

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CMS CEP COR LTD., and CMS CEP COR AMERICAS LLC,
Petitioner,

v.

SANDVIK INTELLECTUAL PROPERTY AB,
Patent Owner.

Patent No. 11,014,090

Inter Partes Review No. IPR2024-01381

SECOND DECLARATION OF HARRI KYTÖMAA, PH.D.

I, Harri Kytömaa, Ph.D., make this declaration in connection with the proceeding identified above.

I. INTRODUCTION

1. I have been retained by counsel for Patent Owner, Sandvik Intellectual Property AB (“Sandvik”) as a technical expert in connection with the proceeding identified above. I submit this declaration in support of the Patent Owner Response for *Inter Partes* Review of United States Patent No. 11,014,090 (“the '090 patent”).

2. Exponent is being paid at an hourly rate for my work on this matter. I have no personal or financial stake or interest in the outcome of the present proceeding.

II. QUALIFICATIONS

3. In my previous declaration and accompanying appendix (“Kytömaa I”), I summarized my educational background, experience, career history, publications, and other relevant qualifications. (*See* Ex. 2001, ¶¶ 3–14.) Unless otherwise noted below, I will not repeat them here.

III. MATERIALS CONSIDERED

4. In preparing this declaration, I have reviewed, among other things, the following materials:

- The '090 patent (Ex. 1001);

- The Petition for *Inter Partes* Review of the '090 patent to which my declaration related ("Petition") and Exhibits thereto, with particular attention to the Exhibits set forth below;
- The prosecution history of the '090 patent (Ex. 1001-1, "'090 prosecution history");
- The Expert Declaration by David G. Smith that accompanies the Petition (Ex. 1002, "Smith");
- Excerpts from Richard G. Budynas & J. Keith Nisbett, *Shigley's Mechanical Engineering Design*, Ninth Edition (2011) (Ex. 2003);
- Excerpts from Andrew W. Batchelor & Gwidon W. Stachowiak, *Engineering Tribology*, Second Edition (2001) (Ex. 2004);
- Excerpts from Robert C. Juvinall & Kurt M. Marshek, *Fundamentals of Machine Component Design*, 3rd Edition (2000) (Ex. 2005);
- Excerpts from Oscar J. Horger, *Metals Engineering Design*, First Edition (1953) (Ex. 2006);
- U.S. Patent No. 4,410,143 issued to Polinski (Ex. 1017, "Polinski");
- U.S. Patent No. 6,270,026 issued to Piepho (Ex. 1018, "Piepho");
- U.S. Patent No. 2,840,399 issued to Harless (Ex. 1033, "Harless");
- U.S. Patent No. 8,302,754 issued to Yagi (Ex. 1040, "Yagi");
- My previous declaration (Kytömaa I; Ex. 2001) in this proceeding;

- The Decision on Institution (“Institution Decision”) dated March 18, 2025;
- EP Application No. 13192402.9 (Ex. 2008);
- U.S. Application No. 15/035,774 (Ex. 2009);
- Deposition Transcript of David Smith dated June 11, 2025 (Ex. 2011);
- Merriam-Webster’s Collegiate Dictionary, 11th ed. (2012) (definition of “end”) (Ex. 2012);
- The Oxford English Dictionary, 2nd ed. (1989) (definition of “indented”) (Ex. 2013);
- Richard G. Budynas & J. Keith Nisbett, *Shigley’s Mechanical Engineering Design*, Ninth Edition (2011) (Ex. 2015);
- John H. Bickford, *An Introduction to the Design and Behavior of Bolted Joints*, 3rd ed. (1995) (Ex. 2016); and
- Robert C. Juvinall & Kurt M. Marshek, *Fundamentals of Machine Component Design*, 3rd Edition (2000) (Ex. 2017).

IV. DEFINITIONS AND STANDARDS

5. I have been informed and understand that claims are construed from the perspective of one of ordinary skill in the art at the time of the claimed invention, and that during *inter partes* review, claims are to be given their broadest reasonable construction consistent with the specification.

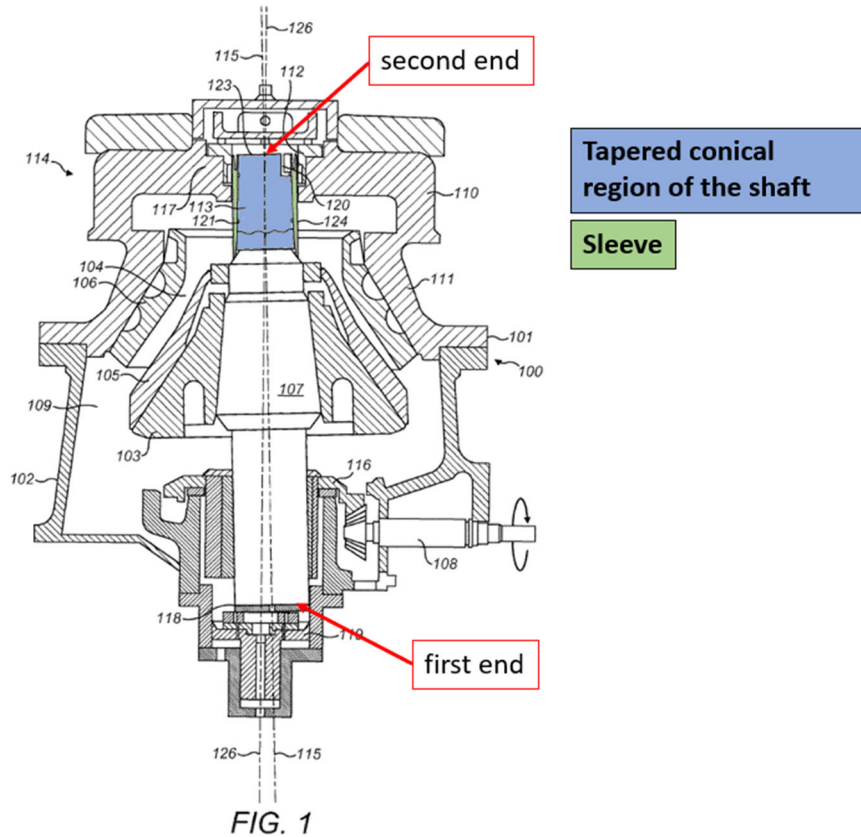
6. I have also been informed and understand that the subject matter of a patent claim is obvious if the differences between the subject matter of the claim and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. I have also been informed that the framework for determining obviousness involves considering the following factors: (i) the scope and content of the prior art; (ii) the differences between the prior art and the claimed subject matter; (iii) the level of ordinary skill in the art; and (iv) any objective evidence of non-obviousness. I understand that the claimed subject matter would have been obvious to one of ordinary skill in the art if, for example, it results from the combination of known elements according to known methods to yield predictable results, the simple substitution of one known element for another to obtain predictable results, use of a known technique to improve similar devices in the same way or applying a known technique to a known device ready for improvement to yield predictable results. I have also been informed that the analysis of obviousness may include recourse to logic, judgment and common sense available to the person of ordinary skill in the art that does not necessarily require explication in any reference.

V. THE '090 PATENT

A. Background

7. The '090 Patent describes, among other things, a gyratory crusher main shaft assembly which includes “a main shaft, an axially upper region of the main shaft including a tapered conical section with a protective sleeve friction fitted over the cone” and “at least one groove indented within a radially external facing surface of the main shaft at the region of the cone” (Ex. 1001., Abstract; 1:63–66, 2:10–19.) The gyratory crusher main shaft assembly enables efficient mounting and dismounting of the protective sleeve using both (1) a tapered interference fit between the main shaft and the protective sleeve and (2) the at least one groove or channel indented on an outward facing external surface of the shaft configured to receive a pressurized fluid. (*Id.*, 2:46–58.)

8. Annotated Figure 1 of the '090 Patent below shows a main shaft 107 positioned within a gyratory crusher. The shaft 107 has a first end positioned at a bottom end of the crusher and a second end positioned at the top end of the crusher, as shown in the figure below. A tapered region 113 (blue) of the shaft 107 extends from the second end of the shaft 107 toward the first end of the shaft 107.



9. In annotated Figure 1 above and Figure 2 below, a protective sleeve 124 (green) is shown mounted to the tapered region 113 of the shaft 107. (*Id.*, 5:25–51.) The protective sleeve 124 comprises an inward facing surface 201 that has a tapered conical profile corresponding to a tapered conical profile of the main shaft tapered region 113. (*Id.*) A fluid supply conduit 120 may connect to a groove 121a, which is indented into the shaft and extends circumferentially around the tapered region 113. (*Id.*, 5:22–25; 6:24–31.) A fluid can be delivered to the groove 121a to lubricate the interface between an outer surface 200 of the shaft 107 and the inward facing surface 201 of sleeve 124. (*Id.*, 6:54–62.) Figure 2 also shows an additional groove 121b coupled in fluid communication with groove

121a via an axially extending groove or channel 208. The oil grooves, along with the tapered surfaces of the shaft and sleeve, promote efficient mounting and dismounting of the sleeve to the main shaft. (*Id.*, 2:46–59.)

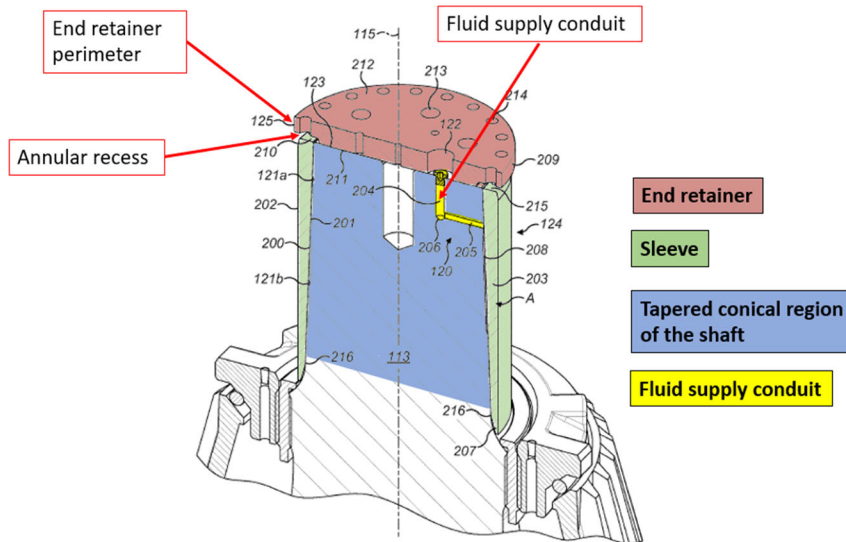


FIG. 2

10. Also shown in annotated Figure 2 (above) is an end retainer 125. The end retainer 125 is releasably mounted at shaft end surface 123 (the second end of the shaft body). (*Id.* 5:56–57.) End retainer 125 includes an annular recess 210 that extends circumferentially around a retainer perimeter 209 and is indented in an underside surface 211 of the end retainer so as to create an axially and radially extending annular gap immediately axially above the annular sleeve end 215. (*Id.* 6:9–14.)

11. Annotated Figure 3 of the '090 Patent, shown below, depicts the shaft with the protective sleeve removed. (*Id.*, 4:34–35.) This figure shows grooves

121a and 121b more clearly, depicting how the grooves are coupled in fluid communication with one another via the axial groove or channel 208.

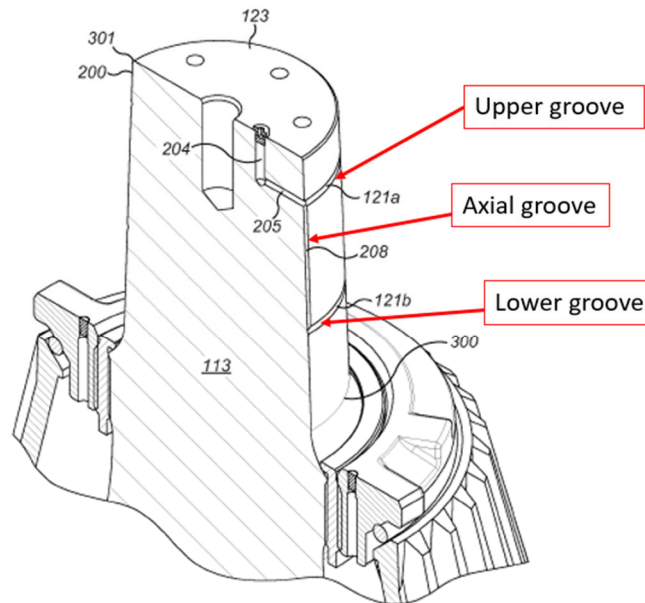


FIG. 3

(*Id.*, FIG. 3 (Annotated).)

12. As also illustrated in Figure 3 above, the radial taper of tapered region 113 may be uniform along the axial length between uppermost end 301 and lowermost end 300 of the tapered region 113 of the shaft. (*Id.*)

1. Summary Of The Challenged Claims And File History

13. Petitioner challenges claims 1–14 of the '090 Patent. (Paper 2, 1–2.) Claims 1, 9, and 14 are independent claims as shown below with limitations indicated with alpha-numeric designations:

[1pre] A gyratory crusher main shaft of a crusher comprising:

[1a] a shaft body having a radially outward facing external

surface, and a first end and a second end;

[1b] an axial region of the shaft body extending from the second end and being tapered relative to a longitudinal axis of the shaft body such that a cross sectional area of the shaft body at the tapered axial region decreases in a direction from the first end to the second end;

[1c] a shaft sleeve mounted on the tapered axial region; and

[1d] at least one groove indented at the external surface and positioned at the tapered axial region, the at least one groove being arranged to receive a pressurized fluid to facilitate mounting and dismounting of the shaft sleeve at the shaft body.

[9pre] A gyratory crusher main shaft assembly for a crusher comprising:

[9a] a shaft body having a radially outward facing external surface, and a first end and a second end,

[9b] an axial region of the shaft body extending from the second end and being tapered relative to a longitudinal axis of the shaft body such that a cross sectional area of the shaft body at the tapered axial region decreases in a direction from the first end to the second end,

[9c] a shaft sleeve mounted on the tapered axial region, and

[9d] at least one groove indented at the external surface and positioned at the tapered axial region, the at least one groove being arranged to receive a pressurised fluid to facilitate mounting and dismounting of the sleeve at the shaft body; and

[9e] a sleeve fitted over the tapered axial region, the sleeve having a tapered wall thickness, such that the wall thickness at a second end of the sleeve is greater than the wall thickness at a first end of the sleeve.

[14pre] A gyratory crusher comprising;

[14a] a main shaft including a shaft body having a radially outward facing external surface, a first end for positioning at a lower region of the crusher and a second end for positioning at an upper region of the crusher relative to the first end, an axial region of the shaft body extending from the second end and being tapered relative to a longitudinal axis of the shaft body such that a cross sectional area of the shaft body at the tapered axial region decreases in a direction from the first end to the second end, the tapered axial region being configured to mount a shaft sleeve;

[14b] a sleeve fitted over the tapered axial region, the sleeve having a tapered wall thickness such that a wall thickness at a second upper end of the sleeve is greater than a wall thickness at a first lower end of the sleeve; and

[14c] at least one groove indented at the external surface and positioned at the tapered axial region, the at least one groove being arranged to receive a pressurised fluid to facilitate mounting and dismounting of the sleeve at the shaft body.

14. Importantly, limitations [1d], [9d], and [14c] require that the “at least one groove” be “indented at the external surface [of the shaft body] and positioned at the tapered axial region.” As I discuss below, Petitioner introduces Harless into its combination to meet limitation [1d] (and the corresponding limitations in independent claims 9 and 14). (Paper 2, 18–21.) This limitation was a basis for the allowance of the issued claims during the original examination. As discussed below, the challenged claims are also patentable over the new references in the Petition.

VI. LEVEL OF ORDINARY SKILL IN THE ART

15. Mr. Smith states that “a person having ordinary skill in the art would be a person who has a bachelor’s degree in mechanical engineering or a related field and at least two years of experience with industrial equipment design and development. A POSITA may also have a combination of more formal education and less work experience or a combination of less/different formal education and more work experience.” (Ex. 1002, ¶ 30.) Mr. Smith also testified that the two years of experience is not limited to rock crushers and that “industrial equipment” is a “broad category.” (See Ex. 2011, 38:25–39:24.) For the purposes of this Declaration, I do not object to Mr. Smith’s position on the level of skill in the art.

16. I meet and exceed the defined level of skill of a person of ordinary skill in the art of mechanical design and the field of comminution in the following ways: First, I have a B.Sc. in Engineering Science, and an M.S. and Ph.D. in Mechanical Engineering. While obtaining my doctorate, I engaged in the design and fabrication of equipment for the handling of bulk solid materials, which is relevant to crushers. For example, I designed and constructed a custom hopper to contain and dispense solid materials. During that time, I also taught undergraduate and graduate-level mechanical engineering courses. After I obtained my PhD, I was a Professor in Mechanical engineering at MIT. There, I taught the MIT capstone mechanical engineering design course that included machine design,

experimental method courses, as well as courses in thermal sciences. Second, much of my research at MIT focused on bulk solids including comminution, how bulk solids respond to compression and methods of efficient particle size reduction through crushing. I have published multiple peer reviewed engineering papers on the subject. Third, I have engaged in the practice of mechanical engineering for decades. At Exponent, where I am a Corporate Vice President, I have worked on mechanical and machine design, including fasteners (such as threaded components and rivets), manufacturing techniques (casting, forging, welded and riveted assemblies), mechanical seal designs (gaskets and seals), bearing design and performance, shaft misalignment, eccentric shaft motion and vibration. These have often been in the context of rotating equipment such as downhole rock drilling tools, as well as pumps, turbines and compressors. Some of this work has involved the failure of metal components through various mechanisms including metal fatigue of engineered components that experienced excessive vibrations and oscillatory stresses. I have also worked on coal handling equipment such as ball mills and crushers associated with coal mining and coal fired power plants.

17. Indeed, while Mr. Smith has testified that he does not have two years of experience with rock crushers (Ex. 2011, 39:8–10), I do have experience with rock crushers and I have published in the field of comminution. (Ex. 2002, 3–14.) Finally, I am a licensed professional mechanical engineer in the following 13

states: California, Massachusetts, Louisiana, Maine, Michigan, Washington, New York, Arkansas, Alabama, Oklahoma, New Jersey, Florida and Texas.

18. Thus, as described in Kytömaa I and in this declaration, I qualify as a POSITA in a number of ways.

19. I will describe *infra* why the challenged claims would not have been obvious to a POSITA. At this point, I would add that the level of skill set forth by Mr. Smith supports the patentability of the challenged claims. To meet the claim limitations, a POSITA would have to modify Polinski, Piepho, and Harless in a number of ways. Such modifications, aside from being unsupported by the disclosures of the references, would have been beyond the level of skill here, especially given that Mr. Smith testified elsewhere that “rock crushers are fairly complex machines” and their successful design requires understanding of a number of fields, such as “tribology, fracture mechanics, and fluid mechanics.” (Ex. 1002, ¶ 27.)

20. Designing the shaft for a gyratory rock crusher involves significant challenges due to demanding conditions. The shaft must withstand variable and unpredictable fatigue loads resulting from a wide range of material hardnesses. Its eccentric design introduces complexity not typically encountered by an engineer with only two years of experience.

VII. CLAIM CONSTRUCTION

21. I understand Sandvik is requesting that the Board construe the term “end” as an extremity of a shaft body or sleeve. I also understand that Sandvik is requesting that the Board construe the phrase “indented at the external surface.” My opinion is that the proposed constructions are consistent with the claim language, the specification of the ’090 Patent, and dictionary definitions and would be understood as the plain and ordinary meaning of “end” and “indented at the external surface” to a POSITA.

B. “End”

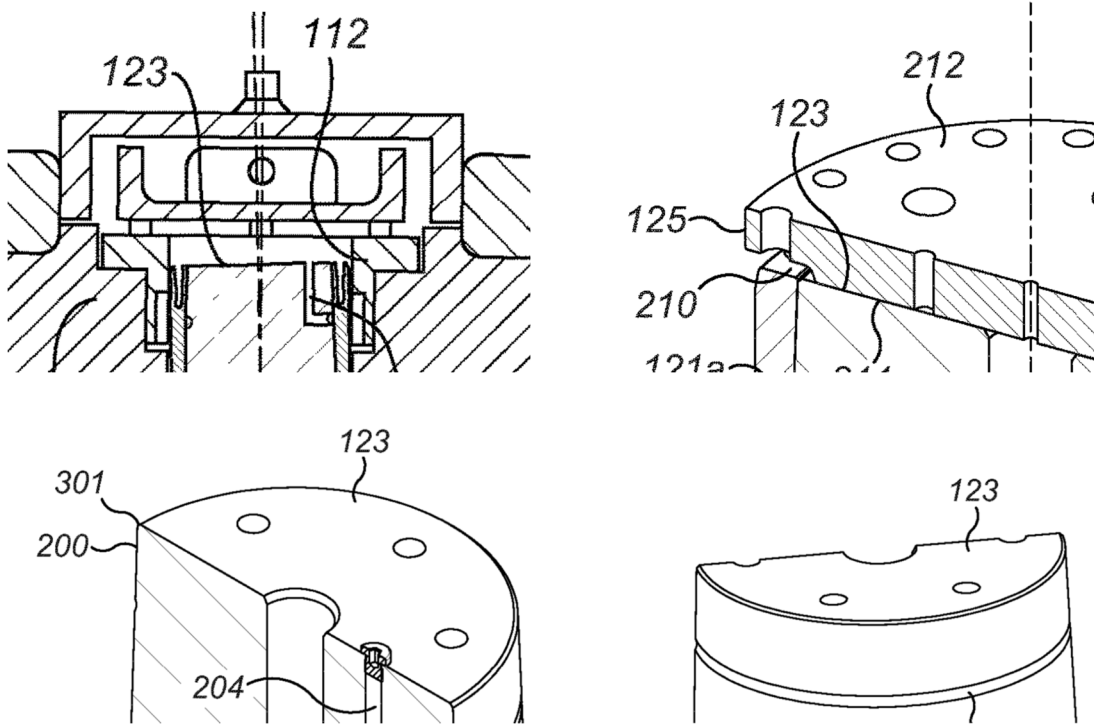
22. The term “end” is an element used in each independent claim of the ’090 Patent. (Ex. 1001.) Challenged independent claims 1, 9, and 14 refer to “a first end and a second end” of a shaft body. Challenged dependent claim 2 also refers to “a fluid inlet conduit extending axially from the second end [of the shaft body].” Challenged claims 9 and 14 additionally refer to “a first end of [a] sleeve” and “a second end of [a] sleeve.” As I discuss in detail below, Sandvik’s proposed construction of “end” as an extremity of a shaft body or sleeve is consistent with the claim language, the specification of the ’090 Patent, and a common dictionary definition.

2. Sandvik’s construction of “end” is supported by the claim language

23. Claims 1, 9, and 14 recite a shaft body having a “second end” and “an axial region of the shaft body *extending from the second end*.” In my opinion, a POSITA would find the most natural reading of this claim language to be that the axial region *extends* from a starting point or originating point, *i.e.*, the outermost extremity of the shaft body. Dependent claim 2 support this reading. It requires that the main shaft include “a *fluid inlet conduit extending axially from the second end* and provided in fluid communication with the at least one groove to allow a fluid to be supplied to the at least one groove from the second end.” Claims 1 and 2 thus require that both the tapered axial region and the fluid inlet conduit extend from the same second end. Given that a fluid *inlet* conduit requires an inlet at some location and is described as extending axially, a POSITA would understand that the second end where the inlet is located is the extremity of the shaft and not a location along the length of the shaft.

3. Sandvik’s construction of “end” is also supported by the specification

24. The specification consistently shows a tapered axial region that extends to the outermost extremity of the shaft body in every single figure showing the shaft body in the '090 Patent (end surface 123):

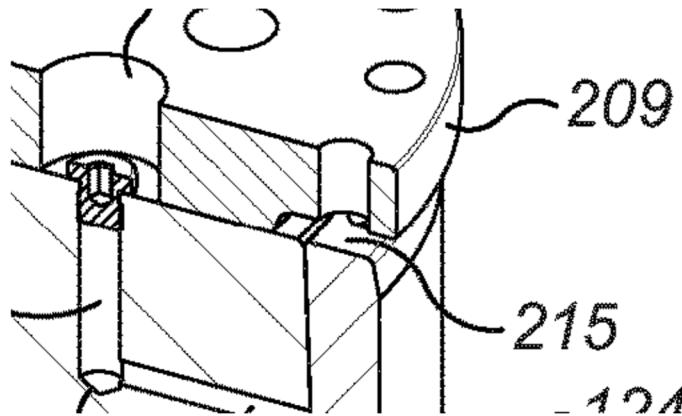


25. (Ex. 1001, FIGS. 1–4.) In all these figures, the end surface 123 of the shaft body is illustrated as the outermost extremity of the shaft body.

26. With respect to the sleeve, the '090 Patent describes that the “[s]leeve 124 comprises a radially inward facing surface 201 and a radially outward facing surface 202 with a substantially cylindrical wall 203 defined between surfaces 201, 202. Wall 203 is tapered so as to decrease in radial thickness *from uppermost end 215 to lowermost end 216.*” (Ex. 1001, 5:35–39.) The specification of the '090 Patent thus describes that the radial thickness of the sleeve decreases from the uppermost end to the lowermost end of the sleeve. I understand that this aligns with the limitations of claims 9 and 14, which require that the sleeve include a first

end and a second end, and that “a wall thickness at a second upper end of the sleeve is greater than a wall thickness at a first lower end of the sleeve.”

27. Furthermore, just like the end surface 123 of the shaft body, the '090 Patent illustrates the uppermost end 215 of the sleeve at the sleeve's upper extremity:



28. (Ex. 1001, FIG. 2.) To be sure, the '090 Patent illustrates the lowermost end 216 at a chamfer region 207. (FIG. 2; *see also* Ex. 1001, 5:52–55.) But chamfers and fillets are extremely common features often positioned at the outermost edges of objects, for instance, to reduce stress concentrations and ease assembly of components. The disclosure is thus still consistent with the lowermost end 216 being at an extremity of the sleeve.

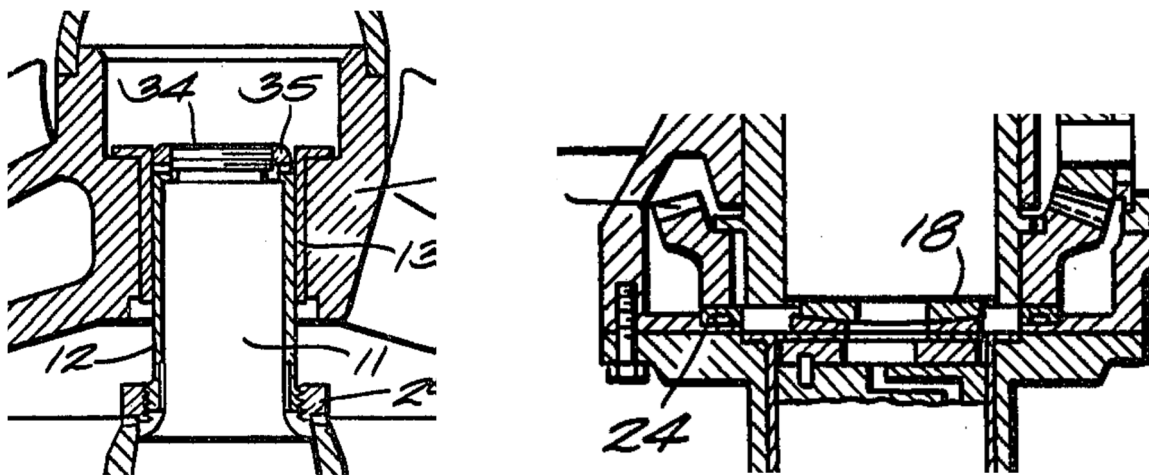
4. A common dictionary definition supports Patent Owner's construction of “end”

29. Sandvik's proposed construction is also consistent with a definition of end provided by Merriam-Webster's Collegiate Dictionary (2012) as “the extreme or last part lengthwise: TIP.” (Ex. 2012, 411 (definition 1c).) A POSITA would

understand this definition is consistent with the use of “end” in the claim language and the specification of the ’090 Patent and supports Sandvik’s construction of “end” as an extremity of the shaft body or sleeve.

5. Testimony from Petitioner’s expert supports Patent Owner’s construction of “end”

30. Petitioner’s expert, Mr. Smith, originally testified that “end” could be near the middle of an object, such as a sleeve. (See, e.g., Ex. 1002, 79.) However, on cross-examination, Mr. Smith testified otherwise. He explained, with reference to FIG. 1 of Polinski, that “there is an upper end of the shaft, generally indicated at around 34, 35. There is a lower end of the shaft, generally indicated around 18.” (Ex. 2011, 62:13–19.) I understand Mr. Smith’s testimony on cross-examination to be more aligned with a POSITA’s natural understanding of the term “end.”



31. Given FIG. 1 of Polinski (excerpted above), this testimony is squarely consistent with Patent Owner’s understanding of “end”—the uppermost extremity

of the shaft body labeled 34 above is the “upper end” in Mr. Smith’s view and the lowermost extremity 18 is the “lower end.” (Ex. 1017, FIGS. 1-2.)

6. Piepho’s use of the term “end” does not override my understanding of “end” in view of the ’090 Patent

32. In the Decision on Institution, the Board noted that “Piepho states that its shaft 14 includes ‘a tapered joint with *the tapered end (25) of shaft (14).*’” (Paper 9, 15 (emphasis in original).) However, I do not understand Piepho to assign any consistent terminology to the region labeled 25. Piepho’s shaft region 25 is described as a “shaft end,” “tapered portion,” “tapered end,” “shaft,” and “upper taper.” (Ex. 1018, 3:1–65.) Moreover, even if Piepho describes shaft region 25 as an “end,” I do not understand Piepho’s use of the term to override at least the intrinsic evidence of the ’090 Patent. As I discussed above, the claim language and specification of the ’090 Patent support Patent Owner’s construction that “end” refers to an extremity of a shaft body or sleeve.

C. “Indented at the external surface”

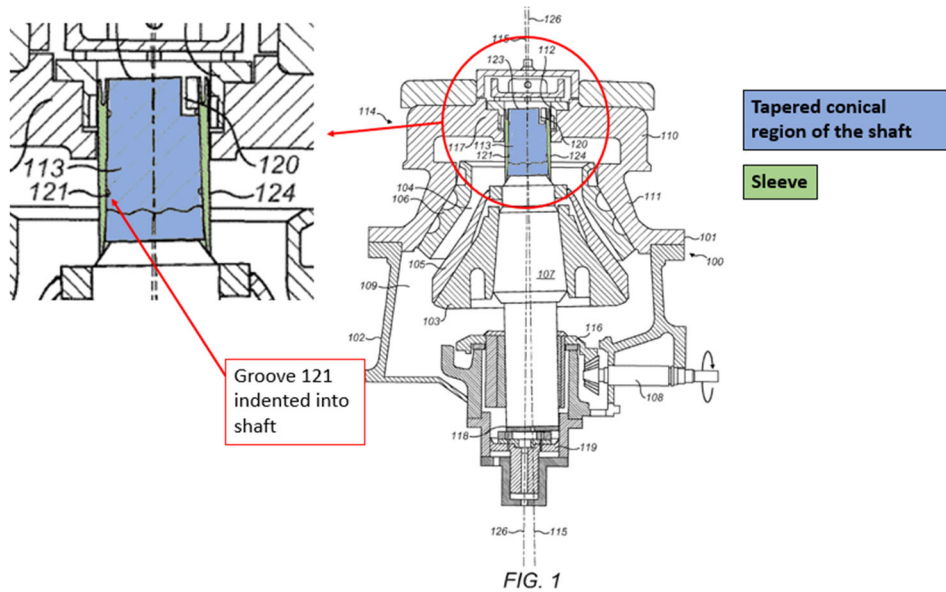
33. The phrase “indented at the external surface” is an element used in each independent claim of the ’090 Patent. (Ex. 1001.) Challenged independent claims 1, 9, and 14 refer to “at least one groove indented at the external surface and positioned at the tapered axial region.” Patent Owner submits that that the phrase “indented at the external surface” should properly construed as a depression or recess in an external surface—specifically, the external facing surface of the shaft

body. This construction is supported by the specification and prosecution history of the '090 Patent as well as a common dictionary definition.

1. The specification supports Patent Owner's construction of "indented at the external surface"

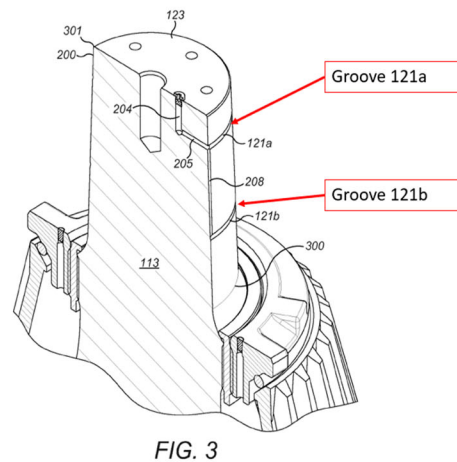
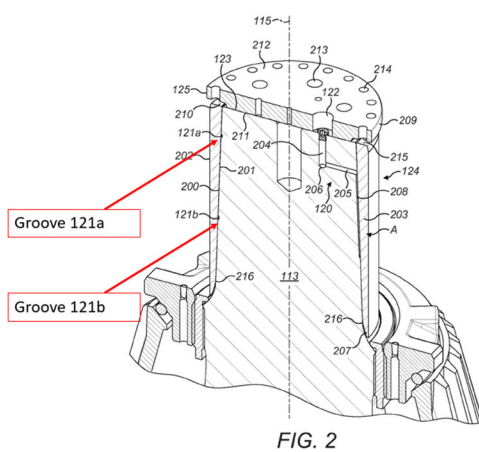
34. From the outset, the '090 Patent unambiguously refers to the at least one groove as a depression or recess in an external surface. For instance, beginning at the abstract, the '090 Patent states that "at least one groove is *indented within a radially external facing surface of the main shaft* at the region of the cone to allow fluid to be introduced under pressure to the region between the sleeve and the cone." (Ex. 1001, Abstract.)

I understand the Detailed Description section and each figure of the '090 Patent to be consistent with the abstract and with Sandvik's proposed construction. For instance, the Detailed Description refers to at least one groove 121 as "*indented within the external facing surface of shaft 107* at region 113. (*Id.*, 5:22–25.) FIG. 1 of the '090 Patent, annotated below, illustrates the groove 121 indented into the surface of the shaft body at the tapered conical region 113.



(Ex. 1001, FIG. 1)

35. FIGS. 2–4 (annotated below) of the '090 Patent also illustrate two grooves (121a and 121b) indented (as a depression or recess in a surface) into the external facing surface of the shaft body at the tapered axial region 113.



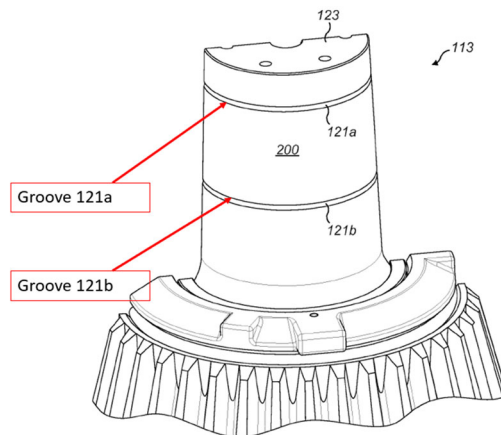


FIG. 4

36. It is my opinion that the specification of the '090 Patent unambiguously supports Patent Owner's construction of "indented at the external surface" to mean a depression or recess in the external surface—specifically, the external facing surface of the shaft body.

2. The prosecution history supports Patent Owner's construction of "indented at the external surface"

37. In response to the anticipation and obviousness rejections during examination, Sandvik noted that the "shaft includes a combination of an upper end region of the shaft being tapered so as to mount a correspondingly tapered protective sleeve with a groove being *in[d]en[t]ed/recessed into the external surface* of this tapered region of the main shaft." (Ex. 1001-1, Amendment dated January 25, 2019, 6.)

38. Sandvik then explained that "the groove 121 indented specifically at the external surface 200 of the main shaft *as opposed to being recessed into the*

sleeve 124 . . . maintains the strength and integrity of the sleeve and avoid[s] it splitting in response to the introduction of the pressurized fluid between the main shaft and the sleeve.” (Id.) Sandvik thus argued that the groove 121 is indented specifically at the external surface 200 of the main shaft body *as opposed to being recessed into the sleeve 124*. Thus, a POSITA would find that the prosecution history of the ’090 Patent supports Patent Owner’s construction of indented at the external surface to mean a depression or recess in the external surface—specifically, the external facing surface of the shaft body.

3. A common dictionary definition supports Patent Owner’s construction of “indented at the external surface”

39. Finally, Patent Owner’s construction is consistent with the Oxford English Dictionary, which provides that a definition of indented is “impressed, struck, or dented in, so as to make a depression or hollow in a surface.” (Ex. 2013, 846 (definition of “indented”).) This definition supports Patent Owner’s construction of “indented at the external surface” as a depression or recess in the external surface of the shaft body.

VIII. THE ASSERTED PRIOR ART REFERENCES

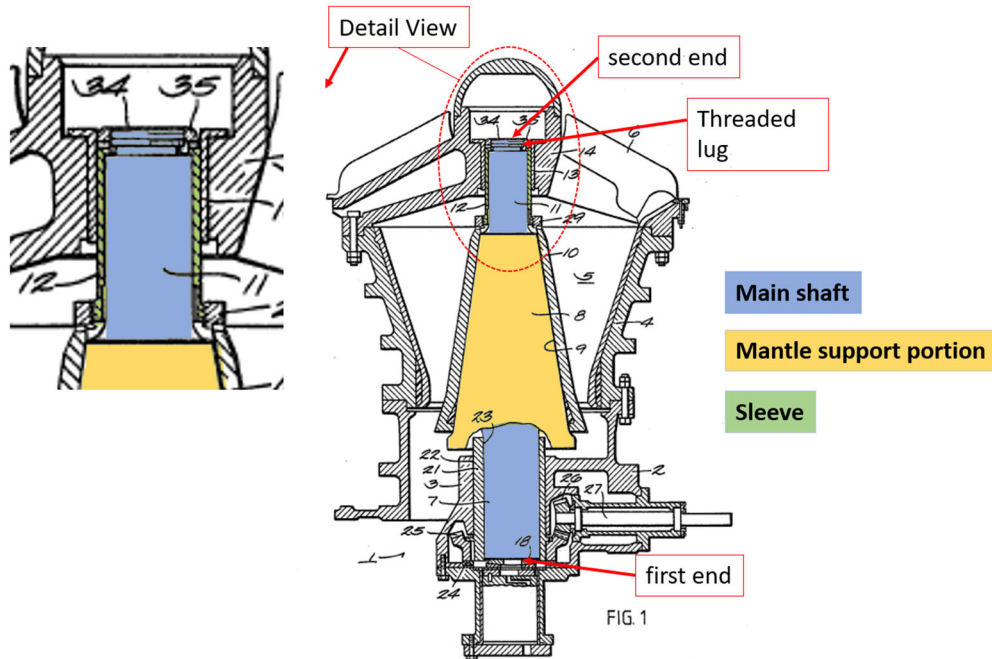
A. Polinski (Ex. 1017)

40. Polinski discloses a gyratory crusher and corresponding gyratory crusher shaft and bearing sleeve arrangement. (Ex. 1017, 1:44–47.) Polinski teaches that conventional gyratory crusher shafts typically include a threaded

section on the shaft for securing the mantle (the portion used to crush rock) to the shaft. (*Id.*, 1:10–20.) Gyratory crusher shafts are subjected to high stresses resulting from cyclic bending loads, according to Polinski. (*Id.*, 1:20–37.) It teaches that the threaded portions cut into the shaft result in stress concentrations that increase the chance of shaft failure. (*Id.*, 1:20–37.)

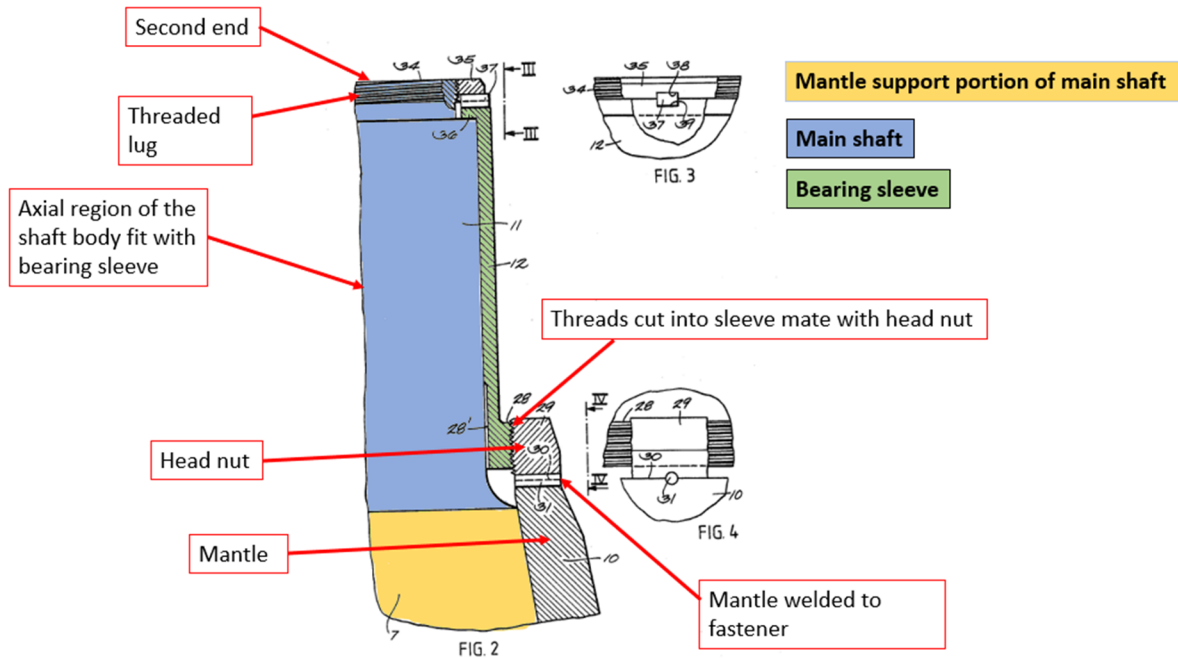
41. Polinski instructs that its invention “contemplates an arrangement wherein abrupt structural discontinuities in the normally high-stressed regions of the main shaft have been essentially eliminated [by instead cutting threads into the sleeve] to minimize the development of fatigue fractures in the shaft while at the same time providing an arrangement which can be easily maintained and repaired in the field.” (*Id.*, 1:60–68.)

42. As illustrated in annotated Figure 1 of Polinski (below), the shaft includes a first end positioned near the bottom of the crusher and a second end positioned near the top of the crusher. (*Id.*, FIG. 1.) Above the cylindrical journal 11, shaft 7 (blue) includes a threaded lug that extends to the second (top) end and is adapted to receive a sleeve nut 35 of a bearing sleeve 12. (*Id.*, 3:15–48.) The shaft further includes a mantle support portion 8 inserted into a conically shaped bore of a crusher mantle 10 and a cylindrical journal 11 fit with a corresponding sleeve 12 (in green). (*Id.* 2:32–47.)



(*Id.*, FIG. 1 (cropped and annotated).)

43. The bearing sleeve 12 (green) is fitted onto the cylindrical journal 11 of the gyratory crusher shaft 7. (*Id.*, 2:30–47.) Polinski teaches that the sleeve nut 35 is configured to secure the sleeve 12 to journal 11, preventing excessive movement (e.g., rotation) of the sleeve on the shaft. (*Id.*) Figure 2 below depicts additional detail of the journal 11 and sleeve 12.



(*Id.*, FIG. 2 (annotated).)

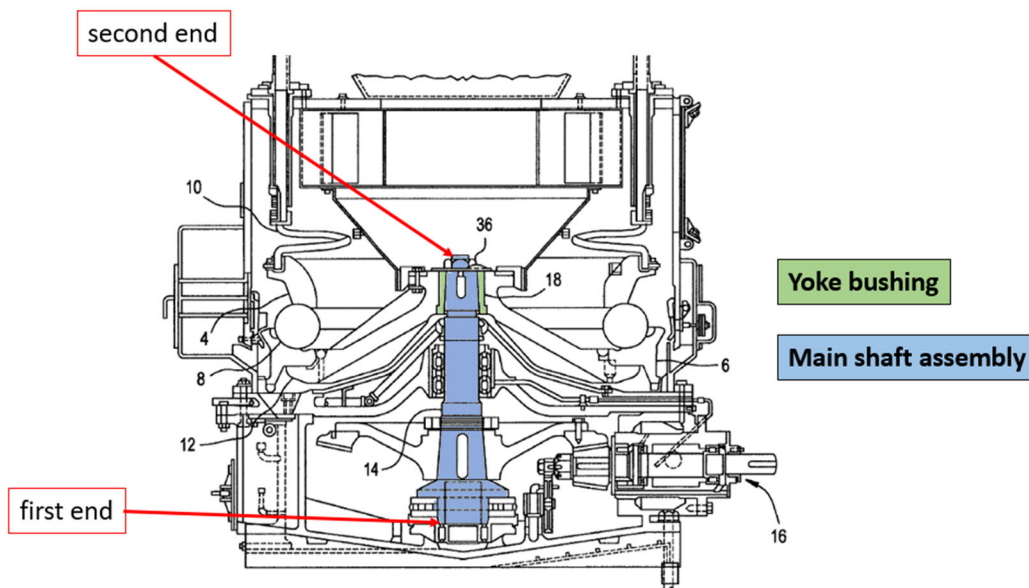
44. As illustrated above, Polinski teaches that a threaded shoulder 28 is provided on a bearing sleeve 12. (*Id.*, 2:67–68; 3:1–10.) The threaded shoulder 28 is configured to receive a head nut 29 that abuts the upper end of the mantle 10 to secure the mantle to the bearing sleeve 12. (*Id.*) Polinski places the threading in the sleeve such that journal 11 omits abrupt changes in the cross-sectional area of the shaft in high stress regions to avoid fatigue crack initiation. (*See id.*, 1:60–68.)

45. As I discussed in Ex. 2001, ¶32, Polinski does not disclose that external facing surface of the journal 11 of shaft 7 includes a taper extending from the second end of the shaft. Neither does Polinski disclose that sleeve 12 includes a taper or that it is mounted to a tapered region of the shaft 7. Finally, Polinski does not disclose a groove indented at the external surface of the shaft 7 and

positioned at a tapered region of the shaft 7. Mr. Smith agrees, because he relies on other references—not Polinski—for a tapered shaft and sleeve and for grooves on a shaft, as discussed below.

B. Piepho (Ex. 1018)

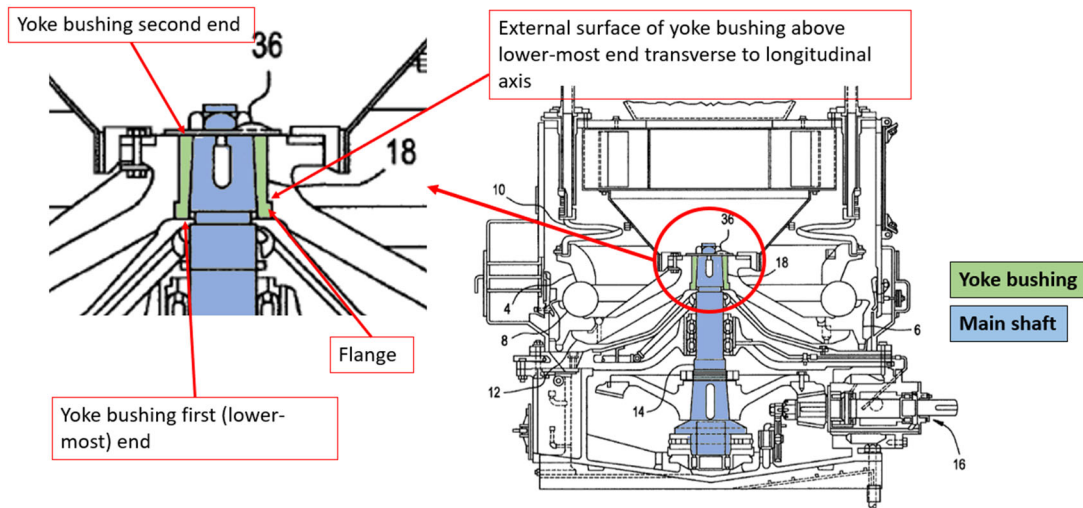
46. Piepho discloses a main shaft for a coal pulverizer. (Ex. 1018, 2:55–57.) In annotated Figure 1, shown below, Piepho illustrates an example of a coal pulverizer assembly that includes a main shaft 14 (blue) fitted with a yoke bushing 18 (green). (*Id.*, 1:45–50.)



(*Id.*, FIG. 1 (annotated and cropped).)

47. The yoke bushing 18 includes a flange extending from its lowermost end. The flange supports the yoke 12 of the coal pulverizer. Mr. Smith and Petitioner agree that the flange acts as a structural support in the related IPR

proceeding. (See IPR2024-01380, Paper 2, 31–32 (Petition referring to Mr. Smith’s declaration that the flange “provide[s] a shoulder bearing surface which can transmit axial loads.”).)



(*Id.*, FIG. 1 (annotated).)

48. Piepho’s purported invention is directed to a main shaft for a coal pulverizer designed to reduce shaft failure due to fretting induced bending fatigue. (*Id.*, 2:55–58.) Specifically, Piepho provides that “[t]he present invention resides in an improved main shaft for a coal pulverizer to reduce shaft failure due to fretting induced bending fatigue.” (*Id.*, 2:56–58.) To mitigate such shaft failures, Piepho discloses coating a portion of the main shaft with an intervening material. (*Id.*, 3:23–35.) The intervening material reduces local stresses in the shaft by reducing the relative movement between the shaft and the yoke. (*Id.*, 2:19–25.)

49. Piepho discloses that conventional coal pulverizer shafts are known to fail due to stress concentrations in the shaft, fretting wear, and cyclic bending loads. (*Id.*, 1:45–65.) Specifically, Piepho explains:

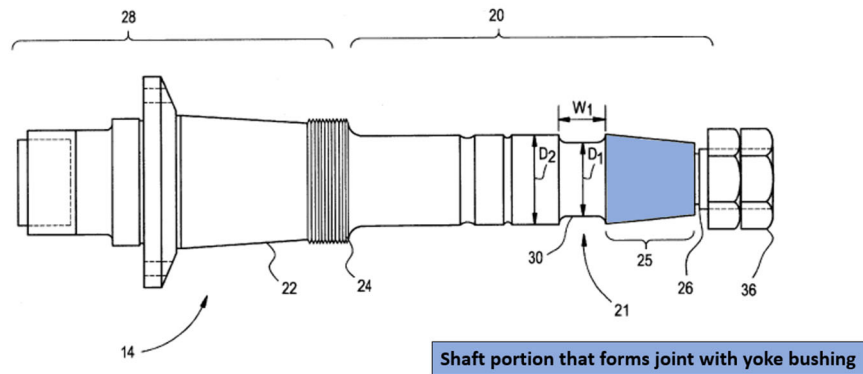
The pulverizer design generates cyclic or alternating type bending loads in the top end of the main shaft. Because the loads are cyclic, rubbing or fretting corrosion will occur. Also of concern is fatigue failure when stress concentration, cyclic loading and fretting corrosion are combined. (*Id.*, 1:53–58.)

50. Piepho further provides that various remedial efforts have failed to correct main shaft failure in coal pulverizers:

[T]here have been many attempts to correct main shaft failure frequency such as employing an anti-seize compound at the taper joint, using a bushing with a undercut center portion, using full contact bushings with no undercut center portion, shot peening, and nitriding as a surface hardening process. Remedial efforts notwithstanding, even carefully fitted taper joints, when subjected to cyclic bending forces often exhibit vulnerability to fatigue failure of shafts because of fretting and strain produced within the assembly. (*Id.*, 1:66–67; 2:1–8.)

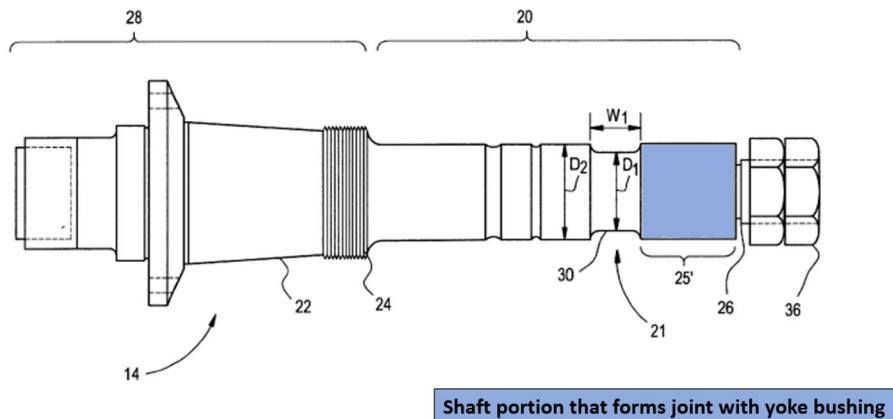
51. The main shaft of Piepho, which may be incorporated into a coal pulverizer, such as the one depicted in Figure 1, is illustrated in Figures 3 and 4 of Piepho, shown below. (*Id.*, 2:47–51.)

FIG.3



(*Id.*, FIG. 3 (annotated).)

FIG.4



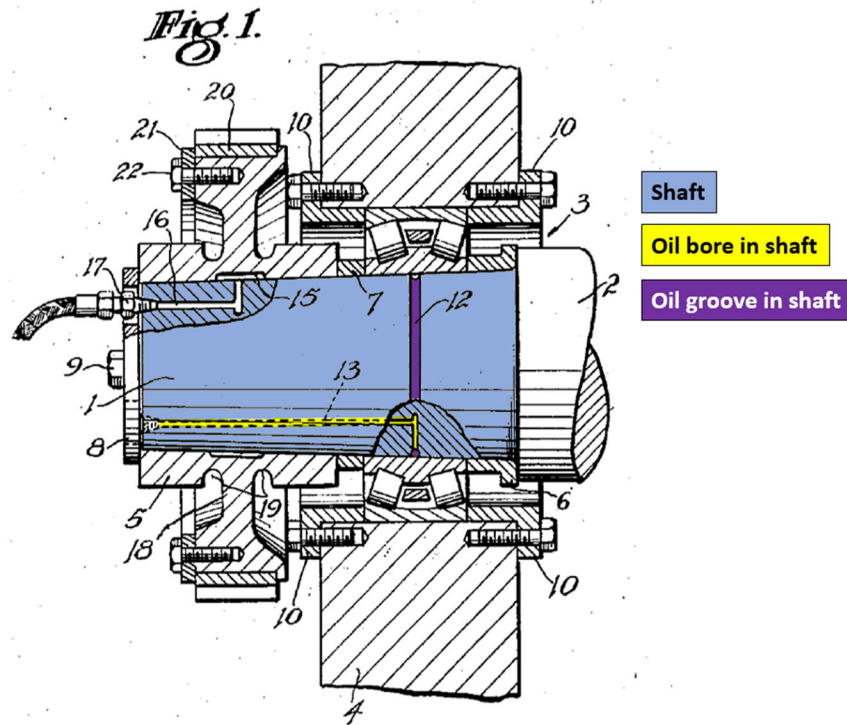
(*Id.*, FIG. 4 (annotated).)

52. The portion of the shaft that is configured to be fit with a yoke bushing (item 18 highlighted in Figure 1 above) when assembled into a coal pulverizer is labeled 25 and is highlighted above in Figures 3 and 4. As illustrated, the portion of the shaft that is configured to be fit with a yoke bushing does not

extend from the second (top) end of the shaft. Instead, a threaded portion labeled 26 extends from the second end of the shaft to the portion labeled 25 configured to be fit with a yoke bushing. The threaded portion 26 would be configured such that a corresponding fastener component 36 can be attached to secure the yoke depicted in Figure 1, shown above, to the shaft. (*See id.*, FIGS. 1, 4.)

1. Harless (Ex. 1033)

53. Harless discloses “improvements in the attachment of gears and other members having axially projecting hubs to tapered shaft ends.” (Ex. 1033, 1:15–17.) Specifically, Harless discloses that “[i]t is an object of the invention to provide for the attachment of a gear or other drive member to a tapered shaft, by expanding certain portions of the hub of the gear, while avoiding the excess pressure necessary to expand the web or any other radially extending part of the gear.” (*Id.*, 1:30–34.) Figure 1 of Harless, below, illustrates a tapered end 1 of a shaft 2 supported by a bearing 3 and frame 4. A gear 5 is mounted to the tapered end 1 of the shaft 2.

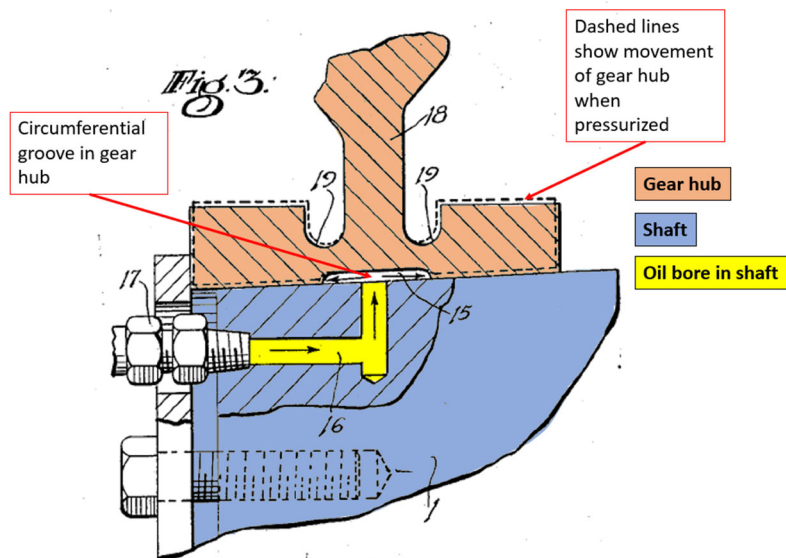


(Id., FIG. 1 (annotated).)

54. As illustrated in Figure 1, above, Harless discloses an oil groove 12 in the tapered end 1 of shaft 2. Oil under pressure can be introduced into circumferential groove 12 (purple) through a bore 13 (yellow) to expand the bearing 3, permitting it to be pushed up against a spacer 6. (*Id.*, 2:19-26.) The oil pressure can then be released, permitting the bearing inner race to contract and fixing it to the shaft with a shrink fit. (*Id.*)

55. Harless also discloses a particular gear hub design that enables avoidance of excess pressure typically necessary to expand the web or any other radially extending part of the gear 5 for mounting on the shaft 2. As shown in

Figure 3 of Harless below, Harless discloses grooves 19 placed near the web 18 of the gear. (*Id.*, 1:30–35.)

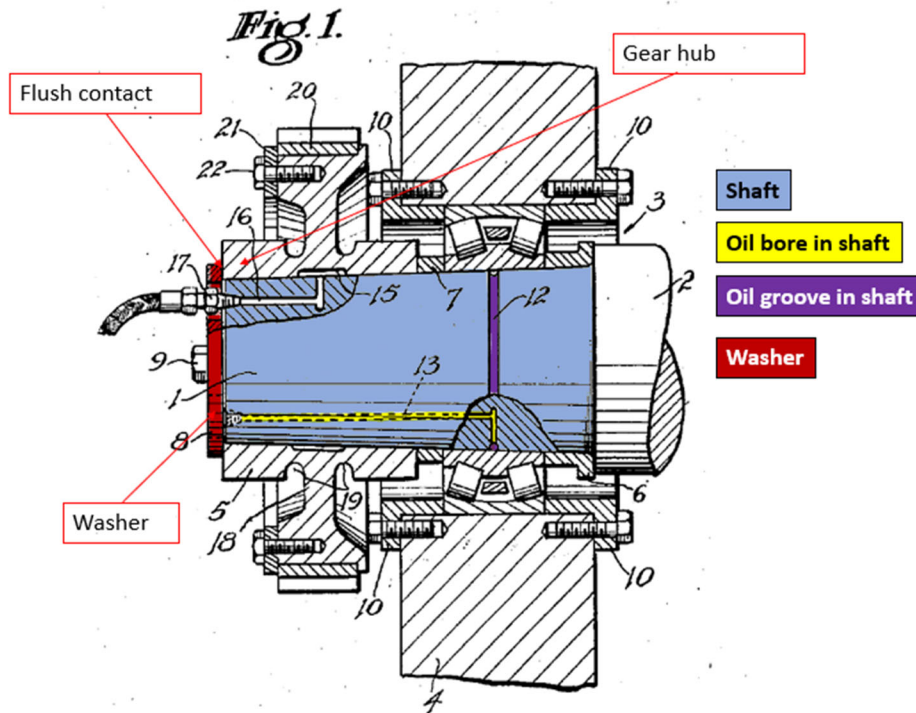


(*Id.*, FIG. 3 (annotated).)

56. An oil groove 15 is indented into the gear hub, as depicted above, and radially aligned with the web 18. (*Id.* 2:32–43.) Oil can be provided to the groove 15 via a bore 16 (yellow) in the shaft, and when a sufficiently high pressure is achieved, the gear hub bends at grooves 19 on either side of web 18 to lift the gear hub from the shaft, allowing it to be installed or removed. (*Id.* 2:32–51.)

57. Harless discloses a washer 8 positioned flush against and in contact with the end of the gear hub 40. (Ex. 1033, FIGS. 1, 7.) FIG. 1 (below) is representative of the positioning of the end retainer relative to the end of the gear hub 40 in Harless. Nothing in Harless discloses that the washer 8 (red) includes a

recess extending circumferentially at the perimeter region to allow axial movement of the shaft sleeve into the recess.



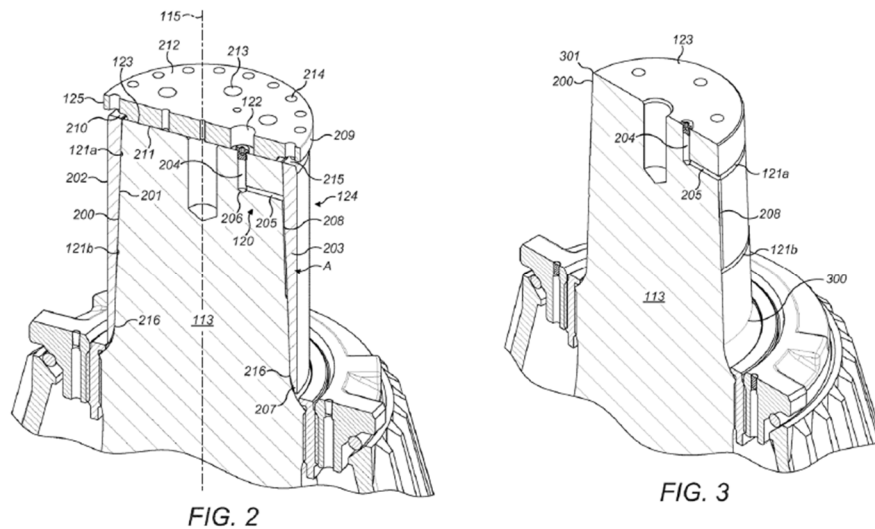
(Id., FIG. 1 (annotated).)

IX. ANALYSIS OF THE ASSERTED PRIOR ART REFERENCES

- A. The Ground Does Not Disclose Or Suggest “an axial region of the shaft body *extending from the second end and being tapered relative to a longitudinal axis of the shaft body such that a cross sectional area of the shaft body at the tapered axial region decreases in a direction from the first end to the second end*”

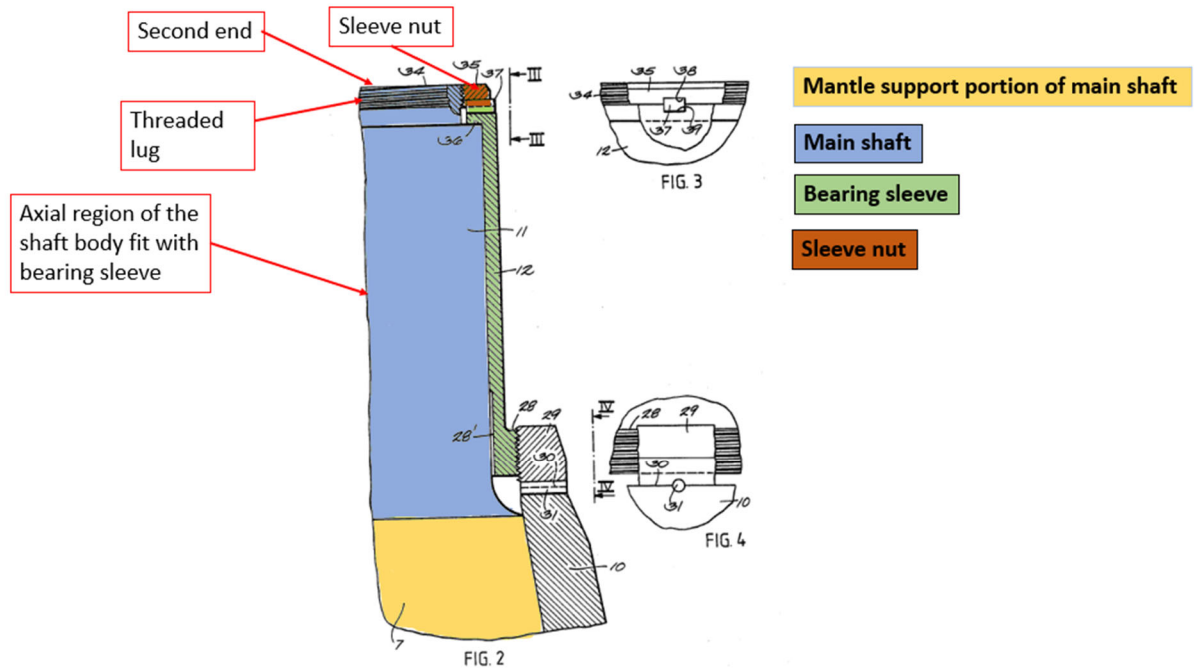
58. Petitioner and Mr. Smith allege that the combination of Polinski and Piepho discloses “an axial region of the shaft body *extending from the second end and being tapered relative to a longitudinal axis of the shaft body such that a cross sectional area of the shaft body at the tapered axial region decreases in a direction*

59. Neither Polinski nor Piepho discloses this claim limitation. Rather, both Polinski and Piepho disclose threaded regions extending from the upper end of the shaft. Polinski discloses a shaft that has a threaded lug 34 extending from its second end. That is, the top of the threaded lug 34 defines the “second end” of Polinski’s shaft body. The threaded lug extends from the second end to a bearing journal 11. (Ex. 1017, 3:23–25.) The threaded lug is adapted to receive a sleeve nut 35 of a sleeve 12. (*Id.*, 3:15–48.) The sleeve nut, in turn, secures annular lip 36



(Ex. 1001, FIGS. 2–3.)

of sleeve 12 to the journal 11 of the shaft 7. (Ex. 2001, ¶ 28; Ex. 1017, 2:30–47, 3:15–47.) This arrangement places sleeve nut 35 in contact with annular lip 36 of sleeve 12, securing the sleeve 12 to the bearing journal 11.

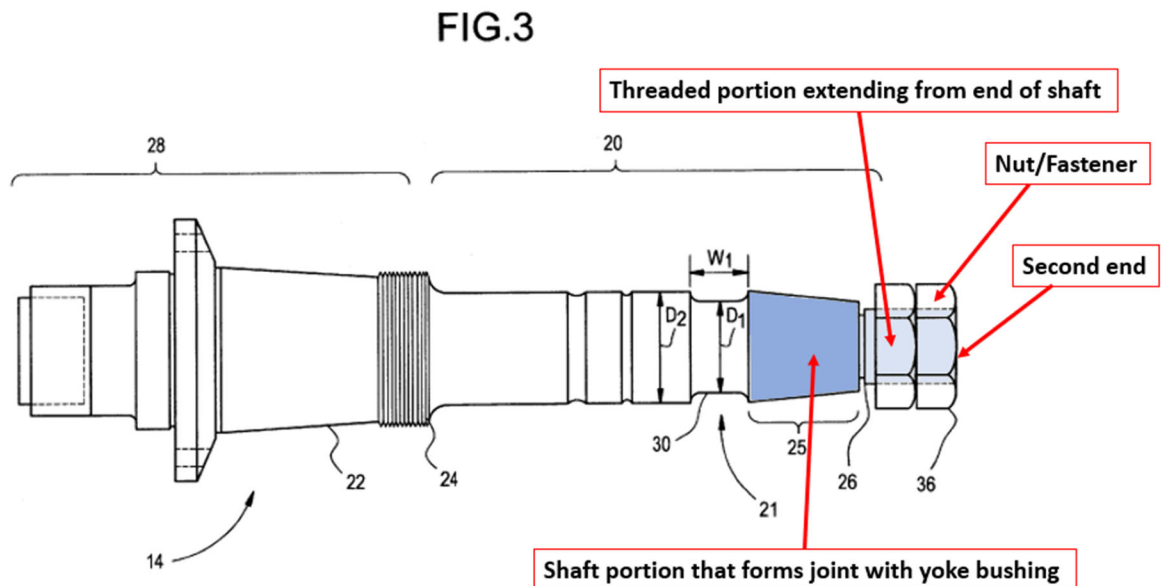


(Ex. 1017, FIG. 2 (annotated).)

60. As shown in annotated FIG. 2 of Polinski above, the annular lip 36 of the sleeve 12 is held against the upper marginal edge surface of the shaft 7 by the sleeve nut 35 which is in turn rigidly coupled to the sleeve 12 by at least one key 37 welded in a corresponding pair of keyways 38 and 39 spaced about the peripheries of the sleeve nut and the sleeve. (*Id.*, 3:28–33.) The threaded lug 34, along with sleeve nut 35, thus secure the sleeve 12 to the journal 11. Nothing in FIG. 2 nor elsewhere in Polinski discloses or suggests an axial region of the shaft

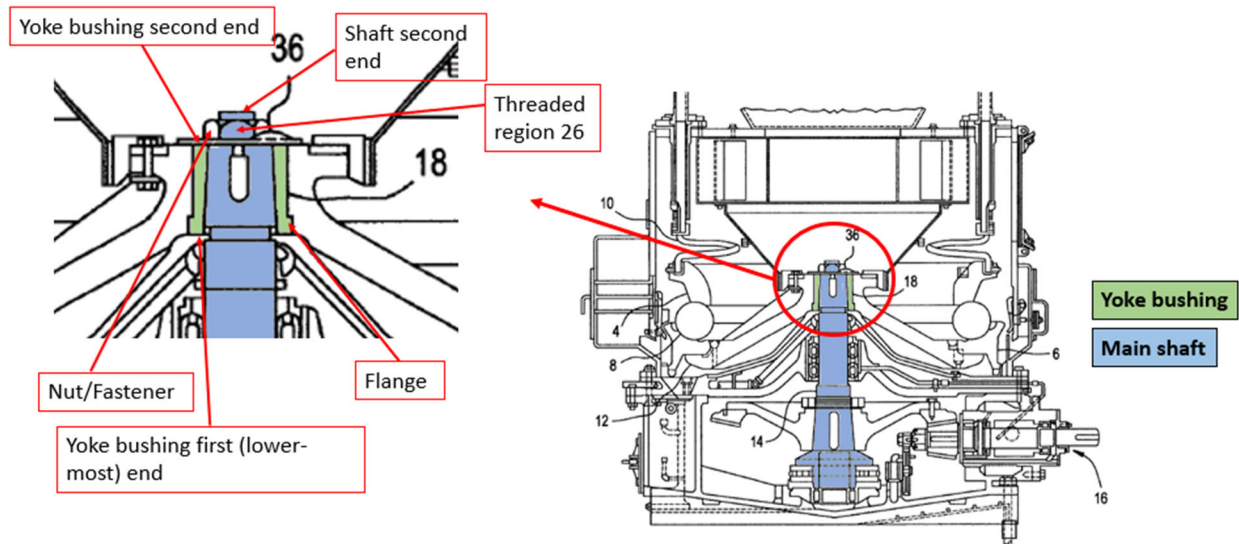
body extending from the second end and being tapered relative to a longitudinal axis of the shaft body. (*See id.*)

61. Piepho likewise includes a threaded non-tapered portion extending from its second end, and thus does not disclose or suggest an axial region of the shaft body extending from the second end and being tapered relative to a longitudinal axis of the shaft body. Figure 3 of Piepho, shown below, depicts an axial region being tapered relative to a longitudinal axis of the shaft body (region labeled 25). However, the tapered region 25 does not extend from the end of Piepho's shaft. Instead, a threaded region labeled 26 extends from the second (top) end of the shaft disclosed by Piepho between the top end and the tapered portion 25.



(Ex. 1018, FIG. 3.)

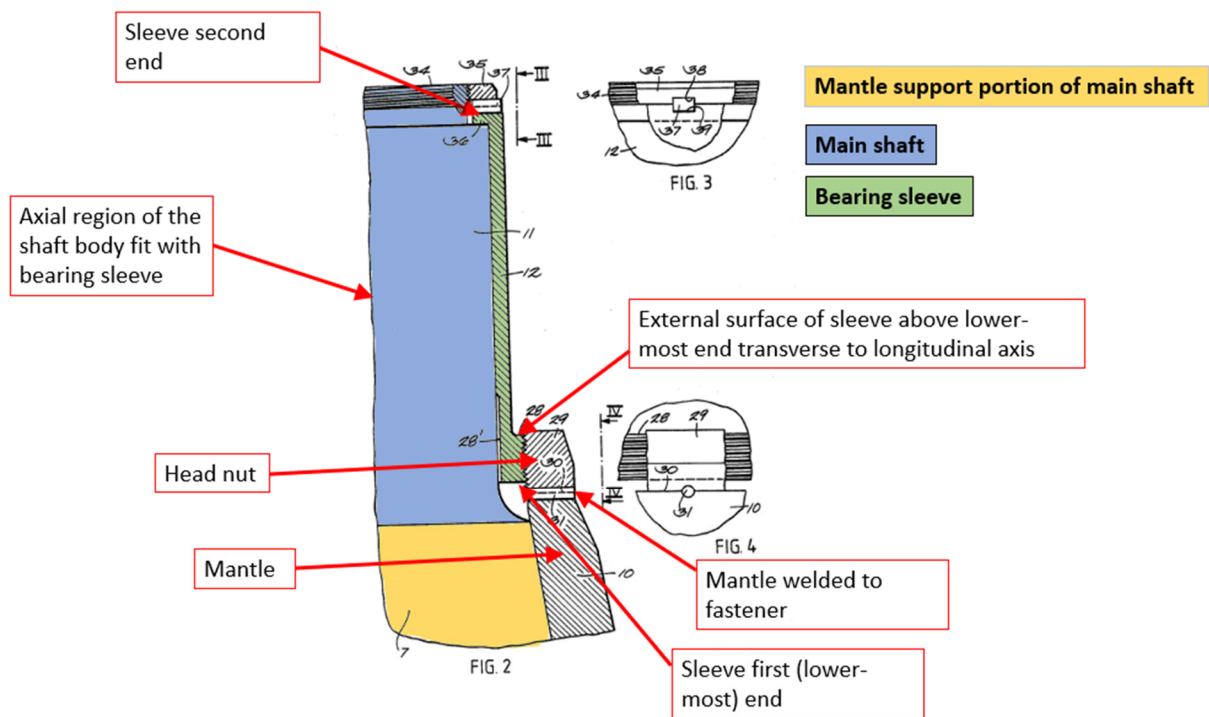
62. FIG. 1 of Piepho, below, shows that the cylindrical region 26 extends above the yoke and is connected to an element labeled 36. A POSITA would understand that element 36 is a fastener secured to the cylindrical portion 26 of the shaft to secure the yoke to the shaft of the coal pulverizer. Mr. Smith agreed that the region labeled 26 is a threaded region used to attach the yoke. (Ex. 2011, 77:18–78:1.)



(Ex. 1018, FIG. 1.)

63. Thus, neither Polinski nor Piepho, taken both alone and in combination, disclose “an axial region of the shaft body extending from the second end and being tapered relative to a longitudinal axis of the shaft body such that a cross sectional area of the shaft body at the tapered axial region decreases in a direction from the first end to the second end,” as recited in claims 1, 9, and 14.

64. Moreover, there is no motivation to modify Polinski to meet the above claim limitation because it would render Polinski's purported invention inoperable for its intended purpose. As discussed above, the threaded lug and sleeve nut secure the sleeve to the journal 11 of the shaft. This is necessary because Polinski's sleeve acts as an axial support for the mantle. Specifically, Polinski discloses that a sleeve 12, relied on by Petitioner for the sleeve recited in challenged claims 1, 9, and 14, includes a threaded shoulder 28 extending from the bottom end of the sleeve 12 for securing a mantle 10 to a tapered mantle support portion 8 of the shaft 7, as shown below in FIG. 2 of Polinski. (Ex. 1017, 3:1–8; *see also* Ex. 2011, 54:3–55:4.)



Ex. 1017, FIG. 2 (annotated).

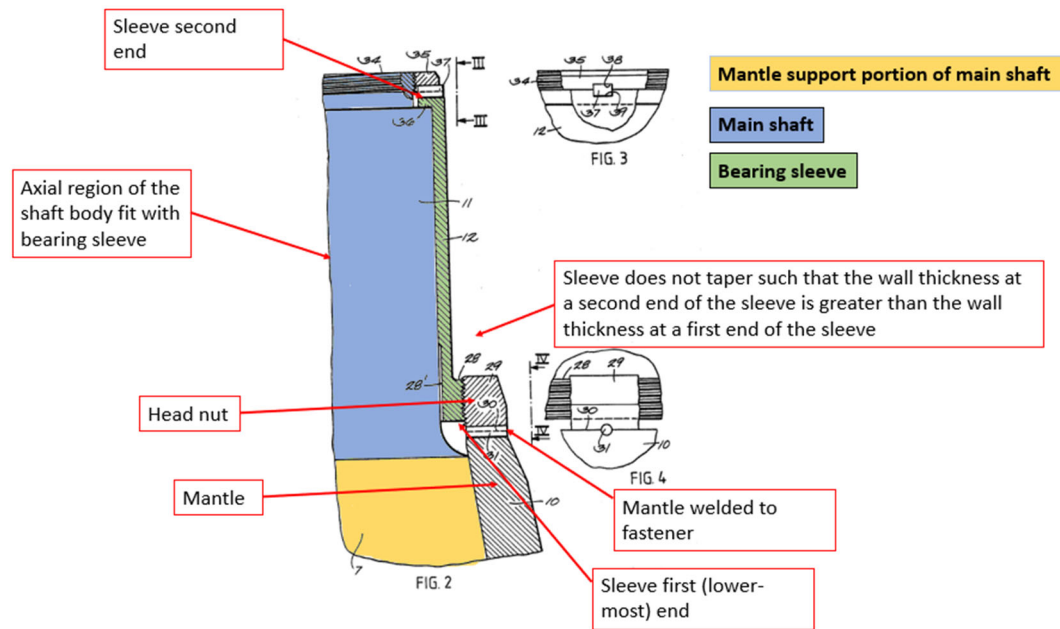
65. Torsional and axial loads on are exhibited on the sleeve via threaded shoulder 28. (*See* Ex. 1017, 2:67–3:47.) The sleeve nut 35 and threaded lug 34 counteract these loads to maintain the sleeve 12 on the shaft and prevent excessive rotation or axial motion. (*See* Ex. 1017, 3:1-47.) Modifying Polinski to remove the threaded lug such that a tapered axial region extends from the second end would render the purported invention of Polinski—the ability to secure the crusher mantle to the shaft 7 using the sleeve 12—inoperable because the sleeve would lack a support at the upper end to counteract the axial and torsional forces exhibited on the sleeve by the crusher mantle during operation.

B. The Ground Does Not Disclose Or Suggest “the sleeve having a tapered wall thickness, such that the wall thickness at a second end of the sleeve is greater than the wall thickness at a first end of the sleeve”

66. Petitioner and Mr. Smith allege that the combination of Polinski and Piepho discloses a “sleeve having a tapered wall thickness, such that the wall thickness at a second end of the sleeve is greater than the wall thickness at a first end of the sleeve,” as recited in claims 9 and 14. As I discussed above, the first end of the sleeve is the outermost extremity of the sleeve at the lower end.

67. The asserted ground fails to disclose or suggest “the sleeve having a tapered wall thickness, such that the wall thickness at a second end of the sleeve is greater than the wall thickness at a first end of the sleeve.” Polinski’s sleeve is not

tapered. Polinski discloses that a sleeve 12, relied on by Mr. Smith and Petitioner for the sleeve recited in challenged claims 9 and 14, includes a threaded shoulder 28 extending from the bottom end of the sleeve 12 for securing a mantle 10 to a tapered mantle support portion 8 of the shaft 7, as shown below in FIG. 2 of Polinski. (Ex. 1017, 3:1–8.)

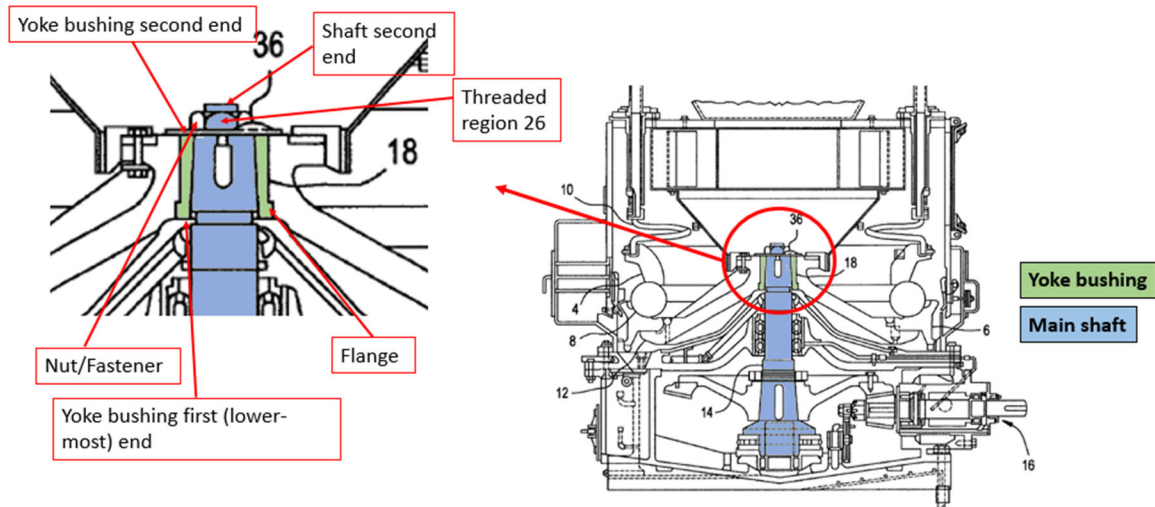


Ex. 1017, FIG. 2 (annotated).

68. As illustrated in FIG. 2 above, Polinski’s sleeve does not have a wall thickness that is tapered “such that the wall thickness at a second end of the sleeve is greater than the wall thickness at a first end of the sleeve.” Rather, the thickness of the sleeve increases at the first end due to the threaded shoulder 28.

69. Piepho also fails to disclose this claim limitation. Piepho discloses a yoke bushing 18 that is tapered on its internal facing surface. However, Piepho’s

sleeve is not tapered “such that the wall thickness at a second end of the sleeve is greater than the wall thickness at a first end of the sleeve,” as required by claims 9 and 14. Rather, Piepho discloses a flange extending from the lowermost end of a yoke bushing 18, shown in annotated FIG. 1 of Piepho below.



(Ex. 1018, FIG. 1 (annotated).)

70. Moreover, a POSITA would not have been motivated to modify Polinski in view of Piepho or Harless to meet the limitation “the sleeve having a tapered wall thickness, such that the wall thickness at a second end of the sleeve is greater than the wall thickness at a first end of the sleeve,” as recited in claims 9 and 14. Such a modification would change Polinski’s principle of operation. Polinski states that “[t]he present invention relates to gyratory crushers and, in particular, to a main shaft and bearing sleeve arrangement supporting the crusher head or mantle within the crusher.” (Ex. 1017, 1:44–47.) To that end, Polinski

discloses a sleeve with a threaded annular shoulder 28 that receives a head nut 29 to secure the crushing mantle 10 to the tapered portion of the main shaft 7. (Ex. 1017, 3:1–9; *see also* Ex. 2011, 54:3–55:4.)

71. To achieve the limitation “the sleeve having a tapered wall thickness, such that the wall thickness at a second end of the sleeve is greater than the wall thickness at a first end of the sleeve,” the threaded shoulder 28 that is used to secure, via head nut 29, the mantle 10 to a tapered mantle support portion 8 of the shaft 7 must be reduced in thickness or eliminated. However, a POSITA would not be motivated to make such a change. Mr. Smith admits, Polinski’s design rests on engagement of the sleeve’s threaded shoulder 28 with head nut 29:

Q. Based on your understanding of Polinski, how does it describe the removal of abrupt structural discontinuities in the normally high stress regions of the main shaft?

A. So based on my understanding, Polinski adds the threads to the lower portion of the sleeve that fits over the shaft. And the mantle attaches to those threads, rather than directly to the shaft. (Ex. 2011, 53:20–54:2.)

72. Thus, to eliminate the threaded shoulder 28 of Polinski’s sleeve would change the very principle of operation of Polinski’s purported invention and would not have been obvious to a POSITA.

73. Nor would it have been obvious to modify Polinski to reduce the thickness of the threaded shoulder 28 because this would significantly increase the likelihood that the connection between the sleeve and mantle would fail. A POSITA would recognize that the threaded shoulder adds significant stiffness to the sleeve where it connects the mantle and would expect that stiffness to be required for load transfer through the joint. Additionally, it is well known that threads reduce the tensile strength of a threaded object relative to the object of the same size. (*See Ex. 2015, 411.*) Reducing the thickness at the threaded shoulder 28 such that the external facing surface of Polinski's sleeve is parallel to its longitudinal axis would significantly increase the likelihood that the sleeve would fail during operation.

74. If the thickness of the shoulder were reduced to align with the remainder of the sleeve axial wall, the threads in the shoulder 28 would not only reduce the material available to carry stress, but also introduce a stress concentration at the thread runout location (i.e., where the threads end) adding another potential failure location. (*See Ex. 2015, 444; see also Ex. 2016, 20–21.*) The larger diameter shoulder in Polinski allows for the shoulder to be fully threaded with no thread runout stress concentration.

75. Moreover, removal of the threaded shoulder present in Polinski would result in more of the load in the threaded connection being concentrated on the first

engaged thread. The additional material provided by the shoulder 28 relative to the remainder of the sleeve's axial wall is needed to distribute the stresses exerted on the sleeve by the mantle. The design threaded connection geometry to distribute stress between threads is well understood and is especially useful in cyclic loading scenarios in which fatigue failure is a concern. (*See* Ex. 2017, 412, 450.)

76. Finally, the additional thickness could not be added to the internal facing surface of Polinski's sleeve. This would render it impossible to mount the sleeve on the shaft. The threaded shoulder is a core feature of Polinski's disclosure that a POSITA, with two years of industry experience, would not be motivated to remove.

C. There Would Have Been No Motivation To Include At Least One Groove In Polinski

77. It would not have been obvious to modify Polinski in view of Piepho and Harless to include at least one groove indented at the external surface—as properly construed—and in a tapered axial region of the shaft, as asserted by Petitioner. As discussed above, Polinski teaches that its invention lies in removing structural discontinuities from high stress regions of the shaft, as follows.

[T]he invention contemplates an arrangement wherein abrupt structural discontinuities in the normally high-stressed regions of the main shaft have been essentially eliminated [by instead cutting threads into the sleeve] to minimize the development of fatigue fractures in the shaft while at the same time providing an arrangement which can be easily maintained and repaired in the field. (Ex. 1017, 1:61–67.)

78. The region of the shaft disclosed by Polinski, referred to in Polinski as the bearing journal 11 (the region fit with sleeve 12), is subjected to “substantial stresses generated by the cyclic bending loads applied to the shaft by the mantle during operation of the crusher.” (*Id.* 1:26–29.) Polinski teaches that the relatively abrupt changes in the cross-sectional area of the shaft above and below the threaded section have resulted in high local stress concentrations in these regions of the shaft. Adding an oil groove to the bearing journal would have a similar effect to the threads described by Polinski. This would have been evident to a person of ordinary skill in the art.

79. For example, Shigley’s *Mechanical Engineering Design* (“Shigley”) provides that “[a]ny discontinuity in a machine part alters the stress distribution in the neighborhood of the discontinuity so that the elementary stress equations no longer describe the state of stress in the part at these locations. Such discontinuities are called *stress raisers*, and the regions in which they occur are called areas of *stress concentration*.” (Ex. 2003, 110 (emphasis in original).) *Shigley’s* further provides that irregularities not inherent in a member, such as grooves, result in stress concentrations. (*See id.*) Specifically, Shigley provides that “[s]tress concentrations can also arise from some irregularity not inherent in the member, such as tool marks, holes, notches, grooves, or threads.” (*Id.*)

80. *Shigley*'s instructs that while ductile materials under static loading are not typically at high risk of fracture due to stress raisers and corresponding stress concentrations, ductile materials are at risk of brittle fracture under *cyclic loading*. (*See id.*, 112.) *Shigley* specifically provides that “[f]or *dynamic loading*, the stress concentration effect is significant for *both* ductile and brittle materials and must always be taken into account.” (*Id.* (emphasis in original).) As noted above, the Polinski shaft is subjected to cyclic (i.e., dynamic) loading. Thus, the Polinski shaft is at risk of brittle failure (e.g., fracture) resulting from stress concentration induced by stress raisers, such as oil grooves.

81. Cutting oil grooves into the Polinski shaft in the bearing journal 11 would introduce stress raisers and corresponding stress concentrations into the shaft, thus increasing the chance of fracture, precisely what Polinski aims to prevent by removing threads from the shaft. Given Polinski's teaching that discontinuities should be removed from high-stress regions of the shaft, a POSITA would not have been motivated to one or more a grooves in the journal 11 of the shaft body of Polinski.

82. Moreover, a POSITA would not be motivated to incorporate a groove into the shaft of Polinski as modified by the proposed combination with Piepho at least for the additional reason that incorporating such a groove would increase the likelihood of fretting wear and fretting induced fatigue failure. Fretting wear is

caused by relative motion between bodies in contact, such as the tapered end of the shaft and the yoke bushing disclosed by Piepho. (*E.g.*, Ex. 1018, 1:51–55.)

83. Polinski is also concerned with mitigating the risk of fretting wear. (Ex. 1017, 3:9–14.) Incorporating a groove into the tapered portion of the shaft disclosed by the purported combination of Polinski and Piepho would lead to increased fretting wear due to increased relative motion (*e.g.*, slip) between the shaft and sleeve at the edges of the contact region defined by the grooves. (Ex. 2001, ¶¶ 54–58; Ex. 2004, 593–595.)

84. Mr. Smith agreed that incorporating grooves to the shaft in a region fit to a sleeve with an interference fit would both add edges along the contact region and increase the likelihood of fretting wear:

Q. And specifically, do you agree that fatigue failure is most likely to occur at edges of contact area between two surfaces?

A. I think that's a reasonable statement.

Q. And would you agree that adding grooves to a shaft in a region fit to a sleeve with an interference fit, would add edges along the contact region?

A. I expect that that would create an edge in a contact region.

Q. Okay. And do you agree that adding such grooves would increase the likelihood of fretting?

A. I think it's possible. I'm not sure that it would lead to a failure, but it would likely increase the likelihood of fretting. (Ex. 2011, 75:3–16.)

85. Thus, introducing a groove would further exacerbate the fatigue failure problem that Polinski attempts to solve by placing threads in the sleeve shoulder, rather than the shaft. A POSITA would not be motivated to introduce grooves into the shaft of Polinski in view of Piepho and Harless for at least these reasons.

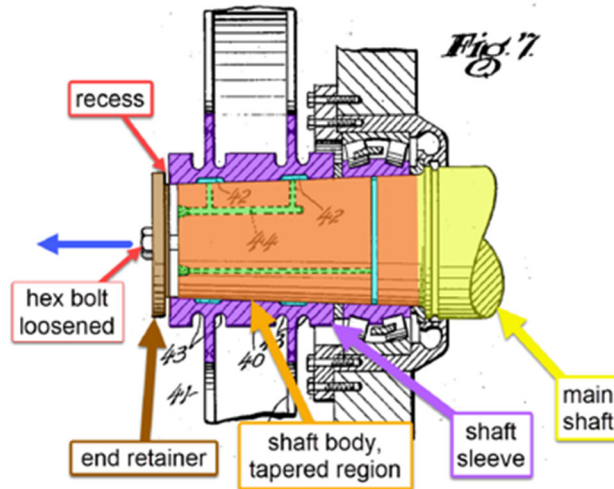
86. Moreover, the increased risk of shaft failure posed by the addition of oil grooves—particularly given the specific concerns with shaft failure addressed by the purported inventions in Polinski and Piepho—would dissuade a designer from incorporating them in order to realize unproven benefits with respect to making and breaking interference fits, especially given the lack of guidance or support in the prior art. (See Paper 2, 21.) Whatever advantages that a groove in a shaft may provide, the designer would need to ensure that those benefits outweighed the heightened risk of *shaft failure*. Because such failure would be an existential threat, it would be a front and center consideration for the POSITA. Mr. Smith agrees. On cross-examination, he admitted that “if you are experiencing a lot of shaft failures, then it becomes a *major concern*” and that “you would want to design it in a way that the shaft fails less often.” (Ex. 2011, 44:5–16.)

87. Moreover, a POSITA, with limited experience and facing a “fairly complex machine” (Ex. 1002, ¶ 27), would be particularly reluctant to introduce a modification that risks undermining the benefits provided by the purported inventions in Polinski and Piepho. A POSITA would know that fatigue is a complicated failure mechanism that is difficult to predict analytically. Fatigue testing is difficult to setup and run and requires many samples to generate meaningful data. Moreover, a strong understanding of the fatigue loading conditions is required to evaluate fatigue, but a POSITA would have difficulty predicting the fatigue loads to use in this scenario to run the analysis. For these reasons, A POSITA would be reluctant to modify Polinski in a way that would compromise the fatigue life of the shaft given Polinski’s (and Piepho’s) core focus is preventing such fatigue failure.

D. The Ground Does Not Disclose Or Suggest The Recess Of Claim 11

88. Claim 11 recites “wherein the end retainer includes a recess extending circumferentially at the perimeter region to allow axial movement of the sleeve into the recess.” (Ex. 1001.) As I discussed above, Harless, cited by Petitioner for a washer 8 purportedly acting as an end retainer, fails to disclose or suggest the above limitation. Petitioner asserts that the recess is present when bolts 9 used to attach the washer 8 to the shaft in Harless are loosened (Paper 2, 39–40; Ex. 1033, 3:16–22.) In support of Petitioner’s position, Petitioner modified FIG. 7 of Harless

to illustrate a purported “recess” after the bolts 9 have been backed off, shown in the figure below:



(Paper 2, 39–40.)

89. As shown, Petitioner colors in lines below the washer 8 to illustrates an “undercut,” which Petitioner asserts is a portion of the retainer that allows it “to seat itself in a centered condition.” (Paper 2, 39.) However, Harless never identifies this unlabeled region as an undercut shoulder in washer 8, nor does it disclose any movement of the washer away from the gear hub when bolts 9 are backed off. (*See* Ex. 1033, 3:16–22.) Mr. Smith and Petitioner merely speculate as to the nature of the lines between the washer 8 and the shaft end and select an interpretation that purportedly discloses a recess when FIG. 7 is modified. To that point, on cross-examination, Mr. Smith admitted he did not know what the lines in FIG. 7 of Harless indicate. (Ex. 2011, 88:3–8; 89:22–90:1.) Thus, Petitioner's

ground is not based on the disclosure of Harless—rather it is based on a speculative interpretation of ambiguous drawings.

* * *

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 that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code.

Dated: June 24, 2025



Harri Kytömaa, Ph.D.