

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

FOURTH 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 Patent Owner’s Revised Contingent Motion to Amend (“Revised Motion”) 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 initial 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 declarations (Kytömaa I, Ex. 2001; Kytömaa II, Ex.

2007; Kytömaa III, Ex. 2010) 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); and
- 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).
- Preliminary Guidance on Patent Owner’s Motion to Amend (Paper 24), dated October 16, 2025;
- Second Declaration of David Smith (Ex. 1044);
- Richard G. Budynas & J. Keith Nisbett, *Shigley’s Mechanical*

Engineering Design, Ninth Edition (Ex. 1049);

- Second Deposition Transcript of David Smith, Dated October 24, 2025 (Ex. 2019).

IV. DEFINITIONS AND STANDARDS

5. Although I am not a lawyer and will not provide legal opinions, I have been advised to apply certain legal standards, such as relating to claim construction and obviousness, in forming my opinions. I set forth my understanding of those legal standards in Kytömaa I. (*See* Ex. 2001, ¶¶ 16–19.) In Kytömaa II, at ¶ 5, I stated that “claims are to be given their broadest reasonable construction consistent with the specification.” This was incorrect. As I correctly stated in Kytömaa I, at ¶ 17, and Kytömaa III, at ¶ 5, the proper standard for construing claims during an *inter partes* review is the *Phillips* standard. Under this standard, a claim term presumptively receives its plain and ordinary meaning to a person of ordinary skill in the art. I have been further informed that claim construction begins with the language of the claim, the specification, and the prosecution history, but that extrinsic evidence including dictionary definition and expert testimony may also be considered. The incorrect statement in Kytömaa II at ¶ 5 did not in any way impact my conclusions in that declaration, because the remainder of the declaration makes clear that I applied the *Phillips* standard.

V. LEVEL OF ORDINARY SKILL IN THE ART

6. 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.) For the purposes of this Declaration, I do not object to Mr. Smith’s position on the level of skill in the art. I meet and exceed the defined level of skill of a person of ordinary skill for the reasons set forth in my third declaration (Kytömaa III). (*See* Ex. 2010, ¶¶ 13–30.)

VI. THE SUBSTITUTE CLAIMS ARE SUPPORTED BY THE ORIGINAL DISCLOSURES AND DO NOT INTRODUCE NEW MATTER

7. In Kytömaa III, I provided my analysis in terms of written description support and patentability for a set of substitute claims. I understand that a new set of substitute claims is being submitted. My analysis below is for the new set of substitute claims.

8. The ’090 patent issued from U.S. App. No. 15/035,774 (the “’774 application”; Ex. 2009). The ’774 application is a national stage entry of PCT/EP2014/060594 (Ex. 2014), filed on May 23, 2014, and claims priority to EP Application No. 13192402.9 (Ex. 2008), filed on November 12, 2013. The

originally filed disclosures (Exs. 2008 and 2009) support each substitute claim and make clear that no new matter has been introduced. The left column of the chart below shows the substitute independent claims in comparison to the challenged independent claims, with added limitations underlined and deleted limitations with strikethroughs. The right column shows exemplary support in the original disclosure—first with respect to the limitations of the challenged independent claims and then for the newly added limitations.

Substitute Independent Claims	Support in EP Application No. 13192402.9 (Ex. 2008) and the '774 Application (Ex. 2009)
15. A gyratory crusher main shaft of a crusher comprising: [15a] a shaft body having a radially outward facing external surface, and a first end and a second end, <u>wherein the second end is an uppermost extremity of the shaft body</u>; [15b] 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; [15c] a shaft sleeve mounted on the tapered axial region; and [15d] <u>at least one groove a plurality of grooves</u> indented at the external surface and positioned at the tapered axial region, the ~~at least one groove~~ <u>plurality of grooves</u> being arranged to receive a pressurized fluid to facilitate	<u>'090 patent claim 1</u> Exs. 2008 & 2009: 3:20–29; FIGS. 1–3. [15a] “a shaft body having a radially outward facing external surface, and a first end and a second end, <u>wherein the second end is an uppermost extremity of the shaft body</u>” Exs. 2008 & 2009: claims 1–2; 8:17–23; FIGS. 1–4. [15d]: “~~at least one groove~~ <u>a plurality of grooves</u> indented at the external surface and positioned at the tapered axial region, the ~~at least one groove~~ <u>plurality of grooves</u> being arranged to receive a pressurized fluid to facilitate mounting and dismounting of the shaft sleeve at the shaft body” Exs. 2008 & 2009: 5:1; FIGS. 3–4.

mounting and dismounting of the shaft sleeve at the shaft body.	
21. A gyratory crusher main shaft assembly for a crusher comprising: [21a] a shaft body having a radially outward facing external surface, and a first end and a second end, <u>wherein the second end is an uppermost extremity of the shaft body</u>; [21b] 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, [21c] a shaft sleeve mounted on the tapered axial region, and [21d] 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; ~~and~~ [21e] <u>wherein the shaft [[a]] sleeve is fitted over the tapered axial region, the shaft sleeve having a tapered wall thickness, such that the wall thickness at a second end of the shaft sleeve is greater than the wall thickness at a first end of the shaft sleeve, wherein the first end of the shaft sleeve is a lowermost extremity of the shaft sleeve.</u>	<u>'090 patent claim 9</u> Exs. 2008 & 2009: 3:20–29; 5:18–22; FIGS. 1–3. [21a] “a shaft body having a radially outward facing external surface, and a first end and a second end, <u>wherein the second end is an uppermost extremity of the shaft body</u>” Exs. 2008 & 2009: claims 1–2; 8:17–23; FIGS. 1–4. [21e] <u>wherein the shaft [[a]] sleeve is fitted over the tapered axial region, the shaft sleeve having a tapered wall thickness, such that the wall thickness at a second end of the shaft sleeve is greater than the wall thickness at a first end of the shaft sleeve, wherein the first end of the shaft sleeve is a lowermost extremity of the shaft sleeve.</u> Exs. 2008 & 2009: 8:20–23; FIGS. 1–2.
26. A gyratory crusher comprising: [26a] a main shaft including a shaft	<u>'090 patent claim 14</u> Exs. 2008 & 2009: 3:20–29; 5:19–20;

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, <u>wherein the second end is an uppermost extremity of the shaft body;</u> [26b] 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; [26c] a sleeve fitted over 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, <u>wherein the first end of the sleeve is a lowermost extremity of the sleeve;</u> and [26d] 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 sleeve at the shaft body, [26e] <u>wherein the sleeve is configured such that when positioned on the shaft body, the sleeve is separated from and not fastened to a crushing head and a crushing shell.</u>	6:18–19; FIGS. 1–3. [26a] “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, <u>wherein the second end is an uppermost extremity of the shaft body</u>” Exs. 2008 & 2009: claims 1–2; 8:17–23; FIGS. 1–4. [26c] a sleeve fitted over 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, <u>wherein the first end of the sleeve is a lowermost extremity of the sleeve</u> Exs. 2008 & 2009: 8:20–23; FIGS. 1–2. [26e]: “<u>wherein the sleeve is configured such that when positioned on the shaft body, the sleeve is separated from and not fastened to a crushing head and a crushing shell of the crusher</u>” Exs. 2008 & 2009: 7:11–13; FIGS. 1–2.
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The chart below shows the exemplary support for the substitute dependent claims.

Substitute Dependent Claims	Support in EP Application No. 13192402.9 (Ex. 2008) and the '774 Application (Ex. 2009)
Claim 16 (dependent on claim 15)	“wherein the plurality of grooves comprise a first groove and a second groove, wherein the first groove is positioned closer to the second end relative to the second groove, and wherein the shaft body further comprises an oil path consisting of: a fluid inlet positioned at the second end; the first groove; the second groove; an axially extending channel indented at the external surface of the shaft body to couple the first groove and the second groove in fluid communication; and an internal oil path extending within the shaft body only to the first groove, the internal oil path consisting of: a first conduit extending axially toward the first end from the fluid inlet; and a second conduit extending from the first conduit toward the radially outward facing external surface of the shaft body to the first groove.” Exs. 2008 & 2009: 4:9–23; 5:4–16; 10:1–9; claim 7; FIGS. 1–4.
Claim 17 (dependent on claim 15)	“wherein the first groove is positioned on a first side of a cross-sectional area center of the shaft sleeve relatively closer to the second end and the second groove is positioned on a second side of a cross-sectional area center of the shaft sleeve relatively further from the second end” Exs. 2008 & 2009: 5:4–16; 10:5–9; FIGS. 3–4.

Claim 18 (dependent on claim 15)	Exs. 2008 & 2009: 4:25.
Claim 19 (dependent on claim 15)	Exs. 2008 & 2009: 4:25–27.
Claim 20 (dependent on claim 15)	“wherein the shaft sleeve is configured such that when positioned on the shaft body, the shaft sleeve is separated from and not fastened to a crushing head and a crushing shell” Exs. 2008 & 2009: 7:11–13; FIGS. 1–2.
Claim 22 (dependent on claim 21)	Exs. 2008 & 2009: 5:24–30.
Claim 23 (dependent on claim 21)	Exs. 2008 & 2009: 6:1–3.
Claim 24 (dependent on claim 21)	“wherein the at least one groove comprises a first groove and a second groove, wherein the first groove is positioned closer to the second end relative to the second groove, and wherein the shaft body further comprises an oil path consisting of: a fluid inlet positioned at the second end; the first groove; the second groove; an axially extending channel indented at the external surface of the shaft body to couple the first groove and the second groove in fluid communication; and an internal oil path extending within the shaft body only to the first groove, the internal oil path consisting of: a first conduit extending axially toward the first end from the fluid inlet; and a second conduit extending from the first

	conduit toward the radially outward facing external surface of the shaft body to the first groove” Exs. 2008 & 2009: 4:9–23; 5:4–16; 10:1–9; claim 7; FIGS. 1–4.
Claim 25 (dependent on claim 21)	“wherein the shaft sleeve is configured such that when positioned on the shaft body, the shaft sleeve is separated from and not fastened to a crushing head and a crushing shell” Exs. 2008 & 2009: 7:11–13; FIGS. 1–2.

VII. CLAIM CONSTRUCTION OF “INDENTED AT THE EXTERNAL SURFACE”

9. The independent claims recite “at least one groove indented at the external surface,” where “the external surface” refers to the shaft body. (*See, e.g.*, Ex. 1001, 7:3–4, 11.) “Indented” means “impressed, struck, or dented in, so as to make a depression or hollow in a surface.” (Ex. 2013, 846 (definition of “indented”)). The claim language thus requires a depression or hollow in a surface, i.e., the claimed external surface of the shaft body.

10. This straightforward reading of the claim language is consistent with the phrase “at the external surface” in the Summary of the Invention.

The subject invention provides for the convenient and efficient mounting and dismounting of the sleeve at the main shaft by virtue of the combination of the fluid filled *grooves or channels, at the external surface of the main shaft* and the radially tapered end section of the

main shaft onto which the sleeve is mounted. ... The conical profiled and *grooved main shaft section* in combination with a corresponding tapered sleeve is therefore advantageous.¹ (Ex. 1001, 2:46–58; *see also* Abstract.)

11. The specification thus explicitly explains that “grooves at the external surface of the main shaft” result in a “grooved main shaft section.” Grooves at the external surface of the main shaft do *not* result in a grooved sleeve.

12. The prosecution history also supports Sandvik’s construction is correct. Although I am not a patent lawyer, I understand that, to overcome prior art rejections, Sandvik argued that the claims require “a groove being *in[d]ent[t]ed/recessed into the external surface* of the main shaft” “as opposed to being recessed into the sleeve.” (Ex. 1001-1, Amendment dated January 25, 2019, 6; Paper 15, 10, 22–23.)

13. I understand that Petitioner and Mr. Smith rely on one dictionary definition (among multiple definitions) of “at” to argue that a groove at the external surface of the shaft can mean a groove in the sleeve. (*See, e.g.*, Ex. 1044, ¶¶ 31–32.) Specifically, Dr. Smith includes definition 1a of “at” from Webster’s Third New International Dictionary (1993), which states: “used as a function word to indicate a presence in, on, or near.” (*Id.*, ¶ 31 (emphasis in original).) As I

¹ All emphases are added unless otherwise noted.

described above, a POSITA would understand that the specification and file history reject a groove in the sleeve.

14. I believe Petitioner misreads the following specification passage to argue that '090 discloses a groove “‘indented’ on the other side of the sleeve.”

According to a specific embodiment, the assembly may optionally comprise a fluid inlet conduit extending radially through the wall of the sleeve in fluid communication with the grove to allow a fluid to be supplied to the groove through the sleeve.

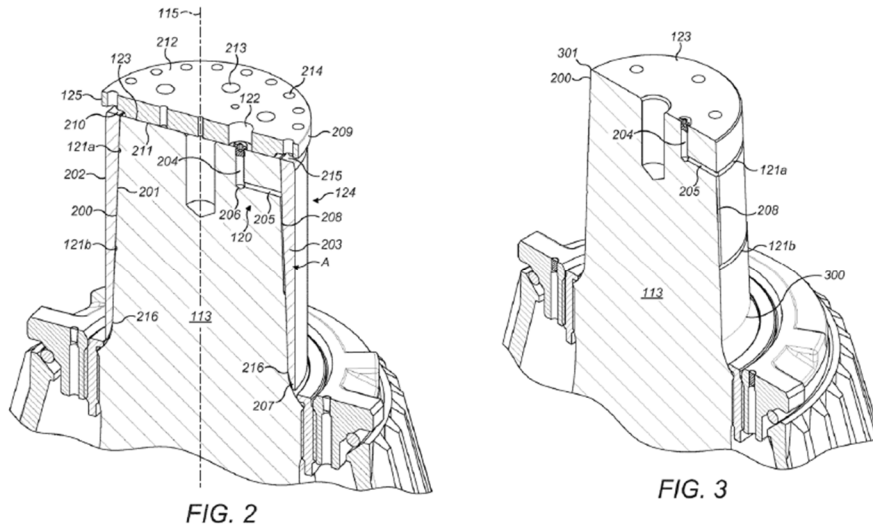
15. Ex. 1044 at ¶¶ 40–41 (quoting Ex. 1001, 4:13-18) (emphasis in original).) Because the sleeve is mounted on the tapered end of the shaft, e.g., Ex. 1001 at 2:46-52, the “other side of the sleeve” refers to the external surface of sleeve, such that the postulated groove would not assist with dismounting the sleeve from the shaft. The quoted passage also makes no reference to a groove on the sleeve at all. Rather, the passage discloses a fluid inlet through the sleeve, as an alternative embodiment to a fluid inlet at the end of the shaft for supplying fluid to the groove. The references to “the groove” in the quoted passage refer to the groove described in columns 3 and 4, which is exclusively described as being indented in the shaft.

VIII. THE SUBSTITUTE CLAIMS ARE PATENTABLE

A. Polinski, Harless, Yagi, and Piepho fail to disclose or suggest limitations [15a]-[15c] of substitute claim 15, [21a]-

[21c] of substitute claim 21, or [26a]-[26c] of substitute claim 26

16. Substitute claims 15–26 are patentable over the instituted ground in this trial, in my opinion. I understand that Petitioner has raised additional art, such as Yagi, in its opposition to Sandvik’s first Motion to Amend. I also understand that the Board addressed such additional art in its Preliminary Guidance. For completeness, I address such additional art below. Substitute claim 15, at [15a]-[15c], requires that an axial region of the shaft body extends from the uppermost extremity of the shaft body, that the axial region is 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, and that a shaft sleeve is mounted on the tapered axial region. Substitute claim 21 requires similar features at [21a]-[21c], and substitute claim 26 requires similar features at [26a]-[26c].

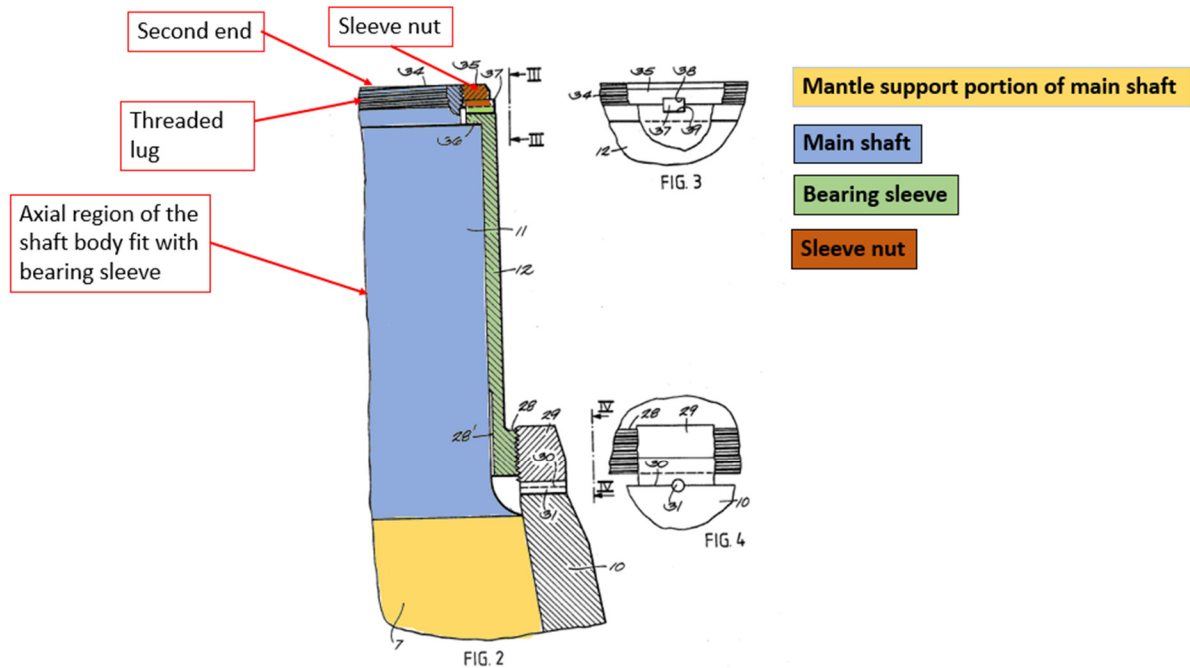


(Ex. 1001, FIGS. 2–3.)

17. As depicted in FIGS. 2 and 3 above, a tapered axial region 113 extends from the uppermost end surface 123 (uppermost extremity) of the shaft—the second end. The sleeve 124 includes a corresponding taper and is mounted on the tapered axial region 113 of the shaft body.

18. In the Petition, Petitioner challenged the issued claims based on the combination of Polinski (Ex. 1017) in view of Piepho (Ex. 1018) and Harless (Ex. 1033). I understand that Petitioner relied on Polinski (Ex. 1017) in view of Harless (Ex. 1033) and/or Yagi (Ex. 1040) in its Opposition (Paper 19) to Patent Owner’s Motion to Amend (Paper 14). The Preliminary Guidance (Paper 24) also referenced all four references. In any event, none of these references discloses or suggests [15a]-[15c], [21a]-[21c], and [26a]-[26c]. Polinski discloses a cylindrical journal 11 forming an upper region of a gyratory crusher main shaft 7. (Ex. 1017,

2:42–47.) A sleeve 12 having an inner cylindrical surface is fit via heat-shrink fit to the journal 11. (Ex. 1017, 3:15–18.) This arrangement is depicted below in FIG. 2 of Polinski.

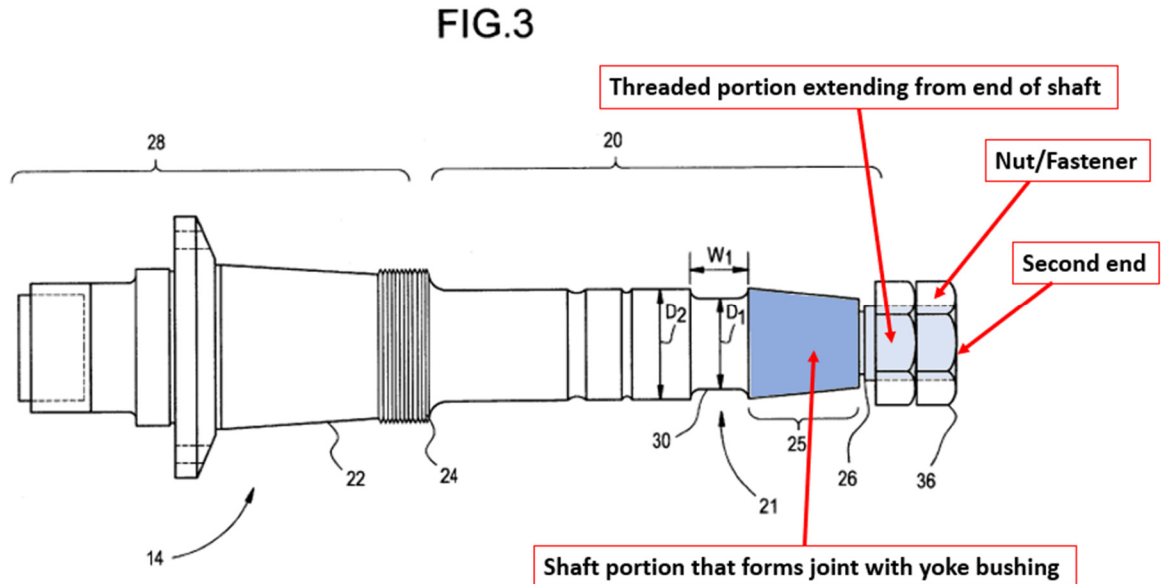


(*Id.*, FIG. 2 (annotated).)

19. Nothing in FIG. 2 nor elsewhere in Polinski discloses or suggests a tapered region extending from the uppermost extremity of the shaft. (*See id.*; *see also* Ex. 2007, ¶¶ 59–60.) Polinski necessarily also fails to disclose a sleeve having a corresponding taper on its inner surface mounted to the shaft.

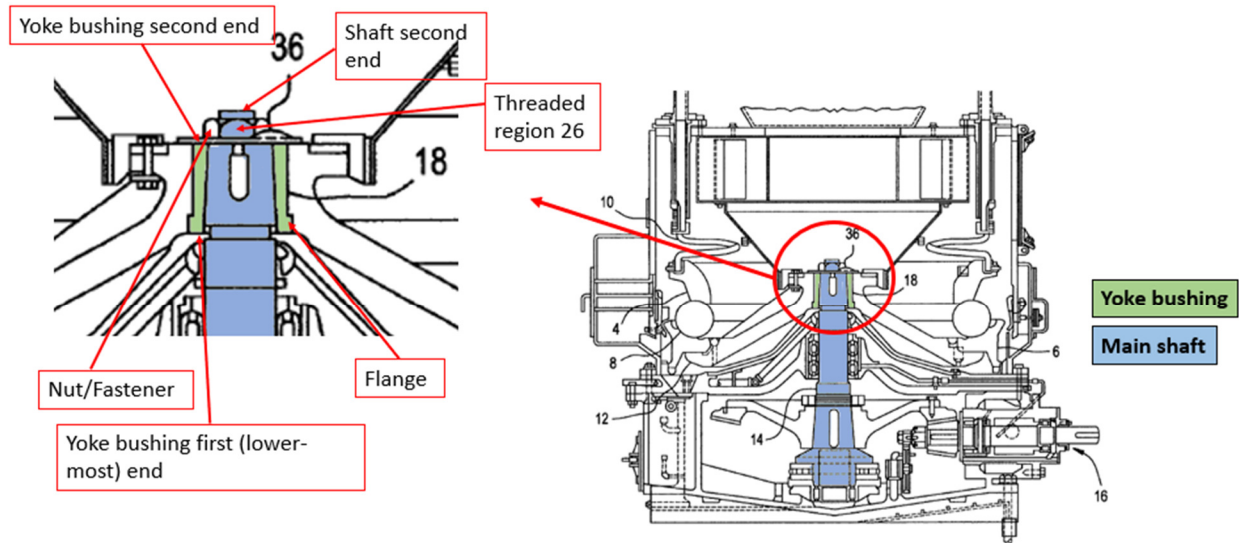
20. Piepho also fails to disclose or suggest tapered region extending from the uppermost extremity of the shaft. FIG. 3 of Piepho, shown below, depicts an

axial region being tapered relative to a longitudinal axis of the shaft body (region labeled 25).



(Ex. 1018, FIG. 3.)

21. The tapered region 25 does not extend from the uppermost extremity of Piepho's shaft. Instead, a threaded region labeled 26 extends from the uppermost extremity of the shaft disclosed by Piepho. (Ex. 2007, ¶¶ 61–63.) Consistent with FIG. 3, FIG. 1 of Piepho, below, shows that the threaded region 26 extends above the yoke and is connected to an element labeled 36.



(Ex. 1018, FIG. 1.)

22. 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. (Ex. 2007, ¶¶ 61–63.) Mr. Smith agreed that the region labeled 26 is a threaded region used to attach the yoke. (Ex. 2011, 77:18–78:1.)

23. Thus, neither Polinski nor Piepho disclose or suggest “a shaft body having a radially outward facing external surface, and a first end and a second end, *wherein the second end is an uppermost extremity of the shaft body*; 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; [and] *a shaft sleeve mounted on the tapered axial region,*” as set forth in substitute claims 15, 21, and 26.

24. Although Mr. Smith contends that both Harless and Yagi disclose a taper extending from the end of a shaft fit with a tapered sleeve, (*see* Ex. 1044, pp. 40–42), it would not have been obvious to a person of skill in the art to modify Polinski in view of Harless or Yagi (or Piepho) to include “a shaft body having a radially outward facing external surface, and a first end and a second end, wherein the second end is an uppermost extremity of the shaft body; 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; [and] a shaft sleeve mounted on the tapered axial region,” as set forth in substitute claim 15 or similar limitations in claims 21 and 26. Such a modification to Polinski would undermine Polinski’s load path and render it inoperable.

25. When questioned regarding the forces imposed by the mantle 10 on sleeve 12 of Polinski during his October 24, 2025, deposition, Mr. Smith repeatedly contradicted the express teachings of Polinski, demonstrating a basic lack of understanding of his own “primary reference” (*see* Ex. 1044, ¶ 47.) For example, when asked whether FIG. 2 of Polinski shows forces exerted on the

sleeve 12 by the mantle 10, Mr. Smith responded: “I don’t think that’s specifically described in Figure 2.” (Ex. 2019, 44:6–13.)

26. Mr. Smith then repeatedly testified that he did not expect forces being exerted on the sleeve 12 based on the mantle 10 in Polinski. When asked “would a person of ordinary skill in the art looking at Polinski, specifically Figure 2, understand that the mantle 10 during the operation of the gyratory crusher exerts axial stresses on sleeve 12,” Mr. Smith stated: “Without doing a proper analysis, I can’t say for sure. I would imagine that as the mantle is fit down onto th[e] tapered section of the shaft that most, if not all, of the forces from the crushing operation from the material that go into the mantle will go, essentially, directly into that tapered portion of the shaft.” (Ex. 2019, 45:22–46:9.) Later, he testified that an upward axial force “is not something that you would expect in a crushing operation, where an axial force would generally be expected in the downward direction just based on the geometry and the function.” (Ex. 2019, 47:7–20.)

27. With respect to any torsional forces in Polinski’s design, Mr. Smith explained that “you could get some of that torsional force from the mantle into the sleeve” but “it looks like it’s designed to not have that happen.” (Ex. 2019, 48:12–49:12.) Mr. Smith then testified that “I don’t think that the mantle would really be exerting bending forces on the sleeve 12.” (Ex. 2019, 49:13–22.)

28. Mr. Smith concluded by saying that he believes that Polinski is “designed in a way to prevent forces being transferred from the mantle into the sleeve, whether they are axial, bending, torsional, or otherwise” but that the “real answer is, I don’t know without doing a full and complete analysis.” (*Id.*, 50:4–51:2.)

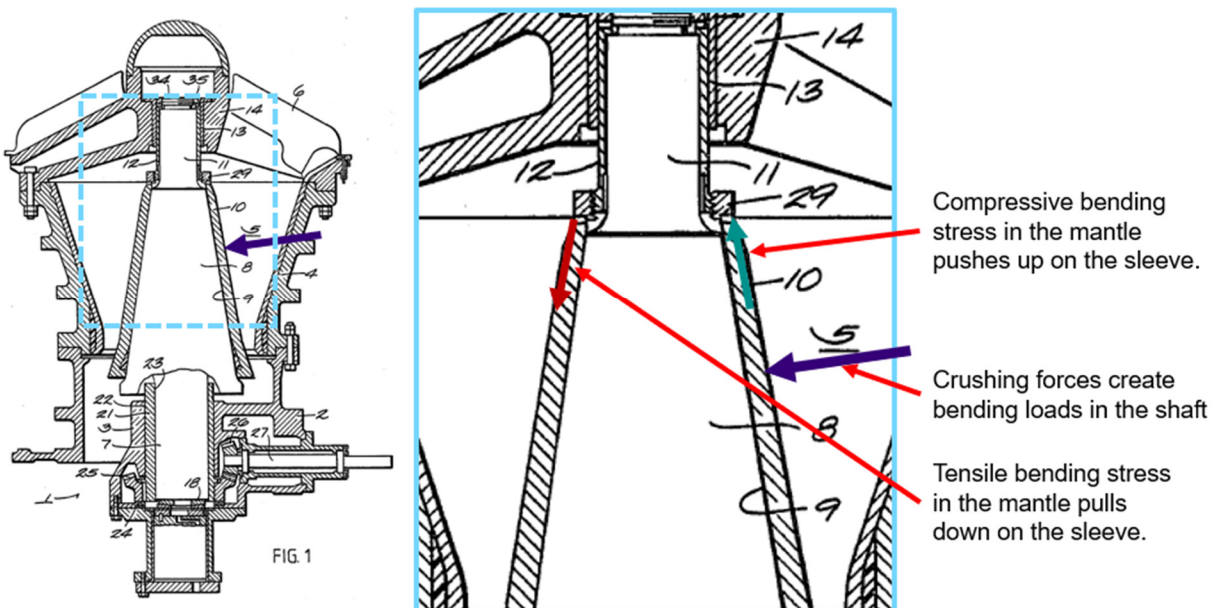
29. Mr. Smith’s testimony regarding Polinski should be disregarded by the Board because it is technically inaccurate and contrary to the teachings of Polinski.

30. Contrary to Mr. Smith’s assertions regarding the ambiguity of Polinski with respect to the forces imparted by the mantle 10 on the sleeve 12, Polinski is perfectly clear that the mantle imparts axial forces on the sleeve: “a bearing sleeve [is] releasably secured about said journal including shoulder means engaging the crusher mantle to **restrain axial displacement of the mantle** along the shaft.” (Ex. 1017, 4:49–52.) If the crusher in Polinski were “designed in a way to prevent forces being transferred from the mantle into the sleeve” (Ex. 2019, 50:13-14) then the mantle would not require anything to secure it to the shaft which is contrary to the specifications of Polinski. Moreover, a POSITA would understand that the mantle 10 imparts torsional and bending loads on the sleeve 12 in addition to such axial forces. (*See* Kytömaa II, Ex. 2007, ¶ 65.) The mantle in Polinski is secured to the sleeve and the combination of the two is secured to the

crusher shaft. The combination of the mantle, sleeve, and shaft would behave as a composite shaft. Thus, torsional and bending loads applied to the mantle would be shared by the shaft, mantle, and sleeve. Polinski describes the origin of torsional loads on the mantle as a result of material in the crusher (*See* Ex. 1017, 3:35-39) and bending loads applied to the shaft during operation (*See* Ex. 1017, 1:26-29, 4:61-62).

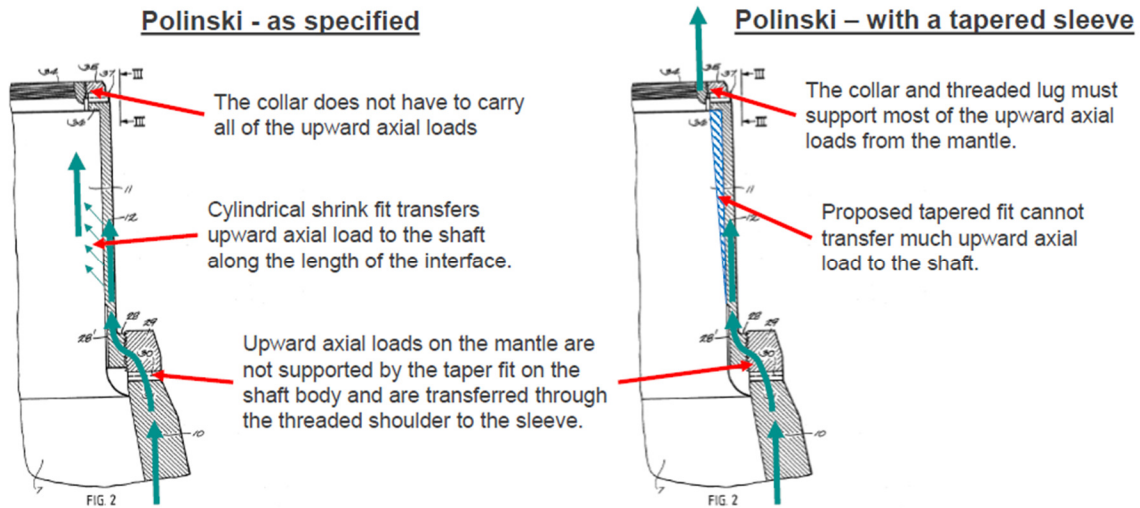
31. When a shaft is loaded in bending, as in a rock crusher, one side of the shaft is under axial tensile stress and the opposite side of the shaft is under axial compressive stress. In the crusher embodiment illustrated in FIG. 1 of Polinski, the mantle, sleeve, and shaft form a composite shaft. Forces in the mantle on the tensile side of the composite shaft would pull down on the sleeve, while forces in the mantle on the compressive side of the composite shaft would push up on the

sleeve as illustrated in the annotated FIG. 1 of Polinski, below.



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

32. The cylindrical interface between sleeve 12 and journal 11 is thus a critical component of Polinski's invention to allow the sleeve 12 to withstand these forces. Polinski utilizes a cylindrical journal 11-to-sleeve 12 interface such that axial and bending loads imposed by the mantle 10 on sleeve 12 via the threaded annular shoulder 28 of sleeve 12 are absorbed by the journal. This load path is illustrated on the left-hand portion of annotated FIG. 2 of Polinski, below.



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

33. If the cylindrical journal 11-to-sleeve 12 interface were modified to be a tapered interface, the load path of axial and bending forces imposed by mantle 10 on sleeve 12 would instead be directed primarily into the retainer mechanism (e.g., the threaded lug 34 and sleeve nut 35) disclosed by Polinski via the sleeve 12, as illustrated in the right-hand side annotated FIG. 2 above. If Polinski is modified to have tapered version of sleeve 12 fit onto a modified tapered version of journal 11, then a mantle-induced upward axial load would no longer be counter-acted by Polinski's designed cylindrical shrink-fit interface. If the threaded lug 34 and corresponding sleeve nut 35 depicted in FIG. 2 of Polinski were removed to meet the limitation that a tapered region of the shaft body extends from the uppermost extremity of the shaft, the wedge geometry between a modified tapered sleeve 12

and modified tapered journal 11 would simply drive the sleeve 12 off the journal 11 under operation.

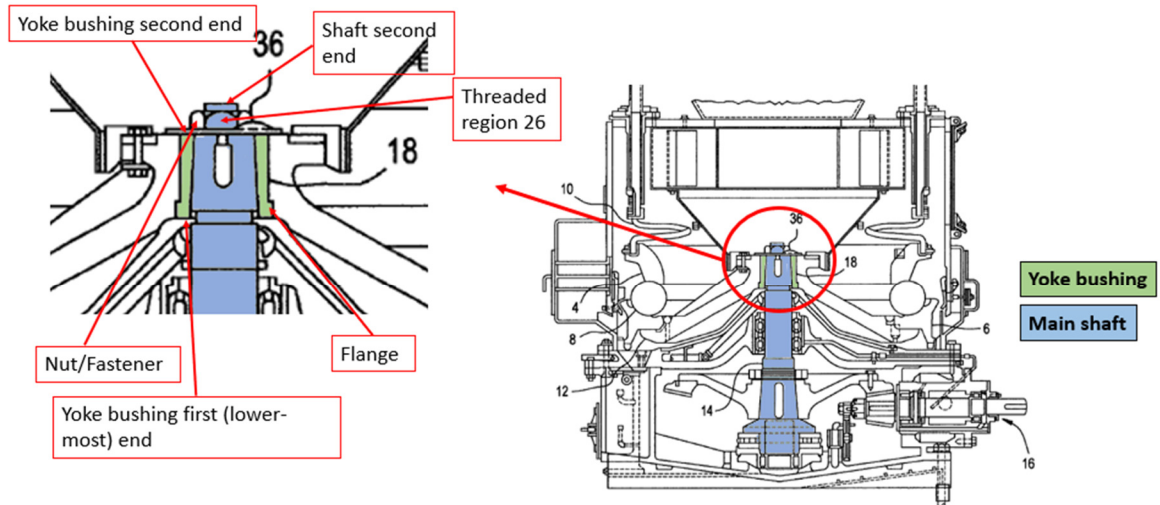
34. Moreover, Polinski does not contemplate an end retainer mechanism configured to absorb the forces imparted by the mantle 10 on sleeve 12 along a tapered journal-sleeve interface. Polinski teaches that the “heat-shrink type connection” between the cylindrical inner surface of sleeve 12 and cylindrical outer surface of journal 11 “will generally be sufficient to secure the sleeve and thus the crusher mantle on the shaft during normal crusher operations.” (Ex. 1017, 3:18–23.) The cylindrical heat-shrink fit provides most, if not all, of the security for the sleeve 12 against the axial and bending loads imposed by the mantle 10. The existing retention mechanism for sleeve 12 (the threaded lug 34 and sleeve nut 35) is included to “prevent[] excessive rotation of the sleeve on the main shaft” “[s]hould the threads 28 [of the sleeve’s annular shoulder] become damaged and locked.” (Ex. 1017, 3:42-47.) Modifying Polinski to include a tapered journal-sleeve interface, thereby directing the loads from mantle 10 through sleeve 12 and into an uppermost retainer such as threaded lug 34, would require that the retainer be designed to carry loads on the sleeve that are not transferred to the shaft as described in Polinski. Thus, a POSITA would not be motivated to make such a modification to Polinski.

35. For at least the reasons discussed above, a POSITA would understand that Polinski and Piepho, taken both alone and in combination, fail to disclose [15a]-[15c], [21a]-[21c], and [26a]-[26c].

B. Polinski, Harless, Yagi, and Piepho fail to disclose or suggest [21e] and [26c]

36. Polinski, Harless, Yagi, and Piepho do not disclose or suggest “the shaft sleeve having a tapered wall thickness, such that the wall thickness at a second end of the shaft sleeve is greater than the wall thickness at a first end of the shaft sleeve, wherein the first end of the shaft sleeve is a lowermost extremity of the shaft sleeve,” as recited in [21e], for at least the reasons set forth in my second declaration. For the similar reasons, the references do not disclose or suggest the limitations of [26c]. (*See* Ex. 2007, ¶¶ 66–76.) First, I note that Yagi does not even have a sleeve. Similarly, Petitioner and Mr. Smith rely on a gear hub disclosed by Harless—this is also not a sleeve.

37. 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. 1018, FIG. 1 (annotated).)

40. Moreover, a POSITA would not have been motivated to modify Polinski in view of Piepho, Harless, or Yagi to meet [21e] or [26c]. As discussed above in Section VIII.A, Polinski's sleeve 12 is configured to support and axially restrain the mantle 10 on the shaft 7. The heat-shrink fit between sleeve 12 and journal 11 secures the sleeve 12 and absorbs axial (and other, e.g., torsional, bending) forces applied to the sleeve 12 by mantle 10. If journal 11 were tapered—as proposed by petitioner—the sleeve 12 itself would carry the forces exerted by the mantle. Assuming, for the sake of argument, that there is some retention mechanism to prevent the sleeve 12 from being displaced from the tapered journal 11 by the mantle 10, the retention mechanism would have to withstand the forces imparted by the sleeve—forces that are *not* contemplated by Polinski.

41. The risk of damage to the sleeve on a tapered shaft is heightened should Polinski's sleeve be modified to either omit or reduce the thickness of the threaded annular shoulder 28 to meet the limitations of [21e] or [26c]. As I discussed in Kytömaa II, to achieve the limitations of [21e] or [26c], 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. 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, even with cylindrical journal 11. 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—even with Polinski's cylindrical journal-sleeve interface.

42. Moreover, 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 would 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.)

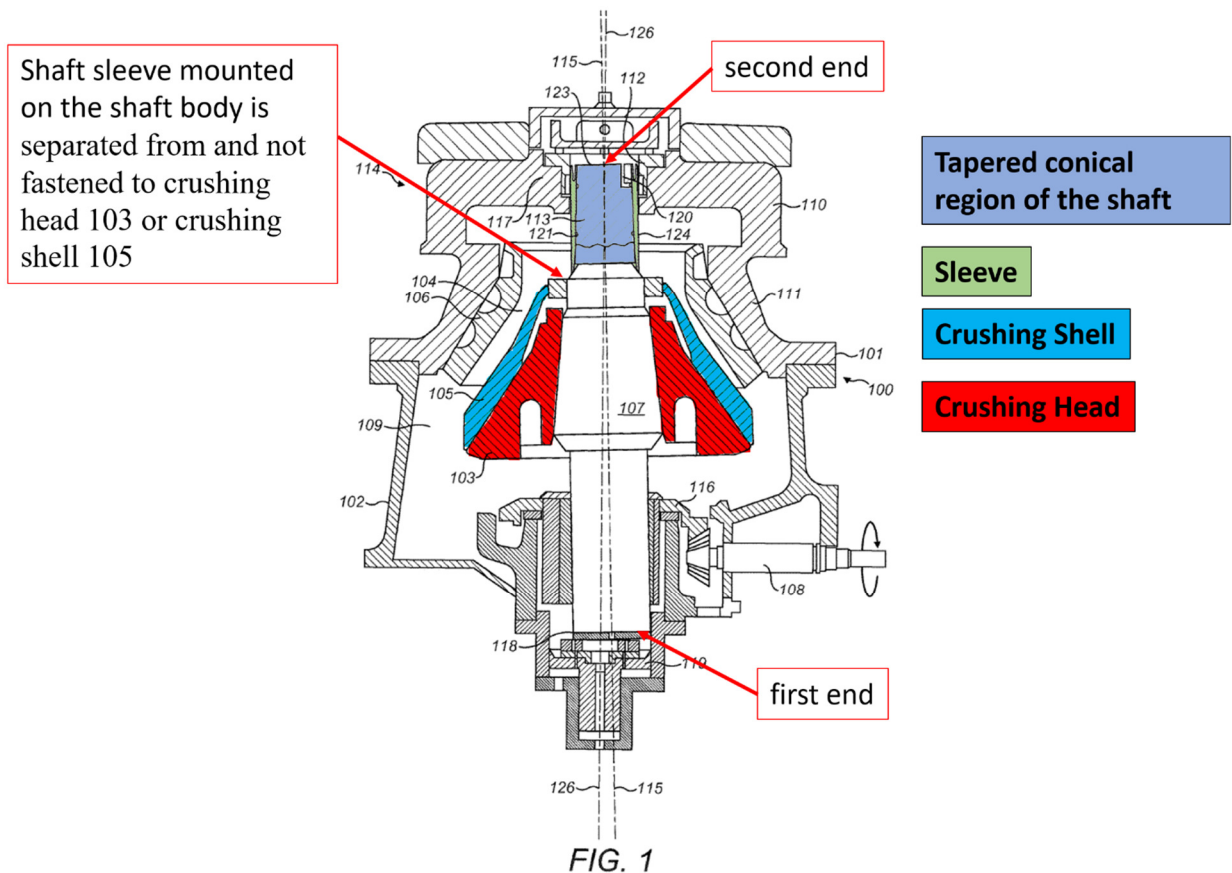
The larger diameter shoulder in Polinski allows for the shoulder to be fully threaded with no thread runout stress concentration. Removal of the threaded shoulder present in Polinski would additionally result in more of the load in the threaded connection being concentrated on the first engaged thread.

43. The additional material provided by the shoulder 28 relative to the remainder of the sleeve's axial wall—combined with the cylindrical journal-sleeve interface—is needed to distribute the stresses exerted on the sleeve by the mantle. 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. Polinski, Harless, Yagi, and Piepho also fail to disclose or suggest the limitations of substitute claim 26

44. Substitute claim 26, in [26e], requires that the sleeve is configured such that when positioned on the shaft body, the sleeve is separated from and not fastened to a crushing head and a crushing shell of the crusher.

45. This arrangement is illustrated in FIG. 1 of the '090 Patent, shown below.

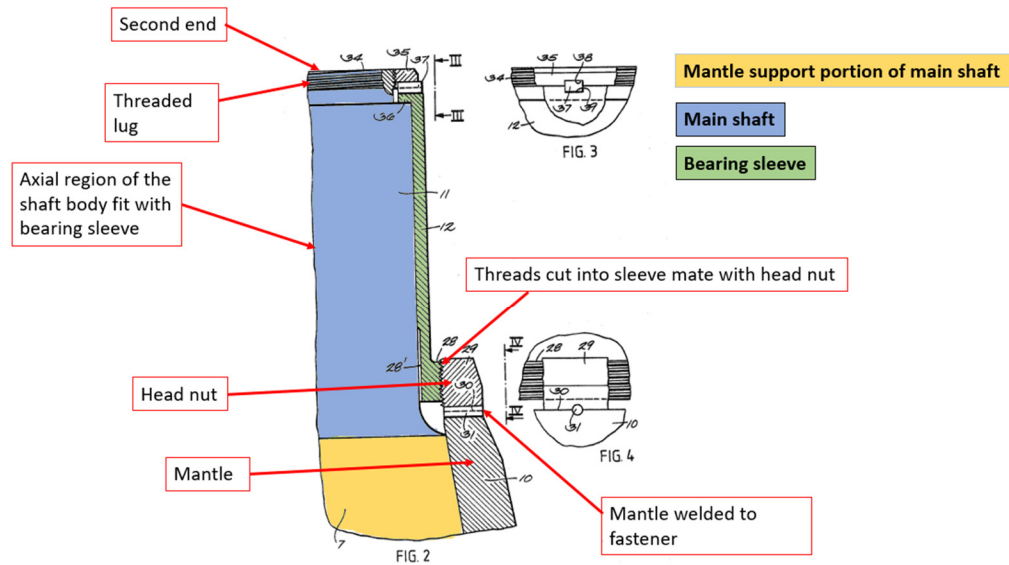


Ex. 1001, FIG. 1 (annotated).

46. As illustrated, shaft sleeve 124 is separated from and is not fastened to either crushing head 103 or crushing shell 105. Mr. Smith similarly testified that the inner-crushing shell 105 and the crushing head 103 are not in contact with sleeve 124 when inner-crushing shell 105 and the crushing head 103 are mounted to the shaft 107. (*See* Ex. 2011, 34:2–35:8.)

47. Polinski, Harless, Yagi, and Piepho fail to disclose or suggest the limitations of substitute independent claim 26, specifically as recited in [26e].

48. Petitioner's primary reference, Polinski, affirmatively teaches the opposite. Polinski discloses that a sleeve 12, relied on by Petitioner for the sleeve recited in challenged claim 14, includes a threaded shoulder 28 near the bottom end of the sleeve 12 for securing a mantle 10 (corresponding to a crushing shell or crushing head mounted to the shaft 7 of Polinski) to a tapered mantle support portion 8 of the shaft 7. Polinski provides that "the bearing sleeve 12 extends generally coextensively with the bearing journal 11 and includes an externally threaded annular shoulder 28 about its lower periphery threadably receiving a head nut 29." (Ex. 1017, 2:67–68; 3:1–9.) "The head nut 29 abuts the upper edge 30 of the mantle 10 to secure it to the tapered portion of the main shaft 7, and at least one rod or dowel 31 is welded in a corresponding pair of semi-circular keyways in the head nut and the mantle to prevent rotation between these members after the head nut is secured in position." (*Id.*, 3:3–9.) This arrangement is depicted below in FIG. 2 of Polinski.



(Ex. 1017, FIG. 2.)

49. Accordingly, as shown in FIG. 2 above, the sleeve 12 is fastened to mantle 10 (corresponding to a crushing shell or crushing head) via head nut 29. Polinski's sleeve 12 is thus **not** configured such that, when positioned on the shaft body, it is separated from and not fastened to a crushing head and a crushing shell. Mr. Smith agreed that the sleeve 12 is connected to the mantle 10 via head nut 29. (See Ex. 2019, 39:14–40:17.)

50. Harless, Yagi, and Piepho do not have disclosures that would meet limitation 26[e].

51. Nor would it have been obvious to a POSITA to modify Polinski in view of these references to include limitation of [26e]. Polinski's core teaching is that the sleeve 12 fastens to and supports the mantle 10. (See Ex. 1017, 1:11–66; claim 1; FIG. 2.) Reconfiguring the sleeve 12 so it is separate from and not

fastened to the crusher mantle 10 (corresponding to the crushing head 103/crushing shell 105) would abandon Polinski's core teaching. The sleeve 12 would no longer serve as an intermediate load path between the mantle 10 and journal 11, thus undoing the fatigue-reduction objective of Polinski.

52. Polinski's sleeve 12 is configured to secure the crushing mantle 10 to the tapered portion of the main shaft 7. (Ex. 1017, 3:1–9.) Specifically, Polinski's invention expressly requires "a bearing sleeve . . . including shoulder means engaging the crusher mantle to restrain axial displacement of the mantle," (Ex. 1017, 4:49–51), and implements that by providing a threaded annular shoulder 28 on the sleeve with a head nut 29 fastened to the annular shoulder 28 that is affixed to the mantle's upper edge 30—i.e., the sleeve 12 is the member that fastens to (and supports) the mantle 10.

53. As discussed *supra*, separating the sleeve 12 from the mantle 10 would defeat Polinski's load path and principle of operation. Polinski's background explains that placing the mantle-securing threads on the shaft created stress concentrations and resulted in fatigue failure. (Ex. 1017, 1:20–66.) Polinski relocates the mantle-securing threads to the sleeve and keeps the shaft free of abrupt changes in cross-sectional area in the high-stress region above the mantle 10. (Ex. 1017, 1:56–66.) A configuration that separates the sleeve from the mantle necessarily moves the fastening back to some other structure, either re-introducing

the stress problem into the shaft 7 that Polinski set out to fix—rendering the reference unsatisfactory for its intended purpose and/or requiring a full re-design of the Polinski apparatus to introduce a new stress-bearing component to secure the mantle 10.

54. A POSITA would not make such a modification to Polinski because it would render Polinski unsatisfactory for its intended purpose.

D. Polinski, Harless, Yagi and Piepho do not disclose or suggest substitute dependent claims 16 or 24

55. Substitute claim 16 recites that “the plurality of grooves comprise a first groove and a second groove, wherein the first groove is positioned closer to the second end relative to the second groove, and wherein the shaft body further comprises an oil path consisting of: a fluid inlet positioned at the second end; the first groove; the second groove; an axially extending channel indented at the external surface of the shaft body to couple the first groove and the second groove in fluid communication; and **an internal oil path extending within the shaft body only to the first groove, the internal oil path consisting of: a first conduit extending axially toward the first end from the fluid inlet; and a second conduit extending from the first conduit toward the radially outward facing external surface of the shaft body to the first groove.**” Substitute claim 24 recites similar limitations. The above limitations are illustrated in FIG. 3 of the ’090 Patent, below.

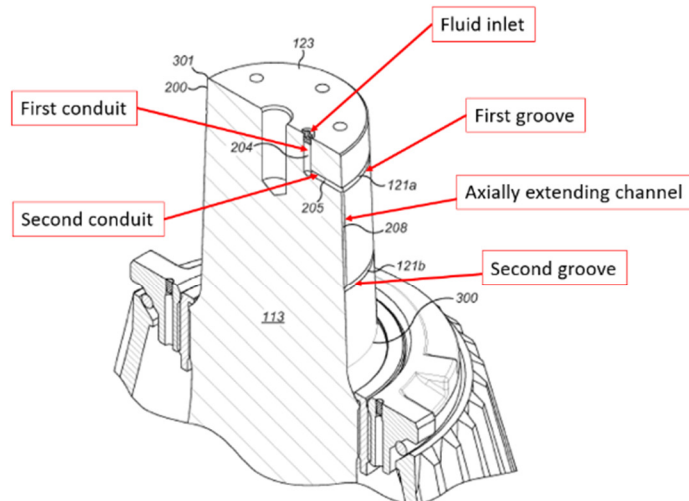
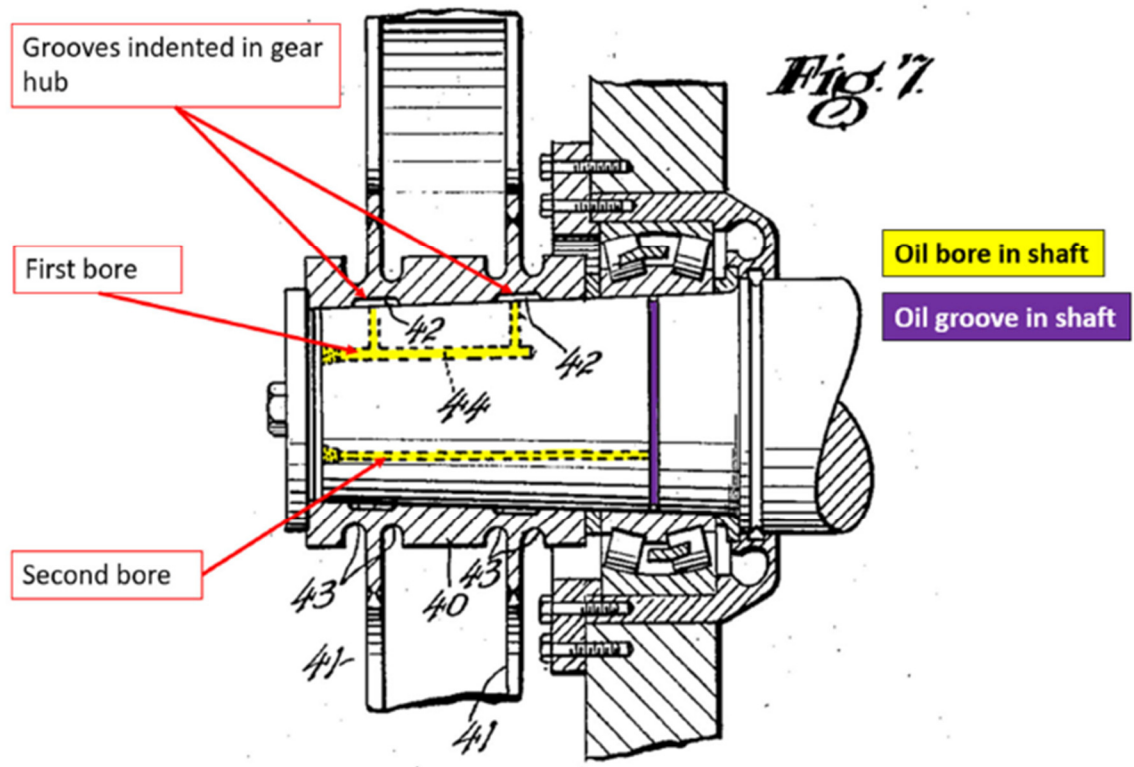


FIG. 3

Ex. 1001, FIG. 3 (annotated).

56. Neither Polinski nor Piepho discloses or suggests any “fluid inlet” or “oil path,” as recited in substitute claims 16 and 24. Although Harless discloses an internal oil bore 44 extending to two grooves 42 in a gear hub (Ex. 1033, 4:20–22; FIG. 7), it does not teach or suggest a bore that extends “internally within the shaft body only to the first groove,” as required by substitute claim 16. Instead, oil bore 44 extends to both grooves 42 as shown in FIG. 7 (below).



(Ex. 1033, FIG. 7 (annotated).)

57. Harless includes a separate oil bore (labeled 13 in FIG. 1 of Harless); however, this bore does not supply the “first groove” because groove 12 is not positioned closer to the second end than any other groove as required by substitute claims 16 and 24, nor is groove 12 “coupled in fluid communication” with another groove as required by substitute claims 16 and 24. Accordingly, Polinski, Piepho, and Harless do not disclose or suggest the limitations of substitute claims 16 and 24. Mr. Smith, in his second declaration, additionally relied on Yagi as allegedly disclosing a “fluid inlet conduit [that] extends internally within the shaft body only to the first groove, wherein the first groove and the second groove are coupled in

fluid communication,” as recited in Patent Owner’s original contingent motion to amend. (*See* Ex. 1044, page 40–49.) However, Yagi fails to disclose or suggest the limitations of substitute claims 16 and 24, which require, in relevant part, that the shaft body includes a fluid inlet positioned at the second end, the first groove, the second groove, an axially extending channel indented at the external surface of the shaft body to couple the first groove and the second groove in fluid communication, and an internal oil path extending within the shaft body *only to the first groove*. Substitute claims 16 and 24 additionally require that the *internal oil path is limited to* a first conduit extending axially toward the first end from the fluid inlet and a second conduit extending from the first conduit toward the radially outward facing external surface of the shaft body to the first groove.

58. Yagi does not disclose—and a POSITA would not read Yagi to suggest—an oil path that configured according to the precise manner required by substitute claims 16 and 24. Those claims require that the shaft body include an *oil path consisting of* (i) a fluid inlet positioned at the second end; (ii) the first groove; (iii) the second groove; (iv) an axially extending channel indented at the external surface of the shaft body to couple the first groove and the second groove in fluid communication; and (v) an internal oil path extending within the shaft body only to the first groove, *the internal oil path consisting of*: a first conduit extending axially toward the first end from the fluid inlet; and a second conduit extending

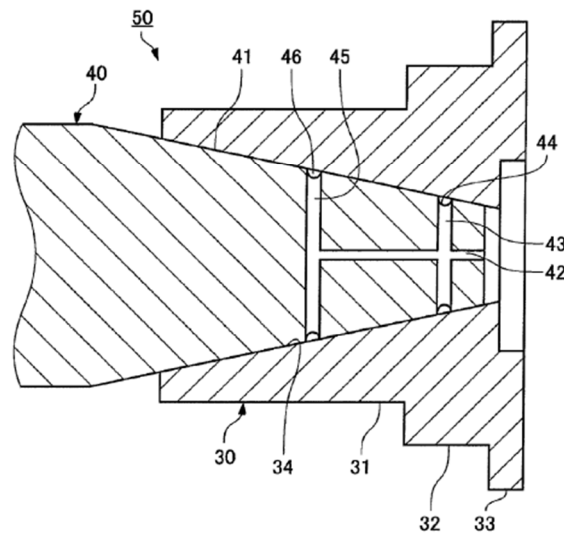
from the first conduit toward the radially outward facing external surface of the shaft body to the first groove. Yagi neither limits its oil conduits to this precise flow-path nor confines flow “only to the first groove,” (*see generally* Ex. 1040) and nothing in Yagi would motivate a POSITA to strip away the additional/alternative flow passages to arrive at the narrowly defined configuration of substitute claims 16 and 24.

59. Mr. Smith concedes that “Yagi connects from the port from what would be the second groove”—not the first, uppermost groove. (Ex. 1044, page 47.) Mr. Smith argues that a POSITA would be motivated to connect to what would be the first (uppermost) groove as the drill depth from the end would be less, easier to manufacture and would cost less. However, this rationale is taken from the '090 Patent itself, not from Yagi, and is improper hindsight. (*See* Ex. 1001, 2:59–3:13.) The '090 Patent describes that it is advantageous to extend an internal conduit only to the topmost groove and then connect two grooves indented into the shaft body using an axially extending channel because it minimizes the axial length of the internal fluid supply conduit, limiting use of very long and thin drills while still evenly dispersing fluid along the shaft-sleeve interface. (*See* Ex. 1001, 3:3–27.)

60. The fluid flow path recited in substitute claims 16 and 24 accomplish Yagi’s objective of permeating oil more easily into a large region between coupled

surfaces in the axial direction using a simpler, easier to manufacture design. FIGS. 4-6C of Yagi illustrate embodiments in which Yagi discloses a two-groove configuration. In FIG. 4, an internal axial oil flow path 42 extends to both an upper groove and a lower groove via two radial flow passages: first radial oil passage 43 and second radial oil passage 45.

FIG. 4



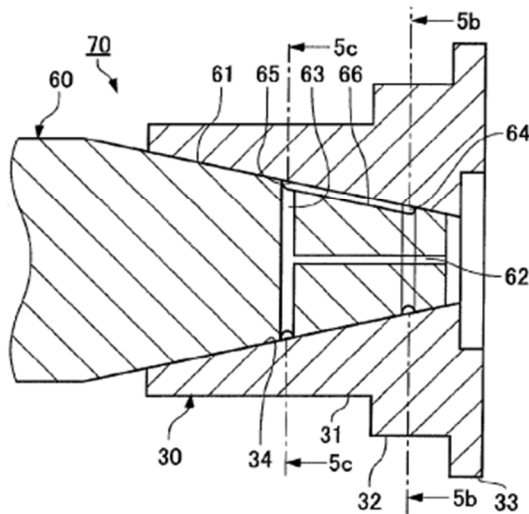
Ex. 1040, FIG. 4

61. The embodiment illustrated above in FIG. 4 thus requires additional internal oil flow passages relative to the limitations recited in substitute claims 16

and 24 to obtain the same objective—distributing oil across a larger region using two circumferential grooves.

62. FIGS. 5A-5C illustrate an alternative two-groove embodiment in which an axial oil passage 62 extends internally only to the bottom-most groove via a radial oil passage 63. FIG. 5A is shown below.

FIG. 5A



Ex. 1040, FIG. 5A

63. As described in the '090 Patent, the configuration of FIGS. 5A-5C is less desirable because “[m]inimising an axial length of an internally extending fluid supply conduit is advantageous during manufacture.” (Ex. 1001, 3:8–10.) The '090 Patent, as reflected in substitute claims 16 and 24, thus achieves Yagi's objective of oil permeating circumferentially in a groove and then axially across a

larger region using two grooves while simplifying internal drilling to a single branch and minimizing drill depth from the shaft end.

64. FIGS. 6A-6C of Yagi do not disclose a new conduit architecture. Rather, FIGS. 6A-6C illustrate a procedure for introducing oil into the oil flow path of FIG. 4, described above. Yagi expressly introduces FIGS. 6A–6C as “a preferred procedure for decoupling” the second embodiment (structure 50), which has an axial oil passage 42 feeding two separate radial passages (43 and 45) that open to two grooves (44 and 46).

65. Thus, Yagi does not disclose or suggest the limitations of substitute claims 16 or 24 and a POSITA would not be motivated to modify Polinski in view of Yagi to arrive at these limitations.

E. Polinski, Harless, Yagi, and Piepho do not disclose or suggest the limitations of substitute dependent claims 20 or 25

66. The ground fails to disclose or suggest the limitations of substitute claims 20 and 25 for similar reasons to those described above with reference to substitute claim 26. (*See* Section VIII.B.)

F. It would not have been obvious to modify Polinski in view of Harless, Yagi, or Piepho to include oil groove(s) at the shaft-sleeve interface

67. Polinski, Piepho, Harless, and Yagi fail to disclose or suggest “a plurality of grooves indented at the external surface and positioned at the tapered axial region,” as recited in substitute claim 15, and “at least one groove indented at

the external surface and positioned at the tapered axial region,” as recited in substitute claims 21 and 26. As discussed in Kytömaa I, Kytömaa II, and Kytömaa III, a POSITA would not have been motivated to incorporate any oil grooves into the shaft disclosed by the purported combination of Polinski and Piepho. (*See, e.g.*, Ex. 2001, ¶¶48–59; Ex. 2007, ¶¶ 77–87; Ex. 2010, ¶¶ 77–87.) Polinski’s stated purpose is mitigating shaft fatigue failure. (Ex. 1017, 1:61–67; Ex. 2001, ¶ 30.) Polinski teaches that structural discontinuities increase the likelihood of fatigue failure and counsels that discontinuities should be removed from the bearing journal 11 fit with sleeve 12. (*See* Ex. 1017, 1:15–20.)

68. Moreover, as I discussed in Kytömaa III, adding *multiple* grooves in the shaft body, in order to satisfy the requirement for “a plurality of grooves indented at the external surface and positioned at the tapered axial region” would create structural discontinuities that would increase the likelihood of fatigue failure in Polinski. As set forth in Kytömaa I, *Shigley* explains that stress concentrations can arise from a single groove. (Ex. 2003, 10; Ex. 2001, ¶¶ 50–51 (“Adding an oil groove to bearing journal would have a similar effect [of high local stress concentrations] to the threads described by Polinski.”) Adding grooves to the shaft adds stress concentration locations which increases the risk of fatigue failure. Adding grooves also adds more regions near the edge of contact area where

fretting wear can occur and provide still more potential initiation sites for fatigue cracks.

69. Petitioner contends that the groove in Harless would simplify making and breaking interference fits. (See Paper 2, 21.) In the Decision on Institution, the Board found that Sandvik had not contested the advantages associated with the introduction of a single groove in a shaft and that the weighing of advantages and disadvantages were better suited for trial. (Paper 9, 19.) 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. On cross-examination, Mr. Smith 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.)

70. In his second declaration, Mr. Smith downplays the complexity of fatigue failure, citing *Shigley*. (Ex. 1044, pages 28–31.) Mr. Smith alleges that I have attempted to “diminish the capabilities of a POSITA” and that I have implied that “a POSITA would be unaware of major sections of *Shigley*.” (Ex. 1044, page 26.) However, contrary to Mr. Smith’s assertions, my testimony is consistent with

Shigley's teachings regarding the complexities of fatigue failure. *Shigley* teaches that “[i]t is relatively simple to design against a static failure, because our knowledge is comprehensive. **Fatigue is a much more complicated phenomenon, only partially understood**, and the engineer seeking competence must acquire as much knowledge of the subject as possible.” (Ex. 1049, p. 266.)

71. Shigley additionally counsels that fatigue failure is “sudden,” “total,” and “dangerous.” (Ex. 1049, p. 266.) On these points, Mr. Smith agrees. (Ex. 2019 69:8–71:2.) Thus, Mr. Smith agrees that shaft fatigue failure is a major concern that can “destroy a whole part.” (Ex. 2019 70:9–13.)

72. In his second declaration, however, Mr. Smith asserts: “A POSITA would know that the small depth of the grooves required to perform their function would not amount to the ‘abrupt changes in cross-sectional area of the shaft’ that Polinski was alluding to.” (Ex. 1044, page 28.) Thus, Mr. Smith appears to assert that a groove could not result in shaft failure. Yet, Mr. Smith agreed that the depth of a groove could be similar to the depth of a thread. (Ex. 2019, 72:7–15.) And Polinski counsels against “abrupt changes in cross-sectional area of the shaft” that do, in fact, result in shaft failure under cyclical loading due to stress concentrations. (Ex. 1017, 1:1–67.) Grooves are well-known stress raisers that lead to stress concentrations.

73. Mr. Smith’s assertion that “A POSITA would know that the small depth of the grooves required to perform their function would not amount to the ‘abrupt changes in cross-sectional area of the shaft’ that Polinski was alluding to” is not based in any inherent difference between the relative depth of a groove, a thread, or any other abrupt change in cross-sectional area. Rather, it appears that Mr. Smith’s assertion is based merely on speculation. For instance, when asked whether, in the context of a gyratory crusher, the depth of a groove would be similar in size to the depth of a thread, Mr. Smith responded “[a]gain, I don’t think I have enough information to compare those.” (Ex. 2019, 72:24–25.)

74. Moreover, Mr. Smith’s testimony regarding the impact of the speculative depth of an oil groove is contrary to *Shigley*, which teaches that “a fatigue crack will typically initiate at a discontinuity in the material” and that such discontinuities can arise because of even small imperfections, such as “tool marks, scratches, and burrs.” (Ex. 1049, p. 267.) Thus, Mr. Smith’s testimony that a groove is not a concern for shaft failure is speculative.

75. As I discussed in Kytömaa III, the loading on the shaft of a gyratory rock crusher is complex and demanding. The eccentric motion and the highly variable crushing forces result in loads that put the shaft at risk for fatigue failure. The failure of a shaft is a significant issue and requires significant downtime and expensive components to replace. A POSITA would thus not be motivated to

introduce *multiple* grooves that run directly contrary to the primary concern of Polinski, to wit, shaft failure.

* * *

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: October 31, 2025



Harri Kytömaa, Ph.D.

APPENDIX A – LISTING OF SUBSTITUTE CLAIMS

Patent Owner presents the following substitute claims in marked up form with underline indicating inserted text and brackets or strikethrough indicating deleted text from the original patent claims.

15. (Substitute for claim 1, if found unpatentable) A gyratory crusher main shaft of a crusher comprising:

[15a] a shaft body having a radially outward facing external surface, and a first end and a second end, wherein the second end is an uppermost extremity of the shaft body;

[15b] 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;

[15c] a shaft sleeve mounted on the tapered axial region; and

[15d] ~~at least one groove~~ a plurality of grooves indented at the external surface and positioned at the tapered axial region, the ~~at least one groove~~ plurality of grooves being arranged to receive a pressurized fluid to facilitate mounting and dismounting of the shaft sleeve at the shaft body.

16. (Substitute for claim 2, if found unpatentable) The main shaft as claimed in claim 15, wherein the plurality of grooves comprise a first groove and a second groove, wherein the first groove is positioned closer to the second end relative to the second groove, and wherein the shaft body further comprises an oil path consisting of:

a fluid inlet positioned at the second end;

the first groove;

the second groove;

an axially extending channel indented at the external surface of the shaft body to couple the first groove and the second groove in fluid communication; and

an internal oil path extending within the shaft body only to the first groove, the internal oil path consisting of:

a first conduit extending axially toward the first end from the fluid inlet; and

a second conduit extending from the first conduit toward the radially outward facing external surface of the shaft body to the first groove

~~—further comprising 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.~~

17. (Substitute for claim 3, if found unpatentable) The main shaft as claimed in claim [[2]]16, wherein the first groove is positioned on a first side of a cross-sectional area center of the shaft sleeve relatively closer to the second end and the second groove is positioned on a second side of a cross-sectional area center of the shaft sleeve relatively further from the second end~~wherein the fluid inlet conduit extends internally within the shaft body such that a part of the fluid inlet conduit extends radially outward to the at least one groove.~~

18. (Substitute for claim 4, if found unpatentable) The main shaft as claimed in claim [[3]]15, wherein the ~~at least one groove~~ plurality of grooves extend[[s]] in a circumferential direction around the tapered axial region shaft body.

19. (Substitute for claim 5, if found unpatentable) The main shaft as claimed in claim [[4]]18, wherein the ~~at least one groove~~ plurality of grooves extend[[s]] substantially or completely circumferentially around the shaft body.

20. (Substitute for claim 8, if found unpatentable) The main shaft as claimed in claim [[7]]15, wherein the shaft sleeve is configured such that when positioned on the shaft body, the shaft sleeve is separated from and not fastened to a crushing head and a crushing shell~~wherein at least a part of the fluid inlet conduit is indented and extends axially at the external surface as a channel to couple the first and second grooves in fluid communication.~~

21. (Substitute for claim 9, if found unpatentable) A gyratory crusher main shaft assembly for a crusher comprising:

[21a] a shaft body having a radially outward facing external surface, and a first end and a second end, wherein the second end is an uppermost extremity of the shaft body;

[21b] 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,

[21c] a shaft sleeve mounted on the tapered axial region, and

[21d] 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 sleeve at the shaft body, ~~and~~

[21e] wherein the [[a]] shaft sleeve is fitted over the tapered axial region, the shaft sleeve having a tapered wall thickness, such that the wall thickness at a second end of the shaft sleeve is greater than the wall thickness at a first end of the sleeve, wherein the first end of the shaft sleeve is a lowermost extremity of the shaft sleeve.

22. (Substitute for claim 10, if found unpatentable) The assembly as claimed in claim [[9]]21, further comprising an end retainer releasably mounted at the second end of the shaft body and having a perimeter region extending radially outward beyond the external surface at the tapered region, the perimeter region positioned to radially overlap the sleeve at the second end of the sleeve to inhibit axial separation of the sleeve from the shaft body.

23. (Substitute for claim 11, if found unpatentable) The assembly as claimed in claim [[10]]22, wherein the end retainer includes a recess extending circumferentially at the perimeter region to allow axial movement of the sleeve into the recess.

24. (Substitute for claim 12, if found unpatentable) The assembly as claimed in claim [[9]]21, wherein the at least one groove comprises a first groove and a second groove, wherein the first groove is positioned closer to the second end relative to the second groove, and wherein the shaft body further comprises an oil path consisting of:

a fluid inlet positioned at the second end;

the first groove;

the second groove;

an axially extending channel indented at the external surface of the shaft body to couple the first groove and the second groove in fluid communication; and

an internal oil path extending within the shaft body only to the first groove,
the internal oil path consisting of:

a first conduit extending axially toward the first end from the fluid
inlet; and

a second conduit extending from the first conduit toward the radially
outward facing external surface of the shaft body to the first groove

~~further comprising a fluid inlet conduit extending axially from the second~~
~~end of the shaft body 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 of the shaft~~
~~body.~~

25. (Substitute for claim 13, if found unpatentable) The assembly as
claimed in claim [[9]]21, wherein the shaft sleeve is configured such that when
positioned on the shaft body, the shaft sleeve is separated from and not fastened to
a crushing head and a crushing shell ~~further comprising a fluid inlet conduit~~
~~extending radially through the wall thickness of the sleeve in fluid communication~~
~~with the at least one groove to allow a fluid to be supplied to the at least one~~
~~groove through the sleeve.~~

26. (Substitute for claim 14, if found unpatentable) A gyratory crusher
comprising:

[26a] 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, wherein the second end is an uppermost extremity of the shaft body,

[26b] 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;

[26c] 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, wherein the first end of the sleeve is a lowermost extremity of the sleeve; and

[26d] 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 sleeve at the shaft body,

[26e] wherein the sleeve is configured such that when positioned on the shaft body, the sleeve is separated from and not fastened to a crushing head and a crushing shell.