.*

3. Deposits that do form on the knife edges will fall off more readily, or will be unable to build up as much before falling off, because, for example:

(a) the shearing action of the deposits (i.e., deposits at the sharp edges are more susceptible to falling off and thus more easily dislodged by the shearing effect of the fuel issuing from the exit of the nozzle passage);

(b) Movement of the valve member against the port will break and dislodge deposits at or adjacent an exit of the nozzle passage. *See id.*

Claims 1, 19 - Patent Owner Arguments to Sczomak

In response to argument that Sczomak discloses a sharp edge, PO says:

1. Petitioner's construction of sharp edge is wrong.

"Petitioner's (non)-construction does not reflect the broadest reasonable construction of the term "sharp edge" within the meaning of the '387 Patent."

My response:

I disagree.

As stated in my declaration, in my opinion, a POSITA would recognize that express construction of "sharp edge" is not needed. *See* , *e.g.*, slides 15-17.

Claims 1, 19 - Patent Owner Arguments to Sczomak

In response to argument that Sczomak discloses a sharp edge, PO says:

2. Sczomak discloses a macro geometric angle, not sharp edge transition

- "Sczomak's disclosure of a "knife edge" is neither synonymous with nor suggestive of a "sharp edge" within the meaning of the '387 Patent."
- "Sczomak's statement that "the lower outer peripheral end of the spray tip 12 is relieved as by a chamfer 30 so as to intersect the valve seat 27 and to define therewith a so-called knife edge" merely provides a high-level, geometric description that an acute angle is formed between the chamfer (30) and the valve seat (27)."
- "Sczomak uses the word "knife" only once and with exclusive reference to the spray tip (12)."

My response:

I disagree:

- Sczomak provides a specific reference to the shape of the edge transition by describing the edge provided at the transition between the valve seat 27 and the chamfer 30 as having a "knife edge," which is synonymous of a "sharp edge." *See, e.g.*, slide 56.
- Sczomak also provides reference to the shape of the edge provided at the transition between the valve seating surface 43 and the chamfer 44 of the poppet valve 40 as a knife-edge. *See, e.g.*, slides 50, 52.
- In my opinion, that Sczomak may refer to an acute angle generally defined between the chamfer 30 and valve seat 27 does not detract from Sczomak's explicit description of the edge itself as a "knife-edge". In my opinion, a POSITA would recognize that it is not the angle defined between the chamber 30 and the valve seat 27 which delineates the "knife-edge", but rather, the knife-edge itself.

Claims 1, 19 - Patent Owner Arguments to Sczomak

In response to argument that Sczomak discloses a sharp edge, PO says (cont.):

2. Sczomak does not disclose a valve member edge having a radius of curvature of less .2 mm

Petitioner relies on the conclusory analysis merely references a single variable (i.e., overhang), but fails to consider other relevant geometric considerations including inter alia the various chamfer angle(s) (30, 43), the relative angle(s) between the valve seat surfaces (27, 43), the contact positions between the valve seat surfaces, and the length of the edge features, etc. Indeed, it will be appreciated that any number of curves having a radius of curvature greater than 0.2 mm can be drawn to represent an obtusely-angled merger between a valve seat surface (43) and the chamfer (44). Whereas a minimum of three points are required to define a circle."

My response:

I disagree:

- Because the maximum overhang between the valve seat 27 and the valve seating surface 43 is 0.01 mm, the edge of the poppet valve must have a radius of curvature of less than 0.2 mm. *See, e.g.*, slide 51.
- Additionally, the edge formed by the intersection of the valve seat surface 43 and chamfer 44 must also have a radius of curvature of less than .2 mm, because Sczomak discloses, at 3:47-49, "the valve seat 27 and valve seat surface 43 effect seating engagement at least at one and preferably at both their outer peripheral edges."

Claims 1, 19 - Patent Owner Arguments to Sczomak

In response to argument that <u>Sczomak's knife edges control the formation of deposits at or adjacent an exit of the nozzle passage</u>, PO says:

"to the extent that Sczomak discloses that any of its features is a variable that results in reduced deposit formation, it is the provision of complementary chamfered surfaces (30, 43) on the spray tip (12) and poppet valve (40) and the acute angle formed between surfaces of the spray tip (12) formed in part by the chamfered surface (30). . . . Thus, contrary to Petitioner's allegations, Sczomak provides that the control of carbon deposits is "due to" (i.e., the result of) the complementary chamfer angle (30, 43) provided on the spray tip (12) and poppet valve (40), rather than by the provision of "sharp edges" exhibiting a certain "radius of curvature less than 0.2 mm" as claimed in the '387 Patent."

My response:

I disagree. Sczomak discloses knife edges on the spray tip 12 and the poppet valve 40. Sczomak also discloses that the edges at the spray tip 12 and poppet valve 40 each have a radius of curvature of less than 0. 2 mm. Sczomak further discloses that the knife edges control the formation of deposits at or adjacent an exit of the nozzle passage. For example,

1. The knife edges, and the edges having a radius of curvature of less than 0.2 mm, minimize the surface available for fuel to adhere – and thus for deposits to form – as opposed to that of a non-sharp edge. *See, e.g.*, Sczomak at 4:8-22 ("any exposed surfaces radially outward of the actual sealed interface of the valve seat 27 and the valve seat surface 43 can and will be wetted by fuel during the injection cycle . . . Thus it is desirable to <u>reduce such surface area</u> which can be wetted by fuel to a minimum."). There will also be less surface area available for fuel to adhere at the knife edge mating surfaces, at or adjacent an exit of the nozzle passage (i.e., smaller crevices for fuel adhesion, and thus deposit formation). See slides 52-54, 63.

2. Deposits that do form on the sharp edge will fall off more readily, or will be unable to build up as much before falling off, because, for example:
   (a) the shearing action of the deposits (i.e., deposits at the sharp edges are more susceptible to falling off and thus more easily dislodged by the shearing effect of the fuel issuing from the exit of the nozzle passage). Sczomak at id. ("<u>In addition</u>, with the chamfered spray tip 12 and head 41 arrangement shown, it appears that <u>any</u> carbon deposit which may engage <u>any exposed valve seating surface</u> either will fall off and/or burn off more readily.").
   (b) Movement of the valve member against the port will break and dislodge deposits at or adjacent an exit of the nozzle passage. *See id.*

3. The knife edges also help minimize fuel from spreading around the edges during injection, toward the outer surfaces – as opposed to that of a non-sharp edge. Less spreading of fuel around the edges = more optimal fuel spray = less fuel adhesion to nozzle surfaces at or adjacent an exit of the nozzle passage = less deposit formation at the nozzles surfaces at or adjacent an exit of the nozzle passage.

Claims 1, 19 - Patent Owner Arguments to Allen

In response to argument that Allen discloses a sharp edge, PO says:

1. **Petitioner's construction of sharp edge is wrong**

"Petitioner's (non)-construction does not reflect the broadest reasonable construction of the term "sharp edge" within the meaning of the '387 Patent."

My response:

I disagree.

As stated in my declaration, in my opinion, a POSITA would recognize that express construction of "sharp edge" is not needed. *See* , *e.g.*, slides 15-17.

Claims 1, 19 - Patent Owner Arguments to Allen

In response to argument that <u>Allen discloses a sharp edge</u>, PO says:

2. Allen discloses a macro geometric angle, not sharp edge transition

The '387 Patent clearly distinguishes between a macro-level, geometric angle between two adjacent surfaces (which does not define a "sharp edge" within the meaning of the '387 Patent) and the micro-level "discontinuity" of the edge feature between the surfaces (which does). The '387 Patent's claimed "sharp edge" at the transition between adjoining surfaces refers to the "sharpness" of an edge feature, a consideration which is separate and distinct from the geometric angle between the adjoining surfaces. However, Allen's use of the term "sharp edge" relates to the angle defined by the adjacent surfaces but is not suggestive of the "sharpness" of the edge between these surfaces.

My response:

I disagree.

- Allen provides reference to the characteristics of the edge transition by at least describing the edge of the diffusion head 28 (the claimed "valve member") as a sharp circular edge. *See, e.g.*, slides 76 -79.
- In my opinion, that Allen also describes that the angle formed at the juncture of seating surface 29 and outer valve surface 30 is acute, this description does not detract from Allen's explicit characterization of the edge itself as "sharp." In fact, Allen discloses a "sharp <u>and</u> acutely angled lip 31." If the acute angle at the edge were determinative of its sharpness, as argued by PO, this phrase , i.e., sharp <u>and</u> acutely angled lip 31, would be redundant.

Claims 1, 19 - Patent Owner Arguments to Allen

In response to argument that <u>Allen discloses a sharp edge</u>, PO says (cont.):

3. Allen is shaped to normal tolerances

PO argues that the "figures of Allen likewise fail to shed light as to the sharpness of Allen's edge features," that "there is nothing in Allen that would indicate that the head (28). . . is machined, created, or shaped other than to normal tolerances," and that it cannot be determined if Allen's valve member includes a sharp edge "without a specific reference to the shape of the transition."

My response:

I disagree.

- Allen explicitly provides a "specific reference to the shape of the transition" by at least describing the edge of the diffusion head 28 (the claimed "valve member") as a sharp circular edge.
- Allen explicitly specifies that the valve member and port edges are formed to include sharp edges.

Claims 1, 19 - Patent Owner Arguments to Allen

In response to argument that Allen's sharp edges control the formation of deposits at or adjacent an exit of the nozzle passage, PO says:

"To the extent that Allen discloses that any of its features is a variable that results in reduced deposit formation, it is the geometric angular relationship itself that purportedly provides these benefits: "with respect to angularity forming the seat 17, the angle between the surfaces 29 and 30 may not be critical; it is, however, preferable that this angle be acute to provide a sharp edge for the lip to insure a quick and complete discharge of fluid, eliminating the danger of fluid drag or adherence and insuring rapid decrease of fluid pressure." Id. at 3:16-22 (emphasis added). "

My response:

I disagree.

Allen discloses a sharp lip 31 on a valve member and a sharp seat 17 on a port. Allen further discloses that the sharp lip 31 and the sharp seat 17 control the formation of deposits at or adjacent an exit of the nozzle passage. For example,

1. The sharp edges "minimiz[e] . . . clinging of fluid to nozzle components," "insure a quick and complete discharge of fluid, eliminating the danger of fluid drag or adherence and insuring rapid decrease of fluid pressure." Less fuel adhesion to nozzle surfaces at or adjacent an exit of the nozzle passage = less deposit formation at the nozzles surfaces at or adjacent an exit of the nozzle passage. *See, e.g.*, slides 76-80, 88.

2. The sharp edges minimize the surface available for fuel to adhere – and thus for deposits to form – as opposed to that of a non-sharp edge. There will also be less surface area available for fuel to adhere at the mating surfaces of the sharp lip 31 and the sharp seat 17, i.e., smaller crevices for fuel adhesion. *See id.*

3. Deposits that do form on the sharp edge will fall off more readily, or will be unable to build up as much before falling off, because, for example:
   (a) the shearing action of the deposits (i.e., deposits at the sharp edges are more susceptible to falling off and thus more easily dislodged by the shearing effect of the fuel issuing from the exit of the nozzle passage);
   (b) Movement of the valve member against the port will break and dislodge deposits at or adjacent an exit of the nozzle passage.

Claims 1, 19 - Patent Owner Arguments to Tartrais

In response to argument that <u>Tartrais discloses a sharp edge</u>, PO says:

1. **Petitioner's construction of sharp edge is wrong**

"Petitioner's (non)-construction does not reflect the broadest reasonable construction of the term "sharp edge" within the meaning of the '387 Patent."

My response:

I disagree.

As stated in my declaration, in my opinion, a POSITA would recognize that express construction of "sharp edge" is not needed. *See*, *e.g.*, slides 15-17.

Claims 1, 19 - Patent Owner Arguments to Tartrais

In response to argument that Tartrais discloses a sharp edge, PO says:

2. Tartrais discloses macro geometric angle, not sharp edge transition

"[t]here is no indication in Tartrais that the reference to element (4) as a "sharp-edged machined part" refers to the sharpness of an edge feature within the meaning of the '387 Patent. Whereas the '387 Patent indicates that the angle between two surface is a separate and distinct consideration from the provision of the claimed micro-level sharp edge "discontinuity" at the transition between the surfaces, Tartrais' reference to a "sharp-edged machine part" is merely an indication that the upper planar surface and the lower conical surface of the valve (1) intersect at an acute angle.

My response:

I disagree.

- Tartrais clearly provides reference to the characteristics of the edge transition by at least describing the edge of the valve 1 (the claimed "valve member") as a sharp-edged machined part 4. *See, e.g.*, slides 104-106.
- In my opinion, that Tartrais describes that the angle formed at this edge is "preferably acute," this description does not detract from Tartrais' explicit characterization of this structure itself as a "sharp-edged machined part 4."
- In my opinion, a POSITA would recognize that it is not the angle formed at the juncture of the upper planar surface and the lower conical surface which delineates the "sharp-edged machined part 4," but rather, the sharp-edge of the machined part 4 which defines the "sharp-edged machined part 4."

Claims 1, 19 - Patent Owner Arguments to Tartrais

In response to argument that Tartrais discloses a sharp edge, PO says (cont.):

3. Tartrais is shaped to normal tolerances

Tartrais also fails to "indicate that the transition between the valve seat and the outer surface of the valve is machined, or created, or shaped in any way other than to normal tolerances . Thus it is not directed to limit deposit build-up through providing a discontinuity. Ex. 1009 at 226/236."

My response:

I disagree.

- Tartrais explicitly provides a "specific reference to the shape of the transition" by at least describing the edge transition by at least describing the edge of the valve 1 (the claimed "valve member") as a "sharp-edged machined part 4."
- Tartrais explicitly discloses that the sharp-edged part 4 as a "sharp-edged machined part 4."

Claims 1, 19 - Patent Owner Arguments to Tartrais

In response to argument that Tartrais discloses a sharp edge, PO says (cont.):

3. Sharp-edged machined part is not located at the transition between the seating surface and the outer valve surface.

PO's contends that a POSITA "would understand the claimed "seating surface" of valve 1 to be "the portion of the planar surface that cooperatively engages in sealed contact with the 'seat 3 in form of a cutting edge,'" not the entire planar surface identified by Petitioner", and thus, "Tartrais's "outer valve surface" is not "adjacent the seating surface," and that Tartrais's "sharp-edge machined part 4" is not located "at the transition between the seating surface and the outer valve surface."

PO also contends that "Petitioner provides no analysis as to why the portion of the planar surface external to the seat (3) would be considered to define the [claimed] 'nozzle passage' as there is no corresponding surface of the body (2) between which fluid can flow. . . . (noting that the portion of planar surface external to seat 3 acts as a diffusor and deflector plate)."

My response:

I disagree.

- In my opinion, a POSITA would understand that neither the claims nor the plain meaning of "seating surface" limits this term exclusively to the precise area that directly contacts the valve seat. Rather, in my opinion, a POSITA would recognize that the plain meaning of "surface" suggests that "seating surface" is broader than the precise point of contact with a seat. Thus, Tartrais' sharp-edged machined part 4 is located at the transition between the seating surface and the outer valve surface.
- In my opinion, a POSITA would recognize that neither the claims nor the plain meaning of "nozzle passage," requires that the entire nozzle passage be formed by "corresponding surface[s]" of the valve seat surface and seating surface. It is my opinion that a POSITA would recognize that Tartrais' seat 3 and planar surface of valve 1 provide a nozzle passage therebetween, as claimed.

Claims 1, 19 - Patent Owner Arguments to Tartrais

In response to argument that Tartrais' sharp edges control the formation of deposits at or adjacent an exit of the nozzle passage, PO says:

"Tartrais does not disclose or suggest the "sharpness" of any of its edge features within the meaning of the '387 Patent, let alone that such "sharpness" contributes to controlling the formation of deposits at or adjacent an exit of the nozzle passage as recited in the claims. To the contrary, Tartrais' reference to a "sharp-edged machine part" is merely an indication that the upper planar surface and the lower conical surface of the valve (1) intersect at an acute angle. As such, it cannot be said that Tartrais recognizes a radius of curvature of the transition as being a result-effective variable."

My response:

I disagree.

Tartrais discloses a sharp edged machined part 4 on the valve 1 and a sharp edge on seat 3. Tartrais discloses that the sharp edges control the formation of deposits at or adjacent an exit of the nozzle passage. For example:

1. The sharp-edged machined part 4 and the sharp edge on the seat 3 "facilitates obtaining a fine, widely spread horizontal liquid surface that is completely even around the valve ," "The sharp-edged machined part 4 prevents the liquid from flowing down the wall [as the liquid squirts out]" such that "the liquid squirts out evenly all around and diffuses in the ambient air that it encounters." More optimal spray, less fuel flowing down the wall (i.e., spreading around the edge) = less fuel adhesion to nozzle surfaces at or adjacent an exit of the nozzle passage = less deposit formation at the nozzles surfaces at or adjacent an exit of the nozzle passage. See, e.g., slides 104-107, 115.

2. The sharp edges minimize the surface available for fuel to adhere – and thus for deposits to form – as opposed to that of a non-sharp edge. See id.

3. Deposits that do form on the sharp edge will fall off more readily, or will be unable to build up as much before falling off, because, for example:
   (a) the shearing action of the deposits (i.e., deposits at the sharp edges are more susceptible to falling off and thus more easily dislodged by the shearing effect of the fuel issuing from the exit of the nozzle passage);
   (b) Movement of the valve member against the port will break and dislodge deposits at or adjacent an exit of the nozzle passage.