

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

WESTPORT FUEL SYSTEMS CANADA INC.,
Patent Owner.

Case No. IPR2023-00292
U.S. Patent No. 6,298,829

REPLY DECLARATION OF DR. J. MATT QUINLAN

I, Dr. J. Matt Quinlan declare as follows:

I. INTRODUCTION

1. I have been retained by Robert Bosch Corp. (“Bosch”) as an independent expert consultant in this proceeding before the United States Patent and Trademark Office (“PTO”). I am not an employee of Bosch or any affiliate or subsidiary of Bosch.

2. I have been asked to reply to certain of the opinions set forth in a May 3, 2024 declaration signed by Dr. Christopher M. Atkinson that I understand was submitted by Patent Owner in an *inter partes* review proceeding relating to U.S. Patent No. 6,298,829, which I refer to herein as the ’829 patent.

3. I am being compensated at my standard rate for my time. My compensation is based solely on the amount of time that I devote to activity related to this case and is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other financial interest in this proceeding.

4. The prior declaration I submitted in connection with this proceeding, which I understand has been designated as Ex. 1003, sets forth among other topics my educational background and professional experience (Ex. 1003, ¶¶ 5-16), my understanding of the law (*id.*, ¶¶ 21-36), the ’829 patent’s effective filing date and the knowledge and characteristics of a person having ordinary skill in the art (*id.*, ¶¶

37-45), and claim construction (*id.*, ¶¶ 86-100). As I have already addressed these topics, I do not repeat them here.

5. In forming the opinions set forth in this declaration, I have considered and relied upon my education, knowledge of the relevant field, knowledge of scientific and engineering principles, my work with those of skill at the time of the alleged invention, and my general experience in the field of art. I have also reviewed and considered exhibit 2022 (the Declaration of Dr. Christopher Atkinson) and Patent Owner exhibits 2001-2013, 2016-2020, and 2023-2032.

II. MEMBRANE 6 DOES NOT SUBSTANTIALLY FLEX DURING OPERATION OF THE INJECTOR IN FIGURE 1 OF KLÜGL

6. Dr. Atkinson includes a section of his declaration discussing his understanding of the meaning of the term “stroke translation” in Klügl and how, in his view, the fuel injector valve shown in Figure 1 of Klügl operates. *See, e.g.*, Ex. 2022, ¶¶ 77-82.

7. In my opinion, this discussion is not only contrary to what Klügl itself teaches, but is internally inconsistent.

8. According to Dr. Atkinson, in Figure 1 of Klügl “[a] POSITA would understand that the innate flexibility of flexible membrane 6 means that a specific movement of the actuator 1 would be ‘partially transmitted’ to the drive piston 3, and never ‘always fully transmitted.’” *Id.*, ¶ 78.

9. Per Dr. Atkinson, this is purportedly the case because “[d]uring actuation, there will be higher pressure in transmission fluid near the contact area between flexible membrane 7 and drive piston 3 and lower pressure at the annular area of flexible membrane 7 where there are no upward forces being applied” resulting “transmission fluid ... flow” and the membrane deformation/bulging discussed previously. *Id.*, ¶ 80. Then, “[d]ue to the inherent flexibility and pliability of flexible membrane 6, the membrane will tend to deform longitudinally upward where it contacts the drive piston and bulge outward where unconstrained in the annular area ... between the edge of the drive piston 3 and the wall of transmission module 2 and guide sleeve 11 in order to accommodate the volume of the transmission fluid contained therein and the pressure differences created within the transmission fluid.” *Id.*, ¶ 79. Dr. Atkinson also includes a figure in which he purports to show this membrane “deform[ation]” and “bulg[ing].” *Id.*, ¶¶ 78-79.

10. So, in sum, according to Dr. Atkinson during operation of the injector shown in Figure 1 of Klügl, there will be fluid flow and pressure differences that cause membrane deformation and bulging that purportedly results in the movement of the actuator to be only “partially transmitted” Klügl’s piston 3.

11. Again, I disagree that a POSITA would have understood the injector of Figure 1 of Klügl to operate in this manner.

12. To begin, Dr. Atkinson's discussion of Figure 1 is actually more akin to how the injector of Figure 3 operates.

13. In the injector shown in Figure 3 of Klügl, there is a "first pressure chamber 5" (formed by membrane 6) associated with piston 3 and a "second pressure chamber 28" (formed by a membrane 26) associated with die 29. Klügl, 5:9-15. Fluid can be pumped from the second chamber to the first chamber via "lines 25." *Id.*, 5:18-23.

14. During actuation, the "third membrane 26" of Figure 3 is "pushed downwards by the die 29" and the "transmission medium located in the second pressure chamber 28" is "pushed into the pressure chamber 5 via the line 25" causing "brief pressure increases" in the chamber 5 that in turn cause the "first membrane 6" to "deflect[] ... in the direction of the drive piston 3" to move the piston to open the valve. *Id.*, 5:28-6:6.

15. Then, because "die 29" and "piston 3" are different sizes (and also because "membrane 6" and "third membrane 26" are also "differently[ly] sized surfaces"), Klügl explains that Figure 3's injector "achieve[s] a stroke ratio between the deflection of the piezoelectric actuator 1 and the deflection of the drive piston 3." *Id.*, 7:9-20.

16. So when describing the operation of the injector of Figure 3, Klügl *does* state and explains that fluid flows, pressure increases occur, membranes deflect, and a stroke ratio is applied to piston movement.

17. When describing the operation of the injector shown in Figure 1, however, there is *no mention* in Klügl of fluid flow, pressure increases, membrane deflection, or application of a stroke ratio.

18. A POSITA would understand that these omissions are purposeful: no fluid flow, pressure increases, membrane deflection, or stroke ratio application occurs in connection with Figure 1's injector.

19. More particularly, Klügl explains that in Figure 1's injector, when "the piezoelectric actuator 1" is actuated it simply "presses the entire transmission module 2 ... in the direction of the drive piston 3, so that pressure is exerted on the drive piston 3 via the first membrane 6 and the transmission medium located in the pressure chamber 5...." *Id.*, 3:23-28. This in turn "moves the drive piston 3" to open the valve. *Id.*, 3:30-32. Klügl also explains that "transmission medium" does not "flow" during this process to avoid "impair[ing]" "activation of the drive piston." *Id.*, 4:11-15. Because of this, in Figure 1, a POSITA would have understood that actuator movement is simply passed along to the piston in a 1:1 ratio.

20. According to Dr. Atkinson, Klügl's characterization of the injector of Figure 1 as "without stroke translation" and the injector of Figure 3 as "with stroke

translation” (Klügl, 1:41-46) relates only to “the type of power transmission” and not “the amount that drive piston 3 ultimately moves.” Ex. 2022, ¶¶ 71, 76.

21. I disagree. While the two injector embodiments do have different structures and operate in different ways, they *also* achieve different results.

22. Klügl—when considered in its entirety—clearly teaches that Figure 3 operates to apply a “stroke ratio” (*i.e.*, the piston moves by a different amount than the actuator) while Figure 1 does not apply a “stroke ratio.”

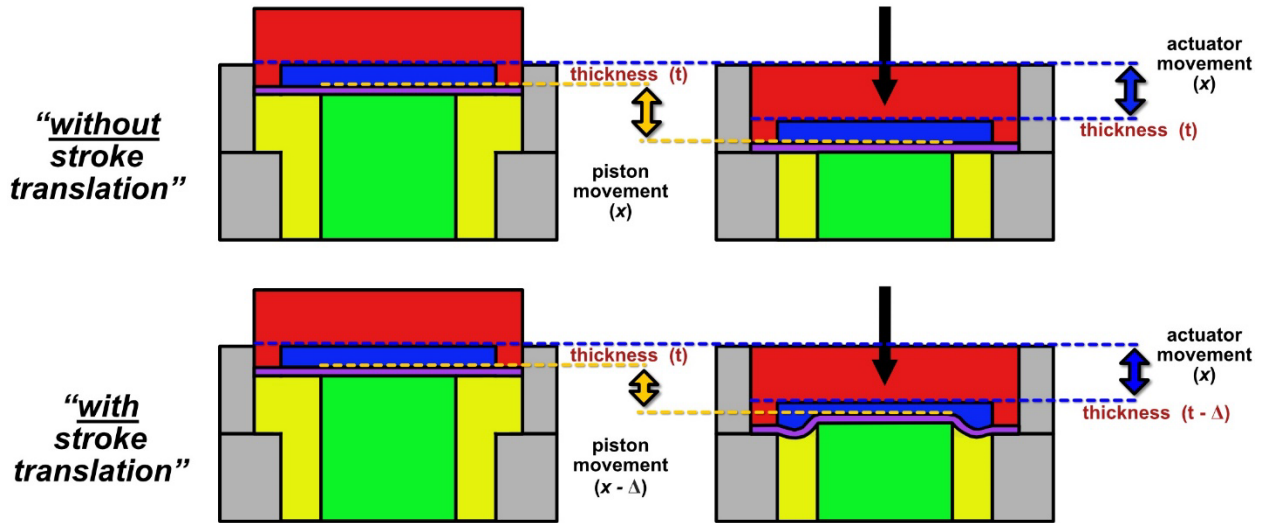
23. Moreover, while Dr. Atkinson opines that the injectors of Figures 1 and 3 are meant to employ different “principles of operation” (Ex. 2022, ¶ 71), his interpretation minimizes those differences.

24. Under Dr. Atkinson’s interpretation, *both* injectors operate with fluid flow, pressure increases, membrane deflection, and the application of a stroke ratio.

25. Once again, this is contrary to what Klügl itself teaches: in Klügl, only the injector of Figure 3 operates with fluid flow, pressure increases, membrane deflection, and a stroke ratio application. The injector of Figure 1 does not operate in this way.

26. In my opinion, Dr. Atkinson’s interpretation of the operation of Figure 1’s injector is actually the *opposite* of how Klügl says this figure’s injector works.

27. This is summarized by the below demonstrative based on Dr. Atkinson’s image:



28. The top images show operation “*without stroke translation.*” The membrane (purple) does not materially flex and the thickness (t) of the hydraulic fluid (blue) between the transmission module (red) and the piston (green) remains constant such that the piston and actuator move by the same amount (x). This is how a POSITA would have understood the injector of Figure 1 to operate.

29. The bottom images show the effect of Dr. Atkinson’s erroneous interpretation on operation. Fluid flow, pressure changes, and deformation of the membrane creates a different shaped space, causing the thickness of the hydraulic fluid (t) to be reduced by Δ in the area of the piston such that it becomes $t - \Delta$. As a consequence, while the actuator still moves x , the piston movement is reduced to $x - \Delta$, resulting in operation “*with stroke translation.*” Once again, this is the opposite of how Figure 1 in Klügl is intended to operate.

30. Dr. Atkinson also appears to improperly limit Klügl's teachings to the exact dimensions shown in its figures. For example, he takes issue with my application of Klügl to Wirbeleit because it "no longer has the voids under the annular portions of flexible membrane 6." Ex. 2022, ¶ 117.

31. A POSITA would have understood that whether membrane 6 meaningfully flexes during injector actuation will depend on a variety of factors.

32. These include the various forces applied to the membrane, the inherent flexibility of the material the membrane is made from, the membrane's thickness, how the edges of the membrane are supported, the fluid pressure in the chamber 5, and the size of the membrane/piston interface. I also disagree with Dr. Atkinson's opinion that the injector "actuation rate" will somehow cause Klügl's membrane to flex. *See, e.g.*, Ex. 2022, ¶ 67. The amount of flexing (or lack thereof) will be primarily determined by the applied forces and structure/properties of the membrane itself, not the injector's "actuation rate."

33. In my opinion, a POSITA would have understood that flexing during actuation can be avoided simply by choosing the correct (less flexible) membrane material and dimensioning it appropriately. This would entail, for instance, simply making the membrane thicker and increasing the membrane/piston interface. Likewise, a POSITA would have, in my opinion, been more than capable of reducing the possibility of membrane failure by designing the membrane appropriately (*e.g.*,

selecting the correct material, dimensioning it appropriately, and properly accounting for applied forces and temperatures). As I previously explained, this type of design exercise would have been well within the normal, routine design capabilities of a POSITA as of filing of the '829 patent.

34. Dr. Atkinson appears to completely ignore that a POSITA would have engaged in this type of routine design exercise when implementing the combined injector of Wirbeleit and Klügl and instead limits the prior art to the dimensions shown in Klügl's figures.

35. Klügl itself explains that it is not limited in this way. Instead, its figures are only meant to "schematically" show the features of injector. Klügl, 1:47. The figures are not meant to be set-in-stone engineering drawings.

III. A POSITA WOULD HAVE UNDERSTOOD THAT KLÜGL'S TRANSMISSION MODULE 2 INCLUDES THE CLAIMED "ADJUSTABLE" "HYDRAULIC LINK"

36. Dr. Atkinson also takes the position that the prior art fails to teach the claimed "adjustable" "hydraulic link." Ex. 2022, ¶ 96.

37. According to Dr. Atkinson, this is purportedly because Klügl includes a "flaw in its design that prevents it from maintaining a desired valve needle lift in response to changes in the dimensional relationship of components within the valve." Ex. 2022, ¶ 68. In particular, "the distance ... from the lower stop 16 to the end of the valve needle 32 is fixed" in Dr. Atkinson's view such that "any 'automatic

adjustment’ provided by the flexible membrane of Klügl’s transmission module will not adjust [the] distance” between the stop and the valve seat “which is the critical distance in Klügl’s design for insuring desired valve needle lift.” *Id.*

38. As an initial matter, this argument appears to apply only to Grounds 3 and 4 in my prior declaration. In Grounds 1 and 2, I explained that a POSITA would have used Klügl’s transmission module 2 when implementing Wirbeleit’s hydraulic transmission element 22. The rest of Wirbeleit’s injector would remain the same. Thus, the combined injector would not include the same type of “lower stop 15” and “valve needle 32” as Klügl. It follows that the supposed “flaw in the design” identified by Dr. Atkinson would not be present. Instead, movement of fluid into or out of chamber 5 of Klügl’s transmission module 2 would in fact be able to make minor adjustments to the lift of Wirbeleit’s valve needle.

39. Dr. Atkinson also appears to misinterpret how Klügl’s transmission module 2 accounts for thermal effects and aging.

40. As Klügl explains, module 2 is meant to account for changes in the dimensions of the *actuator* (e.g., different materials with differing thermal expansion), not the piston 3 or needle 32 (e.g., similar materials with similar thermal expansion).

41. Nothing about the ’829 patent’s claims preclude this type of “adjust[ment].” The claim simply requires that the “hydraulic link” be

“adjustable ... in response to changes in the dimensional relationship between components.” It does not specify or limit which components’ dimensional relationship change.

42. Thus, in my opinion, and as I have previously explained, Klügl does in fact teach a “hydraulic link” that is “adjustable” in the way the claims require.

43. First, “if ... actuator 1 shortens ... due to thermal influences or signs of aging[,]” fluid is pushed into “pressure chamber 5, so that the first membrane 6 is moved in the direction of the drive piston 3” and “drive piston 3” continues to “bear[] against first membrane 6 despite the shortening” of the “actuator.” Klügl, 3:63-4:3.

44. In my opinion, a POSITA would have recognized this adjustment to be important: if the membrane did not bear against the piston due to shortening of the actuator resulting from thermal influences or aging, the piston would move by less during actuation (since the separating space would first need to be cleared before the piston moves). This would in turn reduce needle lift.

45. Second, “if the distance between the ... actuator 1 and the drive piston 3 is reduced, the first membrane 6 is pushed in by the drive piston 3 so that the transmission medium is pressed through the throttle 10 into the compensation chamber 7.” Klügl, 4:4-10.

46. In my opinion, a POSITA would also have recognized that this adjustment is important. If thermal influences or aging results in increases in the

size of the actuator (resulting in a reduced distance between the actuator and the piston) closing element 4 would be pushed too far off its seat during actuation resulting in too much needle lift.

47. So, per Klügl, transmission module 2 is meant to account for thermal effects and aging that cause the actuator to either increase or decrease in size. This in turn would cause the piston to be pushed either too little or too much during actuation. The rest of Klügl—in particular the movement of fluid within transmission module 2 during times of rest—operates to avoid this and ensure that a consistent amount of lift is provided even if components change size.

48. I also disagree with Dr. Atkinson that Klügl’s transmission module 2 cannot both maintain a “substantially constant” fluid thickness in chamber 5 during actuation and provide for the type of “adjustable” “hydraulic link” the claims also require.

49. Dr. Atkinson posits that Klügl’s membrane 6 “will not have different properties during actuation and while at rest (e.g., the membrane will be pliable and flexible in both circumstances).” Ex. 2022, ¶ 67.

50. While I agree that the membrane 6 has the same structure and physical properties at all times, this does not mean that it *behaves* the same during both actuation and periods of rest.

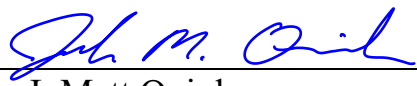
51. The forces applied to the membrane differ during these periods. As Klügl itself explains, during periods of rest, there may be “long-lasting pressure differences between the pressure chamber 5 and the compensation chamber 7” that cause “transmission medium” to be “exchanged between the compensation chamber 7 and the pressure chamber 5 via the throttle 10.” Klügl, 4:25-30.

52. It is these long-lasting differences—which are present only during much longer rest periods and not very short actuation periods—that cause the same membrane to behave differently during actuation and rest.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willfully false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1101 of Title 18 of the United States Code.

Date: 7/25/2024

Location: Monument, CO

Signature: 
Dr. J. Matt Quinlan