

PETITIONER'S DEMONSTRATIVES

FOX Factory, Inc.

v.

SRAM, LLC

IPR2024-00491

U.S. Patent No. 10,328,993

Oral Hearing to be held May 15, 2025

U.S. Patent No. 10,328,993



US010328993B2

(12) **United States Patent**
Watt et al.

(10) **Patent No.:** US 10,328,993 B2
(45) **Date of Patent:** Jun. 25, 2019

(54) **BICYCLE STEERER TUBE WITH VARIANT STIFFNESS**

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(73) Assignee: **SRAM, LLC**, Chicago, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 888 days.

(21) Appl. No.: **14/585,629**

(22) Filed: **Dec. 30, 2014**

(65) **Prior Publication Data**

US 2016/0185414 A1 Jun. 30, 2016

(51) **Int. Cl.**
B62K 21/04 (2006.01)
B62K 19/32 (2006.01)
B62K 21/18 (2006.01)
B62K 19/02 (2006.01)

(52) **U.S. Cl.**
CPC **B62K 21/04** (2013.01); **B62K 19/32** (2013.01); **B62K 21/18** (2013.01); **B62K 19/02** (2013.01)

(58) **Field of Classification Search**
CPC B62K 21/04; B62K 19/32; B62K 21/18; B62K 19/02
See application file for complete search history.

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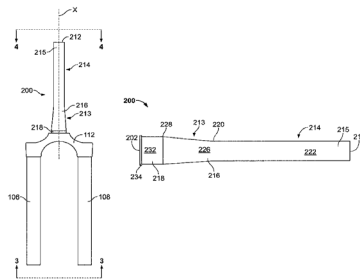
Primary Examiner — Anne Marie M Boehler

Assistant Examiner — Marlon A Arce

(57) ABSTRACT

A bicycle steerer tube is adapted to reside in a plane of travel of the bicycle. A thickness at a point on the wall of the steerer tube body in a lower section thereof varies as a function of the cross-sectional angle of the point to the plane of travel, with the wall thickness being at a maximum in the plane of travel. An inner wall of the lower section may be elliptical, with a minor axis aligned with the plane of travel and a major axis orthogonal to the plane of travel.

65 Claims, 16 Drawing Sheets



Ex. 1001, pg. 1

BICYCLE STEERER TUBE WITH VARIANT STIFFNESS

Ex. 1001, Title

(57) ABSTRACT

A bicycle steerer tube is adapted to reside in a plane of travel of the bicycle. A thickness at a point on the wall of the steerer tube body in a lower section thereof varies as a function of the cross-sectional angle of the point to the plane of travel, with the wall thickness being at a maximum in the plane of travel. An inner wall of the lower section may be elliptical, with a minor axis aligned with the plane of travel and a major axis orthogonal to the plane of travel.

Ex. 1001, Abstract

U.S. Patent No. 10,328,993: Claims

1. A steerer tube for a bicycle, the steerer tube comprising: an elongate hollow body arranged around a steering axis located in a vertical plane of travel of the bicycle, the body having upper and lower sections, a segment of the upper section adapted to be joined to a bicycle handlebar, a segment of the lower section adapted to be joined to a crown of a front wheel fork of the bicycle, the lower section joined to the upper section, and outer surfaces of the upper and lower sections of the body being circular in cross section, and the body formed by a wall, a thickness of the wall at any point in the lower section of the body varying as a function of the cross-sectional angle of the point relative to the plane of travel, the wall thickness being at a maximum in the plane of travel of the bicycle.

Ex. 1001, claim 1

61. A steerer tube for a bicycle, the steerer tube comprising: an elongate hollow body arranged around a steering axis located in a vertical plane of travel of the bicycle, the body having upper and lower sections, a segment of the upper section adapted to be joined to a bicycle handlebar, a segment of the lower section adapted to be joined to a crown of a front wheel fork of the bicycle, the lower section joined to the upper section, and an outer diameter of the lower section of the body is greater than an outer diameter of the upper section of the body, and

Contd.

the body formed by a wall, a thickness of the wall at any point in the lower section of the body varying as a function of the cross-sectional angle of the point relative to the plane of travel, the wall thickness being at a maximum in the plane of travel of the bicycle.

Ex. 1001, claim 61

64. A steerer tube for a bicycle, the steerer tube comprising: an elongate hollow body arranged around a steering axis located in a vertical plane of travel of the bicycle, the body having upper and lower sections, a segment of the upper section adapted to be joined to a bicycle handlebar, a segment of the lower section adapted to be joined to a crown of a front wheel fork of the bicycle, the lower section joined to the upper section, and the segment of the lower section of the body is joined to the crown of the front wheel fork, the body formed of a material different from the crown of the front wheel fork, and the body formed by a wall, a thickness of the wall at any point in the lower section of the body varying as a function of the cross-sectional angle of the point relative to the plane of travel, the wall thickness being at a maximum in the plane of travel of the bicycle.

Ex. 1001, claim 64

Key Features of the '993 Patent Claims

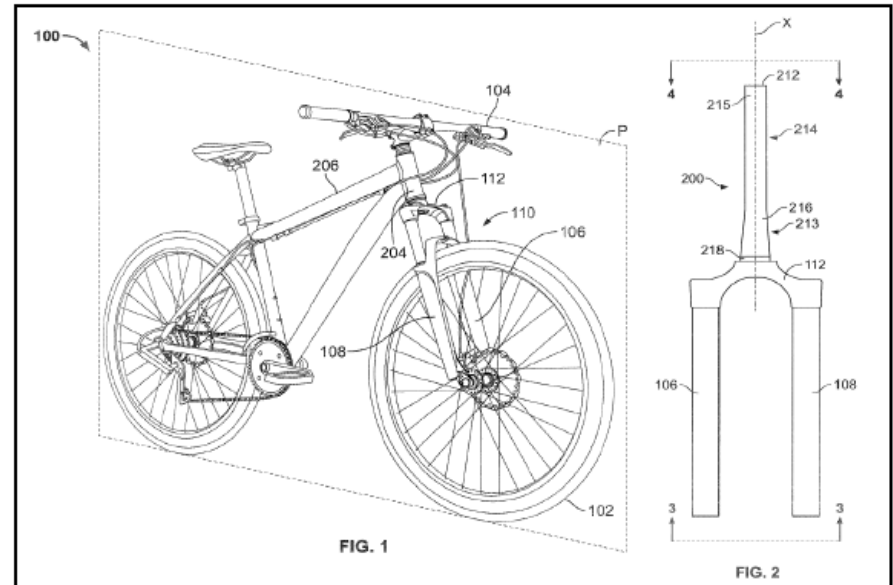
Key Claim Elements

- Wall thickness in the lower section of the steerer tube varies across the tube cross-section
- Wall thickness is maximum in the plane of travel

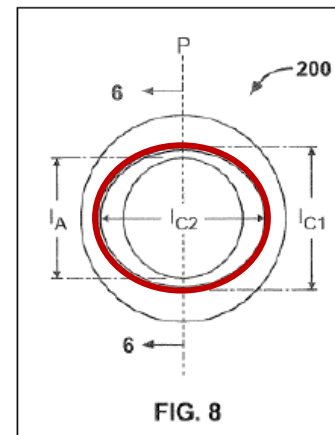
Purported Benefits of the Invention

Steerer tubes according to the invention have a large stiffness and strength in the fore and aft plane of travel of the bicycle. But since side bending stiffness isn't as critical due to lighter side loads, the wall thickness outside of the plane of travel may be reduced. This permits a lighter weight steerer tube that nonetheless meets all loading requirements.

Ex. 1001, 2:4-9



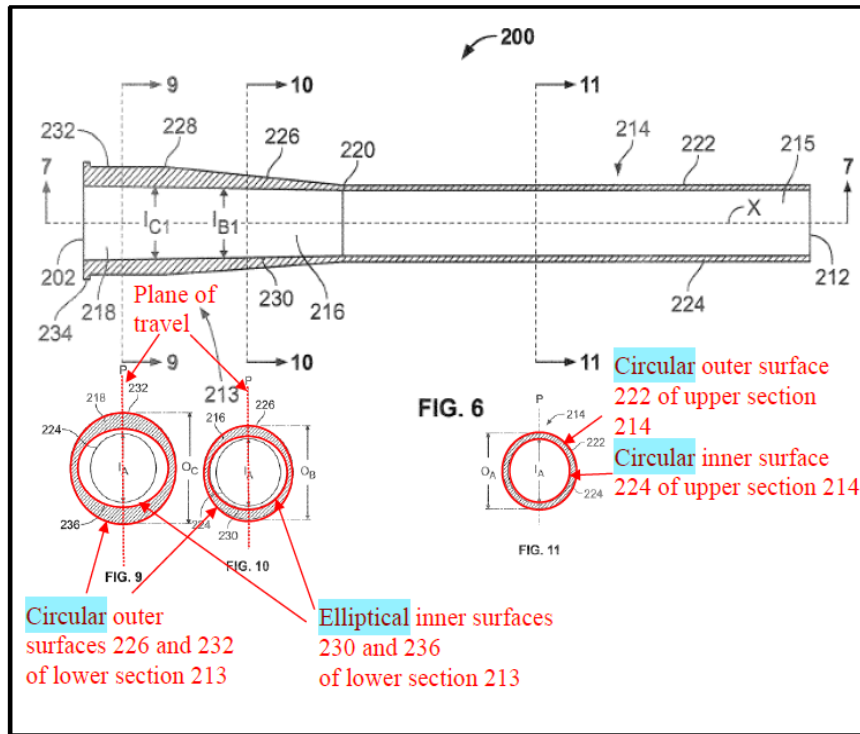
Ex. 1001, 1:8-32, Figs. 1-2



Ex. 1001, Fig. 8

Pet., 2-8

Disclosed Embodiments of the '993 Patent: Elliptical Inner Surface in the Lower Section of the Steerer Tube



Ex. 1003 ¶ 26 (annotated Figs. 6, 9-11 of '933 patent)

29. That is, the cross-sectional shapes of inner surfaces 230 and 236 of lower section 213 change from circular to elliptical from upper end 220 towards tube end 202, while outer surfaces 226 and 232 remain circular. Ex. 1001, 4:7-26, FIGS. 5A-10. Given the elliptical cross-sectional shapes of the inner surfaces 230 and 236, a thickness of the wall of lower section 213 varies over a cross-section of the wall, the wall thickness being at a maximum in the plane of travel P of the bicycle. Ex. 1001, 4:7-26, FIGS. 5A-10. In other words, the minor axis (I_{C1}) of an inner elliptical cross-sectional shape of the lower section 213 lies along the plane of travel P of the bicycle, and the major axis (I_{C2}) is perpendicular to the plane of travel P. See Ex. 1001, FIG. 8. Thus, the elliptical inner contour results in increase in wall thickness in the plane of travel P, which in turn gives the tube greater strength to bear the higher loads and forces in the plane of travel P, while lowering the weight of the tube by having a thinner wall in a plane orthogonal to the plane of travel P (where the loads and forces are lower). Ex. 1001, 2:4-9, 3:29-32, 7:57-62.

Declaration of Dr. Alexander H. Slocum, Ph.D. (Ex. 1003) at ¶ 29

Pet., 4-8; Ex. 1003, ¶¶ 25-29

Level of Skill in the Art

Petitioner's definition

At the effective filing date of the '993 patent, a person of ordinary skill in the art ("POSITA") would have had (1) a Bachelor's degree in Mechanical Engineering or an equivalent degree, and 1-2 years of experience in design work related to optimal mechanical and structural design (e.g., minimizing weight while maximizing strength and stiffness for a particular type of loading) such as practiced, for example, in aerospace, bicycle, or machinery (such as robotics) industries; or (2) at least a Master's degree in Mechanical Engineering or an equivalent degree with a focus on design of mechanical elements and structures, and a good understanding of mechanical and structural design principles. Ex. 1003, ¶23.

Pet., 8; Ex. 1003, ¶ 23

Patent Owner's definition

Patent Owner believes a person of ordinary skill in the art ("POSITA") here is more appropriately connected to, and considers the particularities of, vehicle component and like design. Specifically, one of ordinary skill in the art at the time of the '993 Patent may include a person with a degree in Mechanical Engineering and approximately three years' experience in vehicle component design and like technology, or a Master's degree or higher in Mechanical Engineering with experience in design of vehicle components or like technology. Ex. 2021 (Parnell), ¶57.

Response, 14; Ex. 2021, ¶ 57

- Petitioner's expert is a POSITA under either party's definition. Ex. 2019, 233:22-237:2, 239:5-250:19, 251:24-280:8; Ex. 1024, ¶ 15; Ex. 1003, ¶¶ 4-11, Exhibit A
- Patent Owner's expert provides consulting services in a wide variety of engineering and non-engineering fields that are unrelated to "vehicle components or like technology." Ex. 2021, p. 77; Ex. 1024, ¶¶ 11-13
- Patent Owner's expert's alleged "extensive experience" pertains to four-wheeled vehicles like trucks or ATVs, not two-wheeled ones like bicycles or motorcycles. Ex. 1026, 17:7-18:5

Reply, 1-2

Claim Construction

- Neither party requested claim construction
- District court's claim constructions:

Claim Term	Court's construction
"vertical plane of travel of the bicycle"/"plane of travel of the bicycle" (claims 1, 61, 64)	vertical plane aligned with the running direction of the bicycle
"a thickness of the wall at any point in the lower section of the body varying as a function of the cross-sectional angle of the point relative to the plane of travel" (claims 1, 61, 64)	thickness of the wall at any point in the lower section of the body changing as the cross-sectional angle of the point relative to the plane of travel change[s]

- The Petition's application of the plain and ordinary meaning is consistent with the court's constructions

Reply, 2-5

Unpatentability Grounds

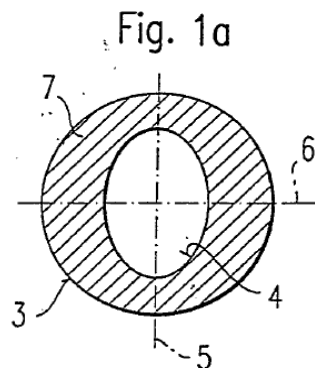
Ground	Claim	Basis Under 35 U.S.C. § 103
1	1-4, 6, 8, 10, 12, 14-18, 20, 22, 24, 26-29, 33-38, 40, 42, 44, 46-49, 53, 56-63 (“Group 1 Challenged Claims”)	Denk in view of Moechnig
2	31, 51, 64 (“Group 2 Challenged Claims”)	Denk in view of Moechnig and Schroeder
3	Group 1 Challenged Claims	Valat in view of Moechnig and Denk
4	Group 2 Challenged Claims	Valat in view of Moechnig, Denk, and Schroeder

**IT WAS KNOWN TO A POSITA BEFORE THE
FILING OF THE '993 PATENT THAT A
STEERER TUBE BEARS HIGHEST LOADS IN
THE PLANE OF TRAVEL**

Denk Teaches to Increase Thickness of the Tube in the Plane of Travel to Increase Strength in that Plane

- Denk explicitly discloses that highest loads occur in the vertical plane of the bicycle frame, which is same as the plane of travel. Ex. 1003, ¶¶ 45-46; Ex. 1006 (Denk), cols. 1-2
- Denk teaches increasing tube wall thickness in the plane of travel to meet the requirements of strength and rigidity in the load direction while lowering weight. Ex. 1003, ¶¶ 45-46; Denk, cols. 1-2
- A POSITA would have known to orient Denk's plane 6 with the plane of travel.

Ex. 1003, ¶¶ 45-46



Denk, Fig. 1a

However, in contrast, the approach according to the invention has the significant advantage that the profile of the wall thickness over the cross section may be optimally adapted to the actual requirements with regard to strength and rigidity.

A consideration of the load on a bicycle frame, for example, shows that particularly high loads occur in the vertical plane of the frame, since the weight of the rider acts essentially in the vertical direction, and the impact loads acting on the front and rear wheel likewise essentially occur within a vertical plane. Loads situated outside this plane, in particular the torque generated about the bottom bracket bearing transverse axis during pedaling, the forces that occur when negotiating a curve, and the forces during pedaling while standing, when the bicycle is inclined during straight-ahead travel when pedaling, may likewise assume high values, but in their total scope and also frequency of occurrence they are lower than the forces occurring in the vertical direction.

The design according to the invention now allows the cross section of the tubular portion of the lightweight component to be designed in such a way that the force absorption capability of the components of a bicycle frame in the vertical frame direction is greater than in an arbitrary orientation perpendicular to this plane. As a result, for the same overall strength and rigidity, the weight may be reduced, or for the same weight, the strength and rigidity may be significantly increased in the load direction specified by the design.

Denk, col. 2

Pet., 10-12, 25; Reply, 10

Klein Discloses a Bicycle Steerer Tube Experiences Highest Loads in the Plane of Travel

- Klein discloses reinforcing the strength of bicycle fork tubes, including the steerer tube, in the fore-and-aft direction. Ex. 1023, 4:21-29; Ex. 1024, ¶ 27

- Petitioner's expert:** "[I]t was known to a POSITA that a tube of a bicycle fork, including the steerer tube, bears the highest loads in the plane of travel, which is aligned with the fore-and-aft direction of the bicycle. Indeed, Klein explains '[t]he heaviest loads will come from vertical bumps or head-on impact and/or braking forces,' and '[b]oth vertical and longitudinal forces stress the front fork at a fore/aft cantilever bending motion.'"

Ex. 1024, ¶ 29 (citing Ex. 1023, 4:21-29)

In the front forks, the normal loading includes some torque loads and some side loading. The heaviest loads will come from vertical bumps or head-on impact and/or braking forces. Both vertical and longitudinal forces stress the front fork at a fore/aft cantilever bending motion. In a simple analysis, it appears that increasing the strength of the fork blades and steerer fore and aft cantilever would be the correct approach.

However, it has been discovered through actual testing and detailed analysis that forces in the fork blades are displaced to the side where the steerer attaches, or the wheel or inside of the fork, a small amount. Thus, the optimum here, according to the invention, is not a direct fore and aft reinforcement, but two reinforcements (e.g. thicker wall) are shifted slightly to the inside of the fork as can be seen in the drawings attached hereto. Another factor is that there is a high degree of compressive stress resulting from the vertical bump loading. Thus, in the preferred embodiment, the front of the blades is reinforced a little bit more (e.g., thicker wall and more metal) than the rear because of the straight compressive stress and the cantilevered compressive stresses are cumulative in the front of the blade and oppose each other in the rear. Thus, there is a slight differential in the thicknesses in these areas.

Klein (Ex. 1023), 4:21-46

Reply, 5-6

Galasso Discloses Increasing Stiffness of Fork Tubes in the Plane of Travel

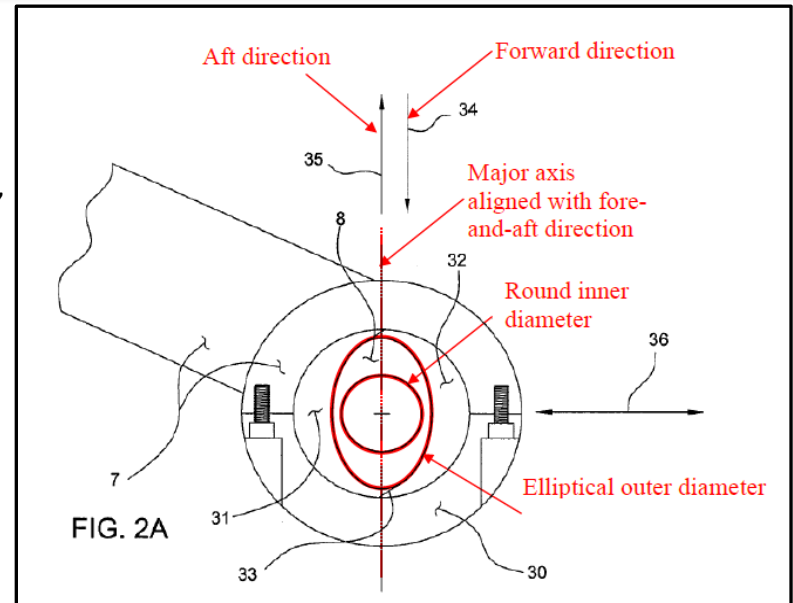
- Galasso discloses a fork tube design where the thickness of the tube is maximum along the fore-and-aft directions 34, 35, such that **“the fork will be in its’ [sic] stiffest front to rear setting.”** Ex. 1013 (Galasso), 5:10-16, FIGS. 1, 2A, 3; Ex. 1024, ¶ 24
- Galasso’s tube designs can be applied to all tubes of a fork chassis, including the steerer tube. Ex. 1024, ¶¶ 24-25

45 Some embodiments disclosed herein provide a fork chassis that is tunable for stiffness. One aspect of stiffness where selective tuning is advantageous is front (fore) to back (aft) and up to down (e.g., fore and aft in FIG. 2A as directions 34, 35 respectively, and up and down directions in FIG. 1 and
50 others as 34, 35 respectively) bending, or “beam,” stiffness. A modern motocross fork is made up of 5 primary structural, or chassis, elements.

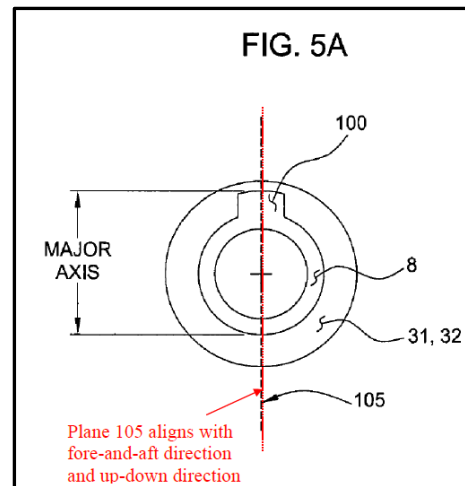
1. the lower/inner tube set (right and left sides of front wheel) commonly referred to as the sliders
- 55 2. the upper/outer tube set (telescopically engaged with the sliders) commonly referred to as the stanchions
3. the lower triple clamp
4. the upper triple clamp
5. the steering tube

60 While the examples herein may often be described in reference to motorcycle or bicycle forks, the elements disclosed herein are suitable for use on a wide variety of vehicles and respective suspension systems.

Galasso, 2:45-63



Galasso, Fig. 2A



Galasso, Fig. 5A

Reply, 6-8;
Ex. 1024, ¶¶ 24-26

Patent Examiners Understood that a Steerer Tube Bears the Greatest Loads in the Plane of Travel

Prosecution of the '993 patent

- USPTO Examiner found that Galasso discloses varying wall thickness, with “the wall thickness being at a maximum in the plane of travel of the vehicle ([s]ee figure 2A).”

Ex. 1002, 42

- Patent Owner did not dispute the Examiner’s analysis of Galasso and instead amended the independent claims to obtain allowance. *Id.*, 24-38

Reexamination of counterpart Chinese patent application

- Reexam decision stated:

It is common knowledge in the art that the steerer tube of a bicycle bears the greatest strength in a traveling plane.

Therefore, in order to enhance the strength of the steerer tube of a bicycle, those skilled in the art, under inspiration by [Denk] can apply the wall shape of the tube of FIG. 1C to [Schroeder] **so that the wall thickness of the steerer tube is at a maximum in the traveling plane of the bicycle, which is obvious to those skilled in the art.**

Ex. 1004, 10-11 (emphases added); *see also id.*, 12, 18-19.

Petitioner’s expert agrees with examiners’ finding. Ex. 1024, ¶ 29

Reply, 9-10

Moechnig Does Not Contradict Prior-Art Teachings and Knowledge of a POSITA

- The Petition relies on Moechnig primarily for its disclosure of how a steerer tube is conventionally mounted on a bicycle. Pet., 13-15, 51, 54
- Moechnig does **not** teach that the highest loads occur side-to-side, and do not occur in the fore-and-aft direction of the bicycle. Ex. 1024, ¶¶ 23-30, 43
- Instead, Moechnig teaches decreasing fore-aft stiffness of the steerer tube (i.e., increasing compliance in the fore-aft direction) to “decrease ... the amount of force that is transmitted to the rider therein increasing the comfort level associated with the use of [a] bicycle.” Moechnig (Ex. 1008), [0049]
- Moechnig also discloses that decreasing the fore-aft stiffness would distribute the load over a greater duration of impact, and “provide greater fore and aft impact performance as compared to steerer assemblies of comparable weight.” *Id.*
- Moechnig teaches a particular use case because different riders prefer different fork stiffness. *Id.*; Ex. 1013, 1:30-48

Reply, 14-16; Ex. 1024, ¶¶ 23-30, 43-45

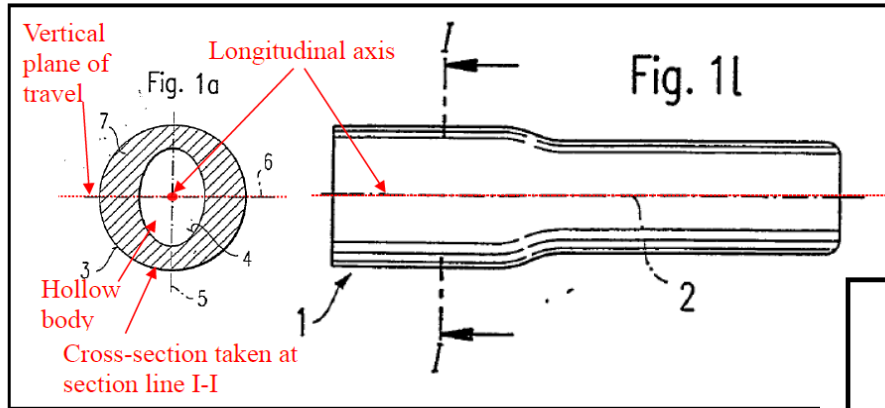
Moechnig's Steerer Tube Design is a Matter of Engineering Design Choice

44. Indeed, Moechnig teaches that more rigid lateral support provides efficient communication of the steering input and lateral handling characteristics. *Id.* Thus, Moechnig teaches a preferred use case that provides different lateral and fore-and-aft performances. *See* Galasso, 1:30-48 (teaching different riders prefer different stiffness of the fork). Moechnig's particular use case is not contrary to the common knowledge that the steerer tube bears the highest loads in the plane of travel, which is aligned with the fore-and-aft direction. In fact, a POSITA would have understood that to withstand the high loads in the plane of travel, one could either increase the stiffness/strength of the tube in the fore-aft direction, or increase compliance of the tube in that direction to bend with the load and absorb shock to the rider and frame while still providing adequate strength against failure. It is a matter of design choice, and while some engineers will increase the tube compliance in the fore-art direction to manage loads, others will opt to increase stiffness in that direction (like in Galasso, Klein, Campagnolo, and Denk); and in either case these goals can be achieved with a varying wall thickness as straightforward analysis would inform the design engineer. In my initial Declaration, I cited formulas for doing such calculations (Ex. 1003, ¶132; *see also* Ex. 1016), and Dr. Parnell has provided no analysis to rebut those calculations, thus implicitly admitting that my analysis and calculations are correct.

Ex. 1024, ¶44

Ground I Based on Denk

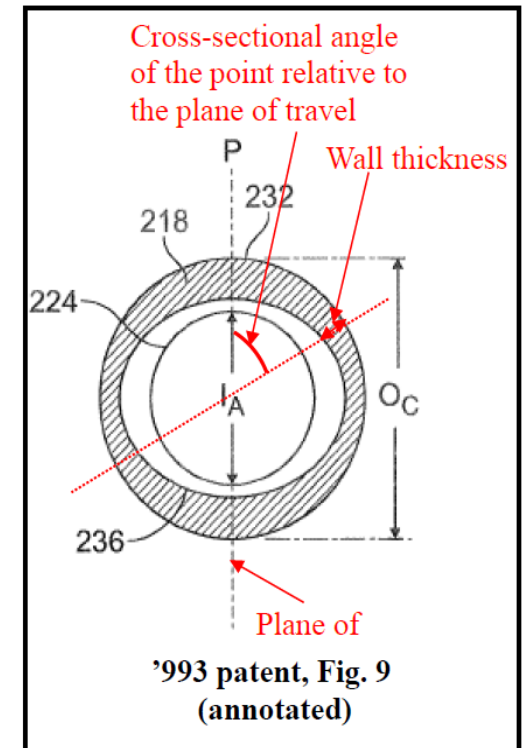
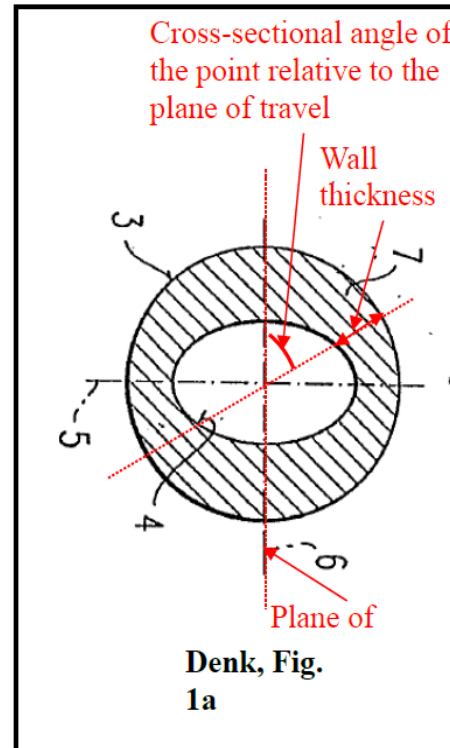
Denk Discloses a Bicycle Tube Design Having an Inner Elliptical Contour and Outer Circular Contour



“The illustrations according to Figs. 1a through 1h show cross-sectional illustrations of the tube along a section line I-I.” Denk, cols. 5-6

Denk, Figs. 1a, 1l (annotations added).

- Denk’s tubular wall is formed between the elliptical inner cross-sectional contour 4 and the circular outer cross-sectional contour 3 in the lower section
- The wall thickness of the tubular body varies over a cross-section
- The maximum thickness is in plane 6 and minimum thickness is in a plane 5 perpendicular to plane 6



Pet., 16-17, 23-26

A POSITA Would Have Found it Obvious to Use Denk's Tube as a Steerer Tube

- Petitioner's expert testified that a steerer tube is a tubular component of a bicycle fork.

Ex. 1024, ¶¶ 31-32;

- Patent Owner's expert agrees that a steerer tube is "a key component of a bicycle fork." Ex. 2021, ¶26; *see also id.*, ¶¶ 28, 33, 47-48, 53; Ex. 1026, 91:1-92:12
- The '993 patent describes steerer tube 200 as a part of bicycle fork 110. Ex. 1001, 4:58-62, FIGS. 1-2

- Denk expressly discloses that its lightweight tube design is suitable for all tubular components of a bicycle frame, including fork tubes. Ex. 1006, Abstract, cols. 1, 4, claim 18

- A POSITA would have understood Denk's disclosure to be applicable to all tubes of a bicycle fork, including the steerer tube.

Ex. 1003, ¶¶ 56-57; Ex. 1024, ¶ 33

Preferred uses of the invention have been described above. Thus, the lightweight component for bicycles is suitable for practically all tubular components, i.e., top tube, down tube, seat tube, head tube, fork tubes, rear wheel stay, seat posts, handlebars, handlebar stem, and the like.

Ex. 1006 (Denk), col. 4

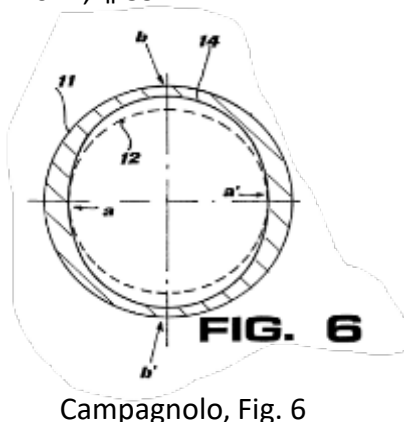
18. The lightweight component according to at least one of Claims 1 through 12, characterized in that the lightweight component is designed in such a way that it is formed as part of a bicycle fork.

Ex. 1006 (Denk), claim 18

Pet., 13-14, 16; Reply, 10-11

A POSITA Would Have Found it Obvious to Align the Maximum Thickness of Denk's Tube With the Plane of Travel

- Denk teaches that bicycle tubes need to have highest strength and rigidity in the vertical plane of the frame, which is coplanar with the plane of travel. Denk, cols. 1-2; Ex. 1024, ¶ 39
- Other prior art, such as Campagnolo, teaches that a bicycle tube “should take into account the actual stresses involved and their possible variations.”
Ex. 1009 (Campagnolo), 7:29-8:3
- Knowing that a steerer tube experiences highest loads in the plane of travel, a POSITA would have known to orient Denk's tube (as shown in Fig. 1a) so that the areas of maximum tube thickness are aligned with the plane of travel. Ex. 1024, ¶ 38



A consideration of the load on a bicycle frame, for example, shows that particularly high loads occur in the vertical plane of the frame, since the weight of the rider acts essentially in the vertical direction, and the impact loads acting on the front and rear wheel likewise essentially occur within a vertical plane. Loads situated outside this plane, in particular the torque generated about the bottom bracket bearing transverse axis during pedaling, the forces that occur when negotiating a curve, and the forces during pedaling while standing, when the bicycle is inclined during straight-ahead travel when pedaling, may likewise assume high values, but in their total scope and also frequency of occurrence they are lower than the forces occurring in the vertical direction.

The design according to the invention now allows the cross section of the tubular portion of the lightweight component to be designed in such a way that the force absorption capability of the components of a bicycle frame in the vertical frame direction is greater than in an arbitrary orientation perpendicular to this plane. As a result, for the same overall strength and rigidity, the weight may be reduced, or for the same weight, the strength and rigidity may be significantly increased in the load direction specified by the design.

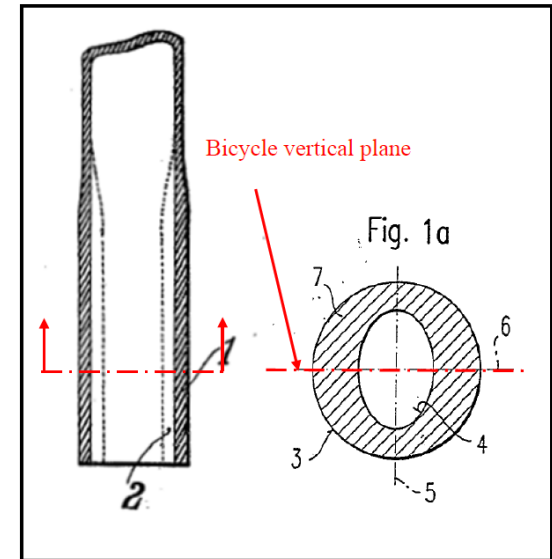
Denk, col. 2

Pet., 13-14, 25; Reply, 13-14

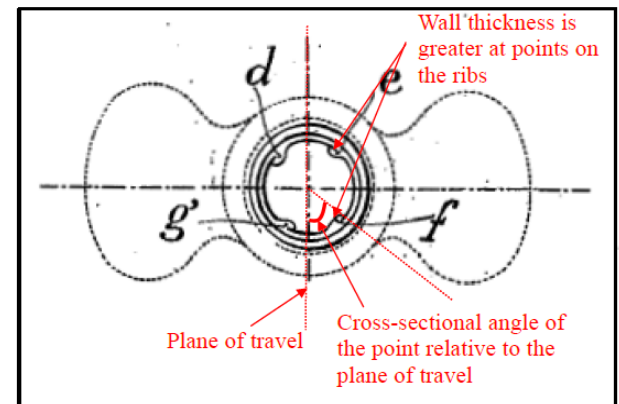
Ground II Based on Valat

Valat Figure 1 Modified in View of Denk Would Have Varying Wall Thickness in the Lower Section

- Valat's Figure 1 shows a first configuration of a steerer tube having greater wall thickness and greater external diameter in the lower section where the loads are greatest. Ex. 1007 (Valat), 1:44-51, 1:58-60, 1:70-78
 - Valat's Figure 2 shows a second configuration with helical ribs formed in the lower section. *Id.*, 1:79-90
 - A POSITA would have understood that both configurations in Figures 1 and 2 are suitable options for a steerer tube. Ex. 1024, ¶ 50
- The lower section of Valat's Figure 1 configuration is modified in view of Denk to have an elliptical inner cross-section
- Valat teaches varying wall thickness in the lower section. Valat, Figs. 2, 3-5



Valat, Fig. 1; Denk, Fig. 1a

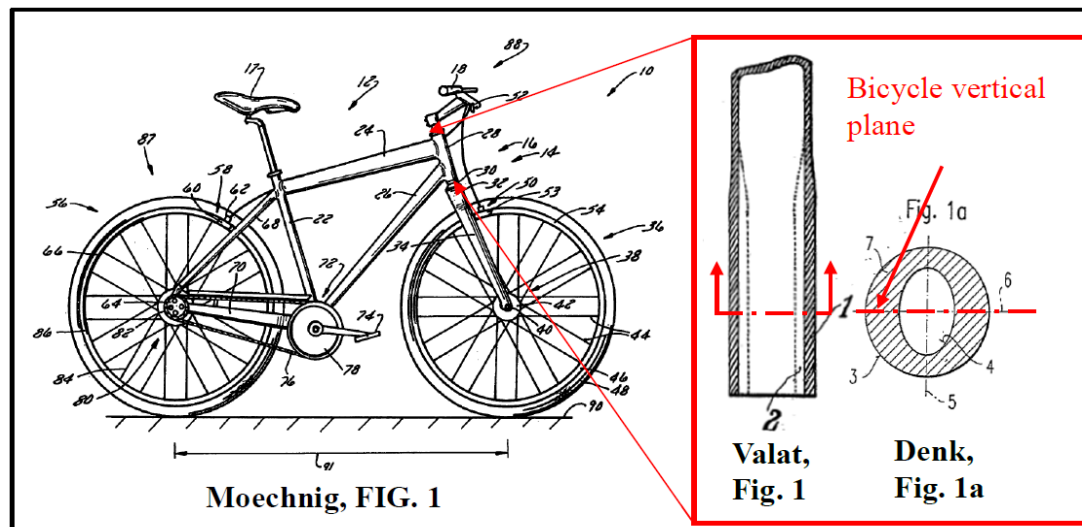


Valat, Fig. 2 (excerpted)

Pet., 49-55, 64-68; Reply, 17-19

Valat Figure 1 Modified in View of Denk Would Have the Maximum Wall Thickness in the Plane of Travel

- A POSITA would have known that a steerer tube bears the greatest loads in the plane of travel (see discussion in slides 10-15)
- A POSITA would have been motivated to orient the elliptical inner contour of the modified steerer tube of Valat in such a way that the areas with the maximum wall thickness are aligned with the plane of travel. Ex. 1024, ¶ 54



Ex. 1003, ¶ 189

Pet., 64-68; Reply, 19-20

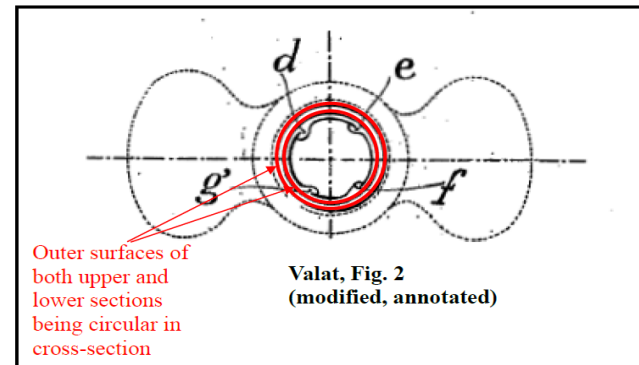
Valat's Steerer Tube Has Circular Outer Contour in the Upper and Lower Sections

- Valat's discussion of greater "external diameter" in the lower section of Figure 1 would inform a POSITA that the steerer tube has a circular outer cross-section in the lower section. Valat, 1:102-105; Ex. 1003, ¶ 182
- Valat's Figure 2 shows both configurations have circular outer cross-section in the upper section
- Patent Owner's criticism of using Figure 2 is unwarranted because, even after swaging in the lower section to create reinforcement ribs, the tube's exterior remains circular over its whole length. Valat 1:70-77; Ex. 1024, ¶ 52

Considering more particularly the steering tube shewn by way of example it should be mentioned that this tube which has the same external diameter over its whole length and is screw threaded at its upper end, generally has a greater thickness a at its lower end, where the loads are greatest, than in the upper part b . The junction is formed by a slight taper c . ..

by the aid of a suitable mandrel having grooves of the form of the reinforcements desired. As shown in Figure 1 for example a tube is chosen of greater external diameter in the part 1 where the reinforcements 2 are to be formed. Under the action of the swaging machine and the

Valat, col. 2



Pet., 62-63; Reply 20

A POSITA Would Have Been Motivated to Modify Valat with Denk's Elliptical Inner Cross-Section

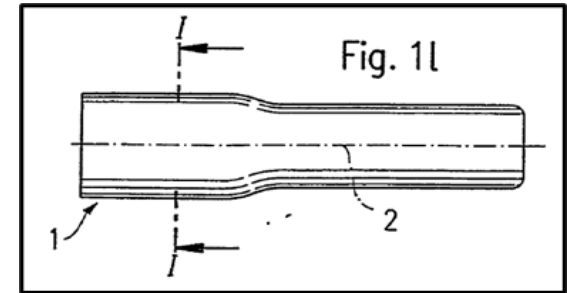
- A POSITA would have understood that having Denk's elliptical shape in place of Valat's helical ribs would allow the wall thickness to change smoothly and continuously and thereby reduce stress concentrations/failure points. Ex. 1003, ¶¶ 154, 156
- A POSITA would also have known that it would have been easier to manufacture a steerer tube with an elliptical inner surface than with reinforcement ribs. *Id.*, ¶ 154
- Additionally, a POSITA would have understood that Denk's inner elliptical contour would improve the strength/rigidity of Valat's steerer tube in the plane of travel where higher loads occur, while reducing weight by having lesser wall thickness in areas of lower stress. *Id.*, ¶¶ 155, 157
- Patent Owner's criticism that Denk does not improve Valat is unavailing because obviousness does not require the modification to be better or preferred over the original. *PAR Pharm., Inc. v. TWI Pharms., Inc.*, 773 F.3d 1186, 1197-98 (Fed. Cir. 2014); see other case in Reply, p. 22
- Denk does not contradict Valat's principle of operation because Valat teaches that "any form and disposition of the reinforcements, as well as any number, can be provided," and does not require reinforcements around the entire perimeter.
Valat, 2:5-7.

Pet., 51-55; Reply 20-23

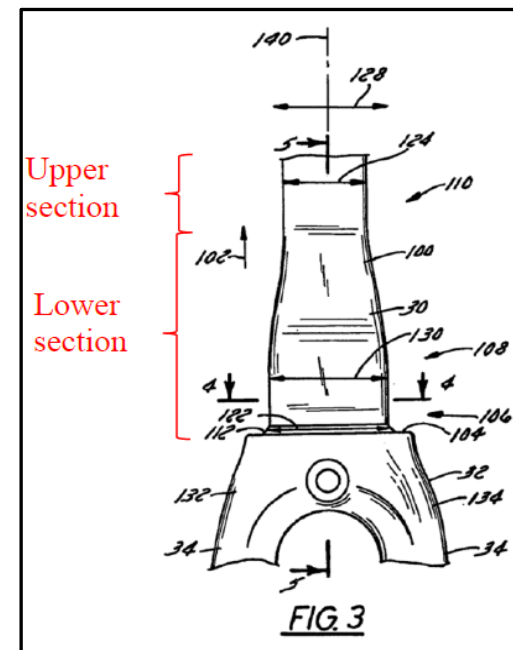
Grounds I and II Disclose the Limitations of the Dependent Claims and/or Render Them Obvious

Denk Discloses Greater Outer Diameter in the Lower Section of the Tube Than in the Upper Section (Claims 2, 16, 27, 36, 47, 61)

- Denk explicitly shows a tube having two sections that are joined by a tapering region, and the outer diameter of one section is greater than the other. Denk, Fig. 1l; Ex. 1024, ¶ 63
- A POSITA would have known, based on common knowledge and the teachings of prior art such as Moechnig and Valat, to position the tube such that the larger diameter section forms the lower section of the steerer tube when mounted on a bicycle. Ex. 1003, ¶¶ 97-98; Ex. 1024, ¶ 64
- It would have been obvious to a POSITA to have a lower section with larger diameter to withstand the greater loads experienced by the lower section of the steerer tube than the upper section. Ex. 1003, ¶¶ 97-98; Ex. 1024, ¶ 64; Denk, col. 3; Valat, 1:44-51



Denk, Fig. 1l

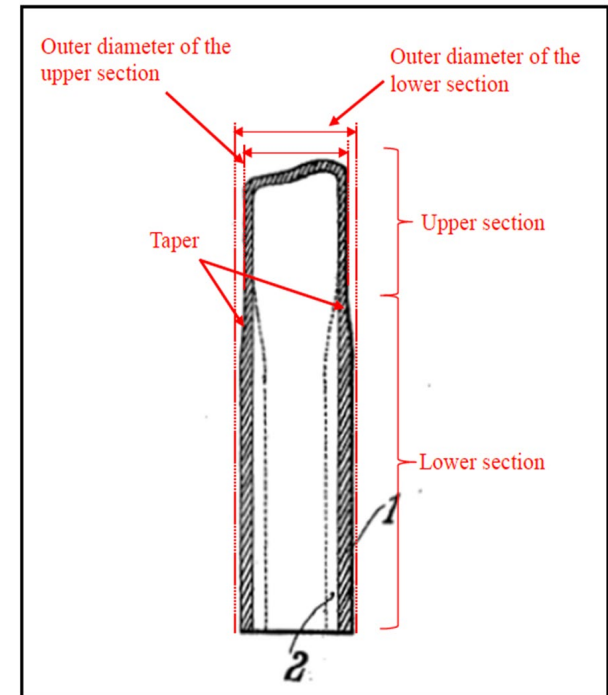


Moechnig, Fig. 3

Pet., 27-28; Reply, 23-24

Valat Discloses Greater Outer Diameter in the Lower Section of the Tube Than in the Upper Section (Claims 2, 16, 27, 36, 47, 61)

- Valat's Figure 1 explicitly shows that the lower section of the steerer tube has an outer diameter greater than that of the upper section. Ex. 1024, ¶ 65
- The Petition proposes to modify the lower section of Valat's first configuration (Figure 1) to have Denk's inner elliptical cross-section, instead of Valat's helical ribs, to reinforce the high-load areas of the wall while minimizing weight. Pet., 51-55, 67-68; Ex. 1003, ¶¶ 154-157, 188-189
- It would have been obvious to a POSITA that Valat's Figure 1 steerer tube (modified in view of Denk) would continue to have a lower section with a greater outer diameter than the upper section. Ex. 1024, ¶ 66
 - Valat's Figure 2 configuration and the related swaging process are not relevant to Petitioner's combination. Ex. 1024, ¶ 66

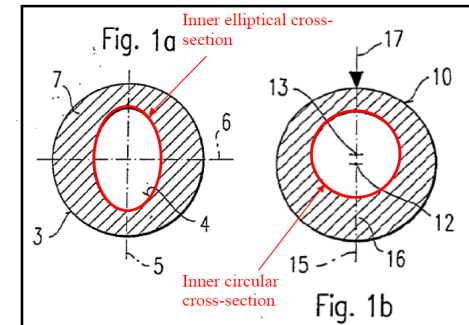


Valat, Fig. 1

Denk Discloses a Circular Inner Cross-Section in the Upper Section of the Steerer Tube (Claims 6, 10, 20, 24, 40, 44)

- Denk also discloses that the inner cross-sectional shape in one region of the tube may be elliptical as shown in Figure 1a, and may be circular in another region as shown in Figure 1b. Denk, cols. 6, 8, Figs. 1a, 1b; Ex. 1003,

¶ 118



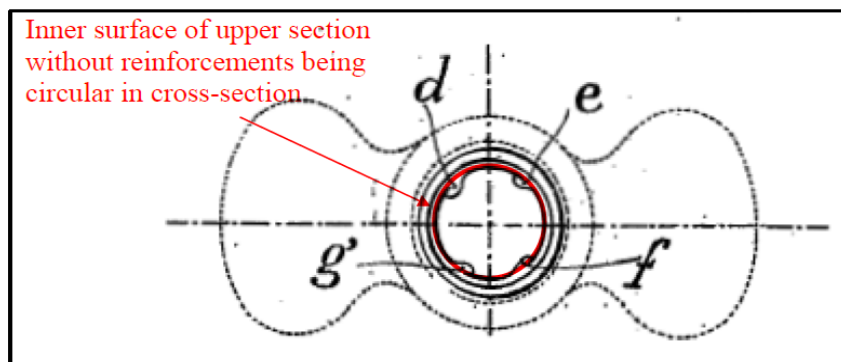
Denk, Figs. 1a and 1b

- Denk discloses with respect to Figure 1a, that “it is possible for the **elliptical inner cross-sectional contour to continually transition into a circular inner cross-sectional contour** in a certain area of the tube.” Denk, col. 8; Ex. 1003, ¶¶ 117-121
 - A POSITA would have understood Denk as disclosing a tube with an inner circular cross-section in the upper section of the tube and an inner elliptical cross-section in the lower section of the tube. Ex. 1003, ¶ 118; Ex. 1024, ¶¶ 69-70
- Moechnig additionally discloses a steerer tube with an elliptical inner cross-section in a lower section and a circular inner cross-section in the upper section of the steerer tube. Moechnig, [0035]-[0036], [0038], FIGS. 1-4; Ex. 1003, ¶ 119; Ex. 1024, ¶ 70
 - Patent Owner acknowledges that Moechnig shows “an interior shape that transitions between elliptical to circular.” POR, 54

Pet., 34-37, ; Reply, 26-27

Valat Discloses a Circular Inner Cross-Section in the Upper Section of the Steerer Tube (Claims 6, 10, 20, 24, 40, 44)

- Valat's Figure 2 explicitly shows the inner circular cross-sectional shape of the upper section. Ex. 1024, ¶ 67
 - A POSITA would have understood the upper sections of both Figure 1 and Figure 2 configurations to have circular inner cross-sections. *Id.*
- Valat discloses that its steerer tube body has an **internal diameter**. Valat, 1:86-90
 - A POSITA would have understood the inner surface of the upper section to be circular in cross-section with an internal diameter and without the reinforcements. Ex. 1003, ¶ 215



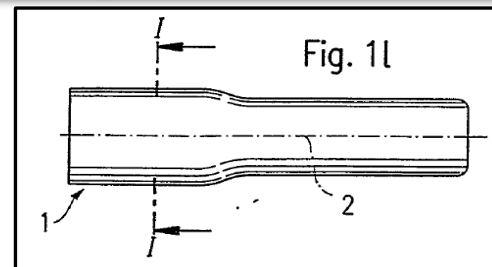
Valat, Fig. 2 (excerpted)

Pet., 76-77; Reply, 27

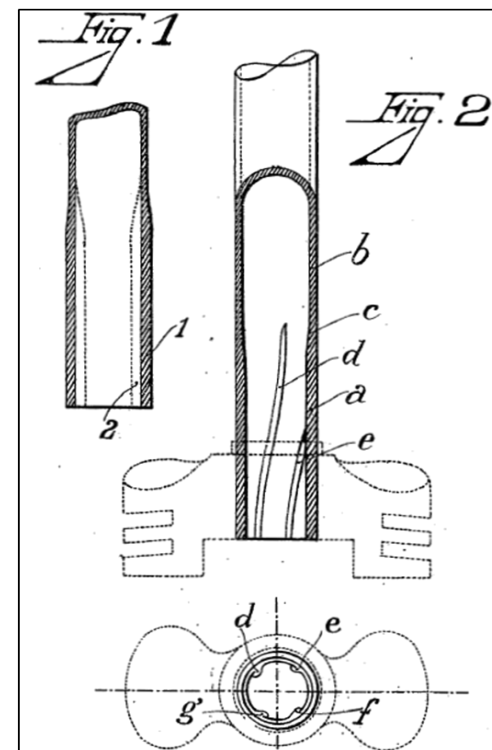
The Major and Minor Diameters of the Elliptical Inner Cross-Section Decrease Over the Tapering Region (Claims 56, 59)

- Both Denk and Valat disclose tubes with tapering regions
- The elliptical inner contour in the lower section of Denk (and Valat in view of Denk) transitions to a circular inner contour in the upper section (discussion on slides 28-29)
- It would have been obvious to a POSITA that when the elliptical contour transitions over the tapering region to a circular contour, **both the major and minor diameters would necessarily decrease over the tapering region and would become equal.**
- Moechnig teaches how the major and minor diameters of an elliptical contour decrease over a tapering region as the tube transitions to a circular contour. Pet., 42-44, 79, 81; Ex. 1003, ¶¶ 137-138; Moechnig, [0038]

Ex. 1003, ¶ 141; Ex. 1024, ¶¶ 72, 73



Denk, Fig. 1l



Valat, Figs. 1, 2

Pet., 42-45, 78-79, 81-82; Reply, 27-28