

Filed November 25, 2025

UNITED STATES PATENT AND TRADEMARK OFFICE

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**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

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Sandvik Mining and Construction USA LLC,  
Petitioner

v.

CMS Cepcor Limited and CMS Cepcor Americas LLC  
Patent Owner

Case 1:24-cv-00481-JLH  
US Patent 11,014,090

**THIRD DECLARATION OF DAVID G. SMITH, IN SUPPORT OF  
PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT 11,014,090**

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## **I. INTRODUCTION**

1. I, David G. Smith, submit this declaration on behalf of CMS Cepcor Limited and CMS Cepcor Americas LLC (hereafter CMS, or Defendants), regarding a Petition for *Inter Partes* Review of U.S. Patent No. 11,014,090 ('090 patent).

2. The subject of my declaration is the invalidity of the '090 patent. This declaration is provided after my review and analysis of the '090 patent, the prior art, relevant background technology, and is also based on my education and experience, as well as additional materials identified herein.

3. This is the third declaration I have submitted in this matter. The first declaration addressed the invalidity of all of the original asserted claims of the '090 patent. The second declaration addressed the amended claims as outlined in Patent Owner's Contingent Motion to Amend. This third declaration will address further claim amendments outlined in Patent Owner's Revised Contingent Motion to Amend.

## **II. BACKGROUND AND QUALIFICATIONS**

4. Counsel for CMS Cepcor has retained me as a technical expert in this action. I have attached, as Exhibit 1, a copy of my Curriculum Vitae, which outlines my educational and employment history. I received a Bachelor's degree in Mechanical Engineering from Brigham Young University - Idaho. I received a

Master's of Science degree in Mechanical Engineering from Brigham Young University (BYU), and a Masters of Business Administration from Brigham Young University (BYU) with an emphasis in Product Development. I am a licensed professional engineer (PE) and a certified safety professional in comprehensive practice (CSP).

5. I have experience in the fields of mechanical engineering, structural design, new product development, the design of equipment, machinery, safety and consumer products. In my role as a consultant, I have consulted on numerous products and custom testing devices. Among the products I have consulted on are drill rigs, pipe breakers, brick saws, auger conveyors, belt conveyors, dry bulk trailers, rock slingers, dump trailers and other hydraulic equipment.

6. I am a named inventor on seven U.S. Patents. I believe that my credentials as set forth above and, in my Curriculum Vitae, demonstrate that I am an expert in the fields of mechanical design, structural design, product design, design of equipment, and design safety.

7. I have attached as Exhibit 2 a list of all my deposition or trial testimony in the last four years.

8. I have attached as Exhibit 3 a list of all of the references and materials I have considered and/or relied on in coming to my opinions in this matter.

### **III. LEGAL PRINCIPLES**

9. I am not a lawyer. Therefore, in formulating my opinions and conclusions in this proceeding, I have been provided with an understanding of the relevant aspects of U.S. patent law that govern the issues of patent validity. I am informed that the priority date for this analysis is November 12, 2013.

#### **Prior Art**

10. I understand that, in this IPR proceeding, the prior art to the '090 patent includes patents and printed publications in the relevant field(s) that predate the patent's effective filing date.

#### **Obviousness**

11. I understand that a claim of a patent may be obvious to a person of ordinary skill in the art if the differences between the subject matter set forth in the patent claim and the prior art are such that the claimed subject matter as a whole would have been obvious at the time of the invention.

12. I understand that obviousness is a determination of law based on various underlying determinations of fact. In particular, these underlying factual determinations include (1) the scope and content of the prior art; (2) the level of ordinary skill in the art at the time the claimed invention was made; (3) the differences between the claimed invention and the prior art; and (4) the extent of any proffered objective "indicia" of non-obviousness. I understand that the objective

indicia, also known as secondary considerations, which may be considered in such an analysis include, among other factors: the commercial success of the patented invention (including evidence of industry recognition or awards), the existence of a long-felt but unmet need in the field satisfied by the invention, the failure of others to arrive at the invention, industry acquiescence and recognition of the invention, initial skepticism of the invention by others in the field, the extent to which the inventors proceeded in a direction contrary to the accepted wisdom of those of ordinary skill in the art, and licensing of the patent.

13. In determining the scope and content of the prior art, I understand a reference is considered prior art for the obviousness analysis if it falls within the inventors' field of endeavor. Additionally, a reference is prior art for the obviousness analysis, even if from a different field of endeavor, if it is reasonably pertinent to the particular problem for which the invention was made. A reference is reasonably pertinent if it is something a person of ordinary skill in the art would have looked to when attempting to solve the problem.

14. While multiple prior art references or elements may be combined to render a patent claim obvious, I understand that a patent claim composed of several elements is not proven obvious merely by demonstrating that each of its elements was, independently, known in the prior art. I understand that I should consider whether there is an "apparent reason" or motivation to combine the prior art

references or elements in the way the patent claims. It is my further understanding that the law recognizes several rationales for combining references or modifying a reference to show obviousness of claimed subject matter. Some of these rationales include: combining prior art elements according to known methods to yield predictable results; simple substitution of one known element for another to obtain predictable results; a predictable use of prior art elements according to their established functions; applying a known technique to a known method or product ready for improvement; and choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success.

#### **IV. THE LEVEL OF ORDINARY SKILL IN THE ART**

15. I have been advised by counsel that the Federal Circuit has noted a list of six factors that may be considered when determining the level of ordinary skill in the art. The factors are listed below. I have used the factors in combination with the available information in determining the level of ordinary skill in the art.

- A. The education level of the inventor.
- B. The type of problems encountered in the art.
- C. Prior art solutions to those problems.
- D. The rapidity with which innovations are made.
- E. The sophistication of the technology.
- F. The education level of active workers in the field.

16. Considering the above factors, it is my opinion that at the time of the invention and the Challenged Claims of the '090 patent, 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 2 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. I use that level of skill in making my observations and reaching my conclusions herein, unless otherwise stated. As a result of my education and experience, I am qualified to testify as a person of ordinary skill in the art (POSITA) in this case. I further note that Dr. Kytoma, the expert for Patent Owner does not object to this definition.<sup>1</sup>

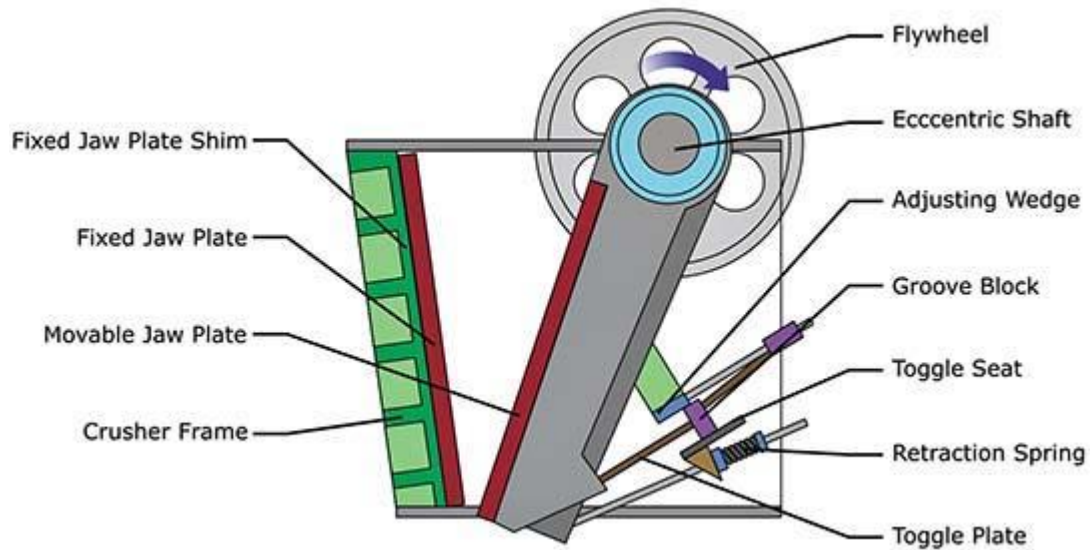
## **V. BACKGROUND AND TEACHINGS OF THE PRIOR ART**

17. As discussed previously, the present matter relates to gyrating rock crushers. Before the advent of crushing machinery, aggregate was produced with manual labor such as by using hammers and pickaxes to break boulders and rocks into smaller pieces. The labor requirements were steep, which led to the development early mechanized rock crushing machinery. Eli Whitney Blake (the nephew of Eli Whitney who invented the cotton gin) is credited with inventing the

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<sup>1</sup> EX2020- Second Declaration of Harri Kytomaa, PH.D. Pp. 4-5

first reciprocating jaw rock crusher in the 1850's.<sup>2</sup> The basic reciprocating jaw crusher (a design still in use to this day) is shown below:



18. As shown above, the jaw crusher uses two jaws (one stationary and one reciprocating) arranged in a V-shape that successively crushes rock into smaller and smaller pieces.

19. The invention of the reciprocating jaw crusher was a quantum leap over manual labor in the rock crushing industry. As time went on, various improvements have been made to this design. Notably, modern jaw crushers have added the ability to pass uncrushable objects (such as large steel scrap) without damaging the equipment. Depending on the size, shape, orientation, and sequence

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<sup>2</sup> <<https://aggregates.seprosystems.com/history-of-rock-crushers/>> accessed 7-30-2024

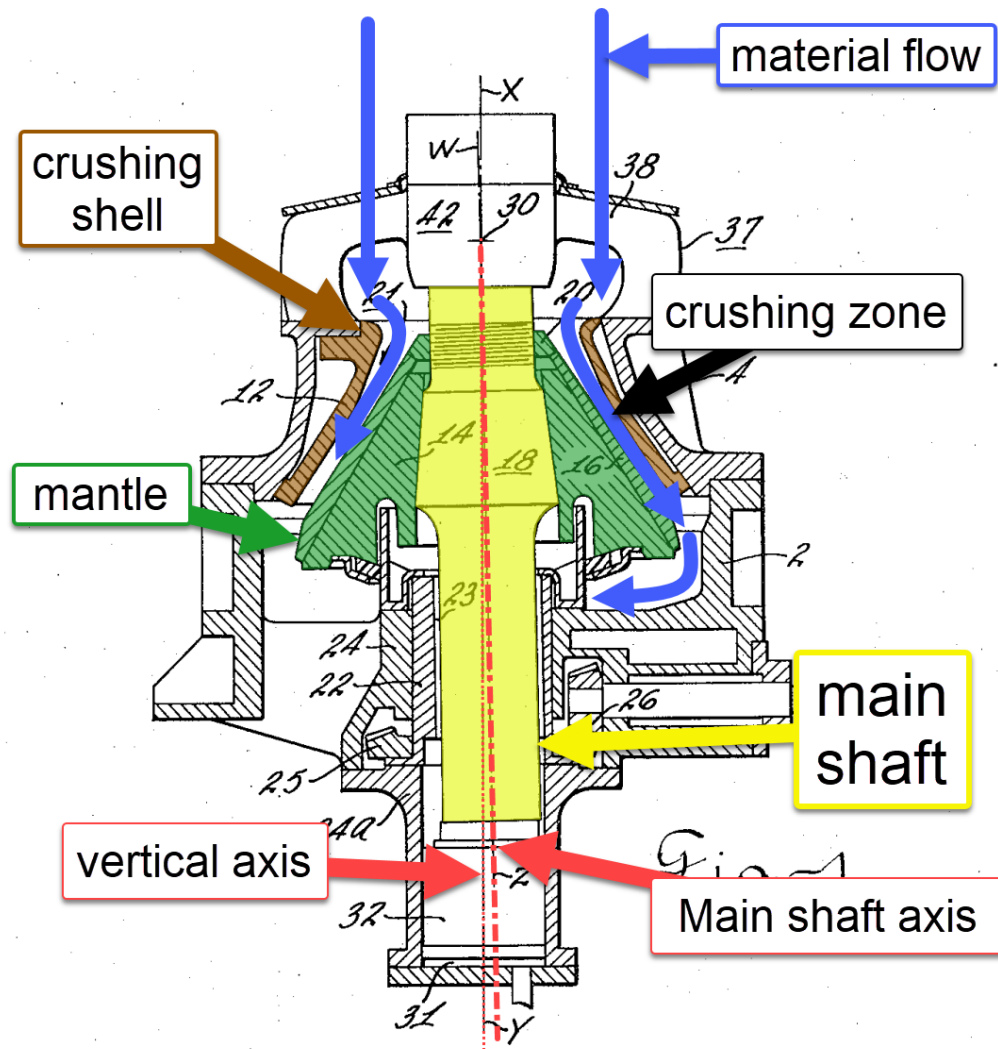
<sup>3</sup> <[https://ogden\\_images.s3.amazonaws.com/www.mininggazette.com/images/2022/04/01160835/4-2-CCPP.gj-.jpg](https://ogden_images.s3.amazonaws.com/www.mininggazette.com/images/2022/04/01160835/4-2-CCPP.gj-.jpg)> accessed 7-30-2024

of the rock entering the crusher, it is possible for a jam to occur. Various methods for eliminating jams have been devised, which typically require manual input or attention.

20. The gyrating cone crusher was first introduced to the market in the 1920's by the Symons brothers.<sup>4</sup> The design topology for a typical gyrating cone crusher (as shown in US 3,813,047 to Torrence) is shown below:

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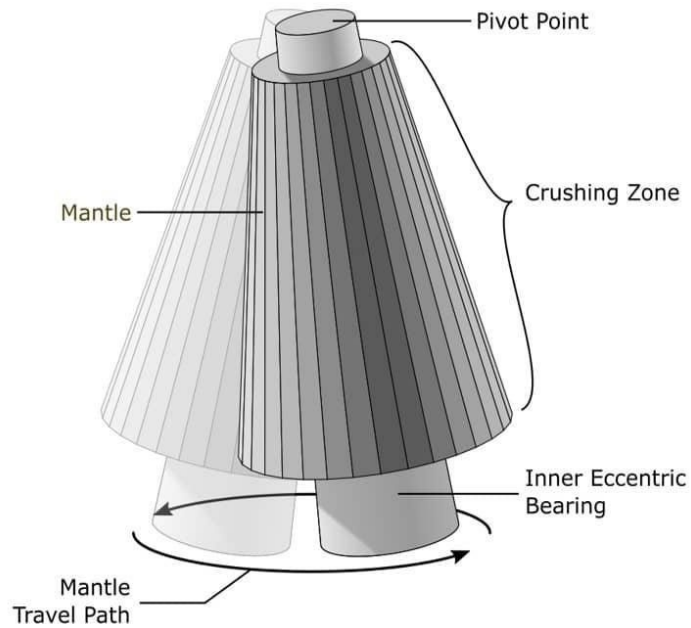
<sup>4</sup> <<https://aggregates.seprosystems.com/history-of-rock-crushers/>> accessed 7-30-2024



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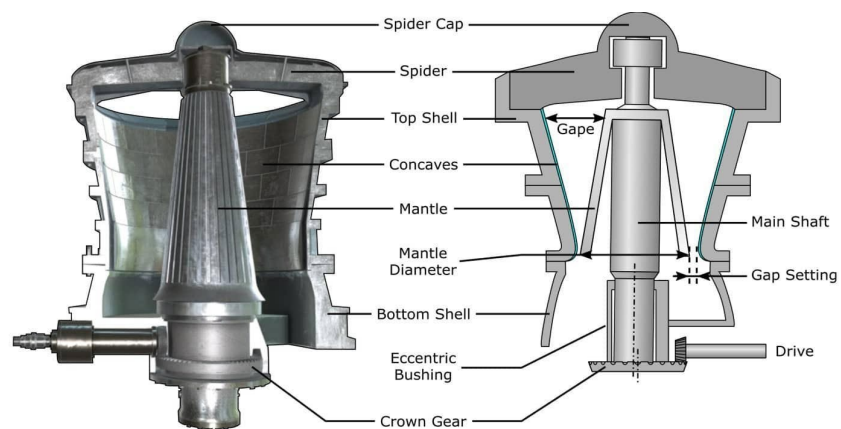
21. As shown above, the typical gyrating cone crusher has a central main shaft fitted with an internal crushing shell (mantle). The main shaft and mantle are situated inside an external crushing shell with some clearance therebetween (the crushing zone). The main shaft is driven by an eccentric drive about an axis that results in eccentric rotation of the shaft and rotation of the shaft around its own axis. An example of the gyrating motion of the eccentric drive is shown below:

<sup>5</sup> US 3,813,047 to Torrence et al. Figure 1, annotated



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22. The gyrating motion of the eccentric drive (shown above) allows rock to slide into the crushing zone and be sequentially crushed into smaller and smaller pieces until it is discharged out the base of the machine. For further clarity, the figure below shows how the diagram of a gyratory cone crusher relates to a physical build:



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<sup>6</sup> <<https://savree.com/en/encyclopedia/gyratory-crusher>> accessed 7-30-2024

<sup>7</sup> <<https://savree.com/en/encyclopedia/gyratory-crusher>> accessed 7-30-2024

23. As discussed previously, the present matter relates to a patent on a particular gyrating cone crusher. The main figure of the '090 patent is shown below:

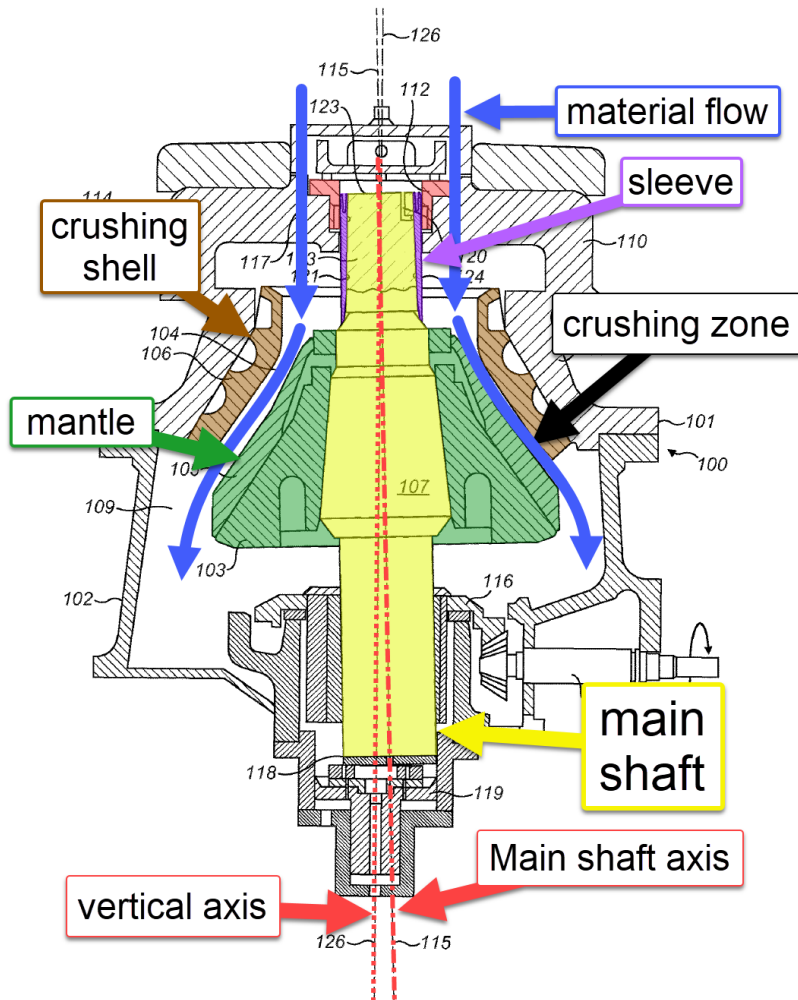
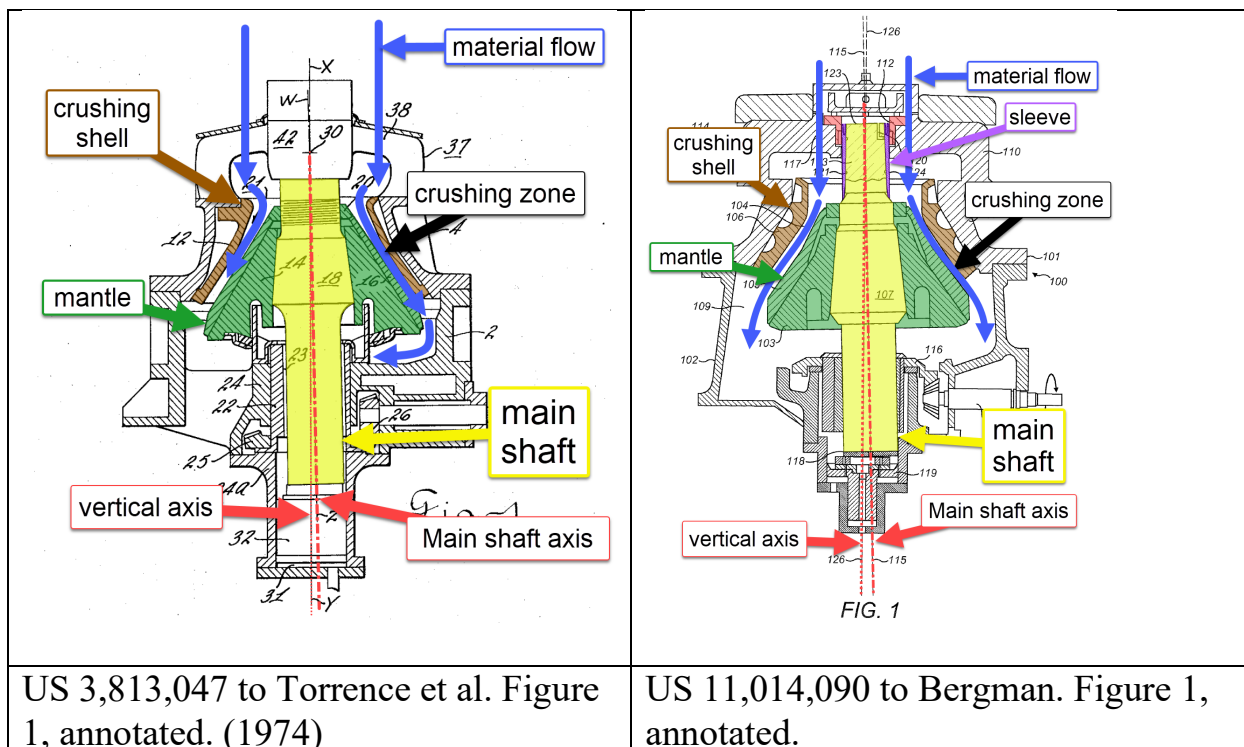


FIG. 1

24. As can be seen above, especially as compared with the Torrence cone crusher above, the '090 patent shows a cone crusher of typical design. It has a main shaft fitted with a mantle on an eccentric drive. The central cone shaft assembly is mounted internal to a crushing shell creating a crushing zone.



25. The '090 patent does not claim to disclose a new cone crusher design topology. Rather, the '090 patent claims to disclose an allegedly new and non-obvious arrangement for assembling, disassembling, and supporting the topmost portion of the main shaft. Specifically, the '090 patent states:

*“It is an objective of the present invention to provide a gyratory crusher main shaft and a main shaft assembly (having a sleeve) that enables convenient mounting and dismounting of the protective sleeve at the upper end of the shaft that obviates a requirement for excessive heating of the main shaft and the use of grinding and cutting apparatus that otherwise carries a risk of damage to the main shaft and injury to the service personnel. It is a further specific objective of the present invention to provide a main shaft and sleeve assembly that facilitates mounting and dismounting of the sleeve at the shaft via control of a pressurised[sic] fluid delivered to the region of an axially upper end of the shaft radially between the shaft and the sleeve.”<sup>8</sup>*

<sup>8</sup> US 11,014,090 to Bergman, 1:63-2:9

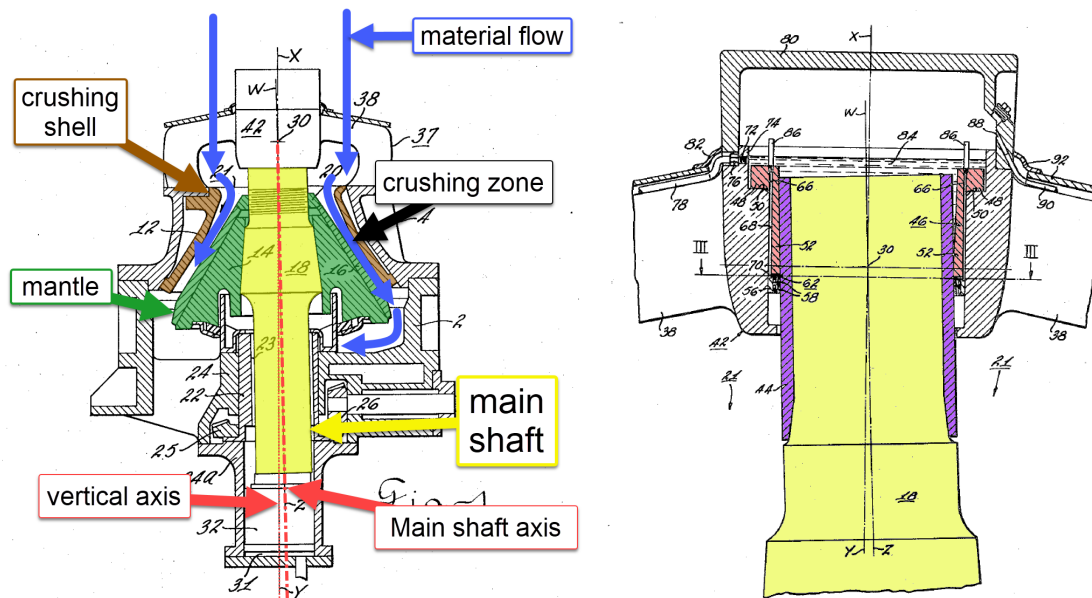
26. However, as will be demonstrated in this declaration, the '090 patent does not disclose anything new and non-obvious. To the contrary, the '090 patent merely uses ordinary design elements, well-known in the art, to produce predictable results. It is the result of nothing more than standard engineering design and does not present anything inventive. For example, the '090 patent describes including a sleeve fitted over the topmost portion of the main shaft of the gyratory crusher. The sleeve is provided with a tapered interference fit of ordinary design. Optionally, the sleeve may also comprise a fluid pathway where a fluid such as oil may be supplied under pressure to assist with mounting or dismounting the tapered sleeve. Several well-known arrangements of fluid pathways are described. Finally, an end retainer of ordinary design and construction is included. As will be demonstrated, each of these design elements are ordinary and well-known to a POSITA. Further, each of these design elements are well understood and the prior art teaches their use in rock crushing machinery already.

**A. Gyratory Crushers with Wear Sleeves Were Known**

**U.S. Patent Publication No. 3,813,047 to Torrence et al.**

27. The US Patent No 3,813,047 (hereinafter Torrence) discloses a rock crusher with a wear sleeve. I understand that Torrence is prior art to the '090 patent because it issued on May 28, 1974, which is before the priority date of the '090 Patent. The top end of the Torrence rock crusher shaft with the wear sleeve is

shown below:

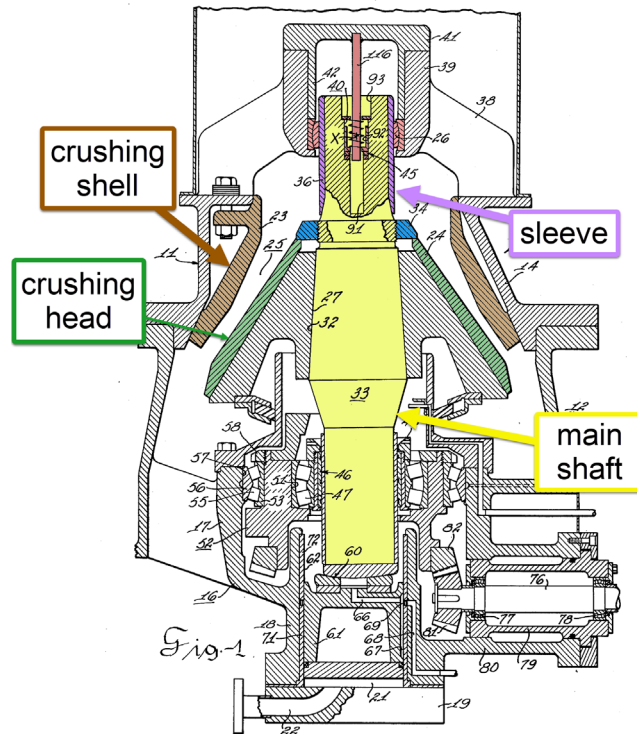


28. As shown in the figures above, Torrence shows a gyratory rock crusher of conventional design. The Torrence reference teaches a wear sleeve as highlighted in purple.

### **U.S. Patent Publication No. 4,037,800 to Coxhill**

29. U.S. Patent Publication No. 4,037,800 to (the '800 patent) to Coxhill describes a prior art system for a gyratory crusher with a bearing sleeve fitted over an upper region of a main shaft. The '800 patent is not listed as a cited reference for the '090 patent. I understand Coxhill is prior art to the '090 patent because it issued on July 26, 1977, which is well before the priority date of the '090 Patent.

30. The Coxhill gyratory crusher with wear sleeve in FIG. 1 of the '800 patent is shown below.



9

31. Coxhill teaches a feature to prevent the shaft from spinning in the same rotational direction as the driven eccentric rotation when the machine is idling.

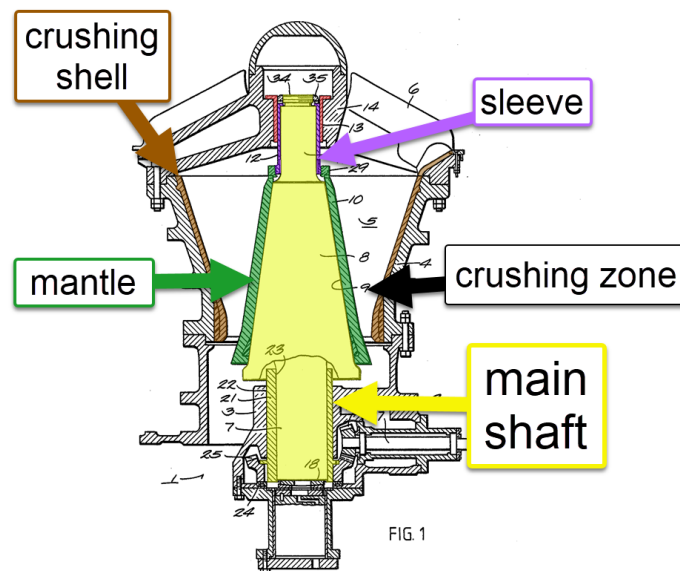
32. Coxhill has a protective bearing sleeve on the upper end of the shaft. The sleeve of Coxhill does not have a taper, but it extends to the extreme end of the shaft and appears cylindrical when viewed from the exterior. The use of a shrink-fit cylindrical sleeve as a wear item to protect a shaft is extremely common and has been used for many years to extend shaft life.

### **U.S. Patent Publication No. 4,410,143 to Polinski**

<sup>9</sup> US 4,037,800 to Coxhill, Figure 1, annotated

33. U.S. Patent Publication No. 4,410,143 ('143 patent or Pat '143) to Polinski describes a prior art system for a gyratory crusher with a bearing sleeve fitted over an upper region of a main shaft. The '143 patent is not listed as a cited reference for the '090 patent. I understand Polinski is prior art to the '090 patent because it issued October 18, 1983, which is well before the priority date of the '090 patent.

34. The Polinski gyratory crusher with wear sleeve in FIG. 1 of the '143 patent is shown below.



10

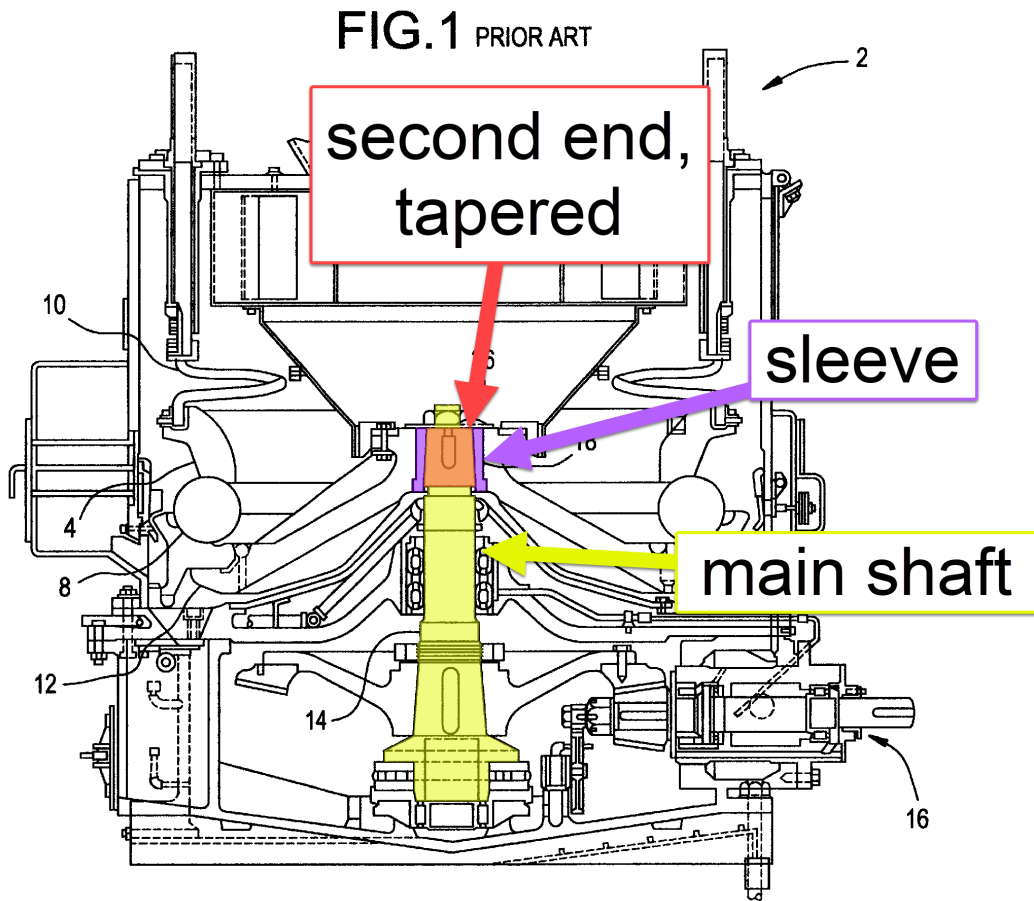
### **U.S. Patent Publication No. 6,270,026 to Piepho et al**

35. Another example of a rock crusher with a wear sleeve is disclosed in U.S. Patent Publication No. 6,270,026 ('026 patent or Pat '026) to Piepho et al.

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<sup>10</sup> US 4,410,143 to Polinski, Figure 1, annotated

(Piepho). The '026 patent is not listed as a cited reference for the '090 patent. I understand Piepho is prior art to the '090 patent because it was filed June 5, 1997, which is before the priority date for the '090 patent. The Piepho rock crusher with wear sleeve in FIG. 1 of Pat '026 is shown below.



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36. Piepho teaches the interchangeability between a cylindrical joint and a tapered joint. Piepho also teaches that a tapered joint is preferable.

“The present invention provides an intervening material between the shaft end (25) and the mating bore in yoke bushing (18) fitted within the bore of yoke (12) to prevent fretting damage. For accurate alignment and for reliable support of the yoke, this joint (21) must be capable of accepting radial, axial, and bending or overturning loads.

<sup>11</sup> US 6,270,026 to Piepho, Figure 1, annotated

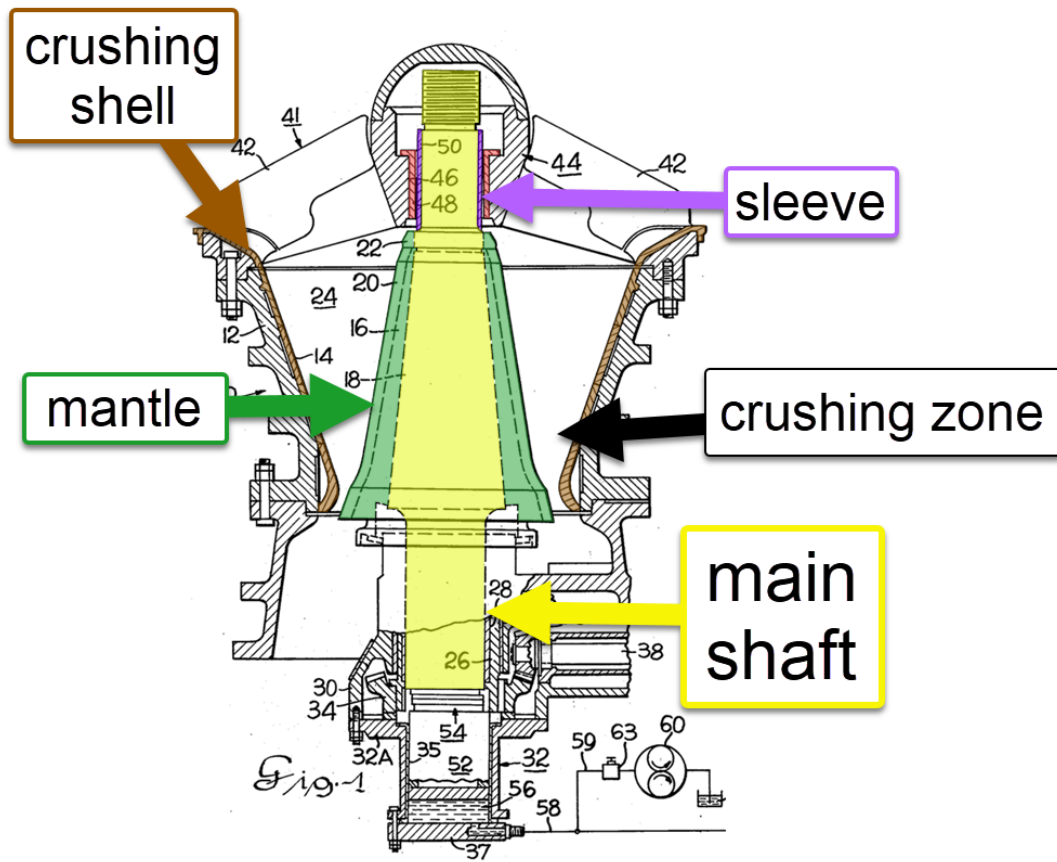
**Preferably, the joint (21) is a tapered joint with the tapered end (25) of shaft (14).**  
The yoke bushing (18) has a mating bore similarly tapered. Shaft end (25) may be constructed for either a keyless or a keyed fit. Also, **Shaft end (25) alternatively may be cylindrical rather than tapered as seen in FIG. 4.**<sup>12</sup>

**U.S. Patent Publication No. 4,060,205 to Pollak**

37. Yet, another example of a gyratory crusher with a wear sleeve is disclosed in U.S. Patent Publication No. 4,060,205 ('205 patent or Pat '205) to Pollak. Pat '205 is not listed as a cited reference for the '090 patent. I understand Pollak is prior art to the '090 patent because it was filed November 29, 1977, which is before the priority date for the '090 patent. Pollak discloses a gyratory crusher with wear sleeve in FIG. 1 of the '205 patent as shown below.

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<sup>12</sup> US 6,270,026 to Piepho 3:24-35, emphasis added



13

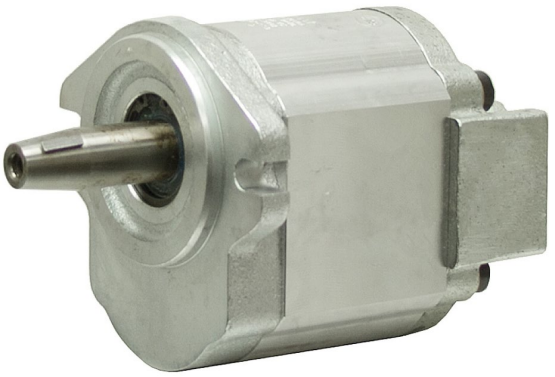
## B. Tapered Interference Fits and Making and Breaking Joints with Hydraulic Fluid were Known

38. The '090 patent describes the use of a friction fit joint between the tapered sleeve and the main shaft.<sup>14</sup> A friction joint is created when a pin or shaft is connected to a bore in a way that requires compression on the pin component and expansion of the bore. Also known as an interference fit joint, a friction fit is so called because the joint is held together by intense pressure developed between the shaft and the bore.

<sup>13</sup> US 4,060,205 to Pollak, Figure 1, annotated

<sup>14</sup> US 11,014,090 to Aberg, 5:8-11

39. It is well-known in the art and would be well-known to a POSITA that interference fits can be accomplished using a straight cylindrical shape, or a tapered conical shape. Not only are conical interference joints common in rock crushers, they are also common across many industries and applications such as boat propellers, hydraulic motors, pulley hubs, gearboxes, engine shafts, lathes, drill chucks, etc. They are a standard design element, are well-known, and well understood as demonstrated by the following table:

|                                                                                    |                                                                                                                                          |
|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
|  |                                                       |
|                                                                                    | <p>16</p> <p>Hydraulic Motor with tapered shaft</p>  |

<sup>16</sup> <<https://www.surpluscenter.com/Hydraulics/Hydraulic-Pumps/Clutch-Pumps-Hydraulic/2-32-cu-in-Hydraulic-Pump-w-Tapered-Shaft-for-Electric-Clutch-Rexroth-AZPN10036RXXR12MA-9-1738-P.axd>> accessed 7-31-2024

|                                                                                                                                      |                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
|  <p>15</p> <p>Boat Propeller with tapered shaft</p> | <p>17</p> <p>Tapered fit pulley hub</p>                                                                                             |
|  <p>18</p> <p>Tapered engine shafts</p>             | <p>Drill chucks with tapered shaft</p>  <p>19</p> |

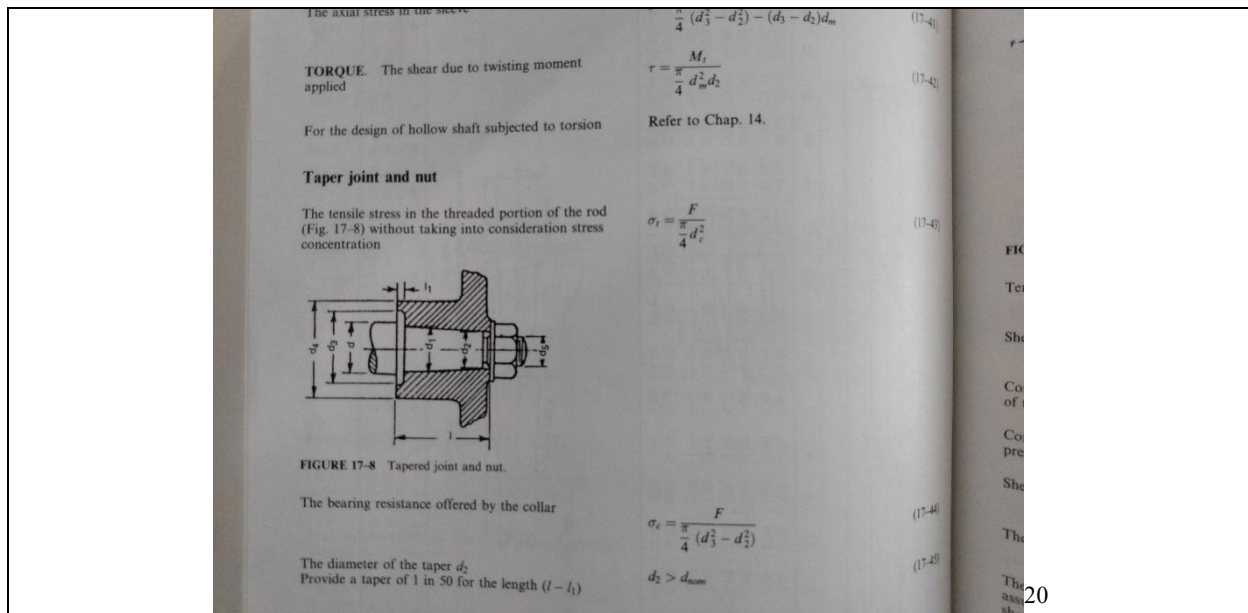
<sup>15</sup> <[https://pbase.com/mainecruising/fitting\\_a\\_prop](https://pbase.com/mainecruising/fitting_a_prop)> accessed 7-31-2024. I note that this website was available at least as early as 2010:

([https://web.archive.org/web/20101027092713/https://pbase.com/mainecruising/fitting\\_a\\_prop](https://web.archive.org/web/20101027092713/https://pbase.com/mainecruising/fitting_a_prop)) Further, boat propellers have been fitted with tapered interference joints for a far longer time than that.

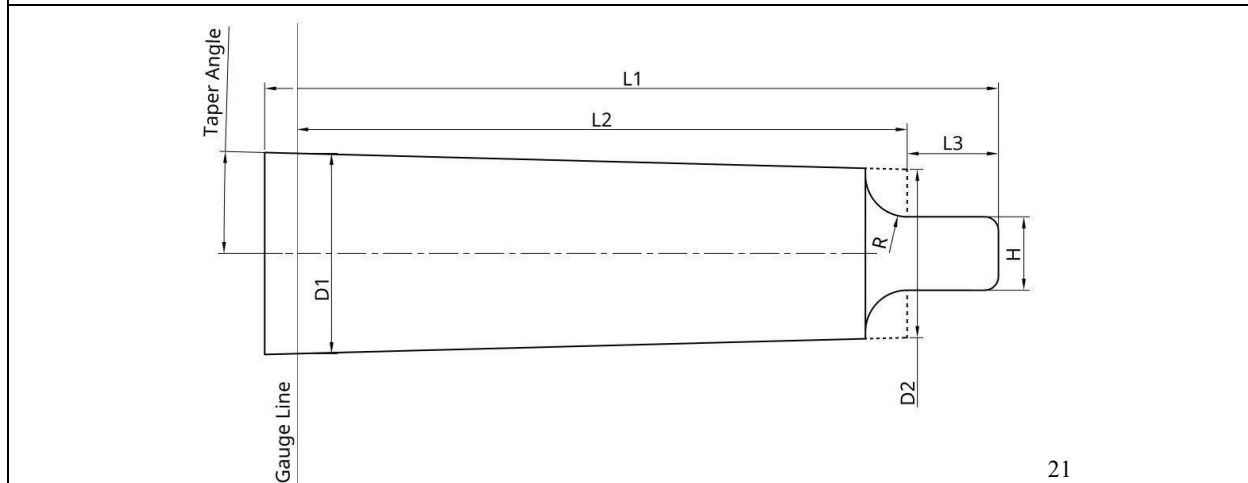
<sup>17</sup> <[https://img.directindustry.com/images\\_di/photo-g/20030-2339083.jpg](https://img.directindustry.com/images_di/photo-g/20030-2339083.jpg)> accessed 7-31-2024

<sup>18</sup> <[https://www.brandnewengines.com/cdn/shop/products/SAM\\_3681\\_1024x.jpg](https://www.brandnewengines.com/cdn/shop/products/SAM_3681_1024x.jpg)> accessed 7-31-2024

<sup>19</sup> <<https://ashdowntooling.co.uk/products/1-5mm-13mm-lathe-tailstock-drill-chuck-morse-taper-3-mt3-to-b16-arbor>> accessed 7-31-2024



I note that tapered interference joints are so common that they are a topic in a typical engineering course on machine design. For example, the above textbook excerpt shows a tapered press fit joint and several formulas of interest for stress calculations.



The famous Morse taper, also a topic covered in a typical engineering course on machine design, was invented in 1864 by Stephen A. Morse.<sup>22</sup> Morse tapers are used to create tapered interference joints commonly used on all manner of shafting for machinery. A Morse taper is a self-holding taper used to reliably hold two components together for transmission of torque.

Engineering standards such as SAE J755, SAE J1419, ASME B18.8.2 and more

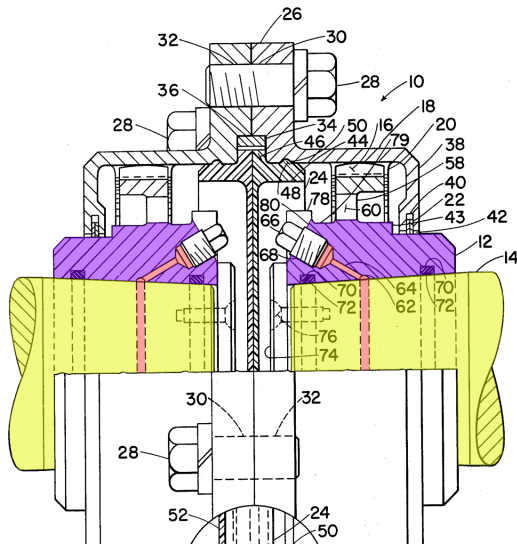
<sup>20</sup> Machine Design Data Handbook, K. Lingaiah, c1994

<sup>21</sup> <<https://www.cgk.co.uk/metalwork/data/morse>> accessed 7-31-2024

<sup>22</sup> <<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3779551/>> 7-31-2024

are written to specify tapered interference fits.

US 4,019,344 to Calistrat (1977)  
Symmetrical sealed gear coupling



I note that not only does Calistrat disclose a dual tapered interference joint setup, it also features a fluid pathway which is used to help break the tapered interference joints, as is well known.<sup>23</sup>

US 3,343,376 to K.K. Carman (1967)  
Lubricant seal for couplings

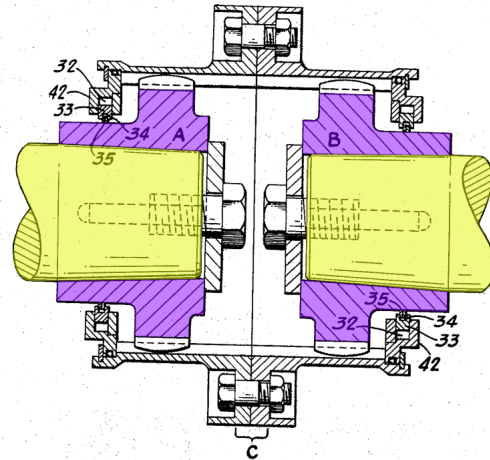


FIG. 8

As shown above, two tapered interference joints are disclosed which use hex bolts to apply the preload. This is an extremely common way for tapered joints to be implemented.

US 2,840,399 to C.A. Harless Et Al (1958) Attachment of Gears to tapered shaft ends

US 3,228,102 to R.E. Sillett (1963)  
Hydraulic assembly and disassembly of parts having a heavy Interference fit

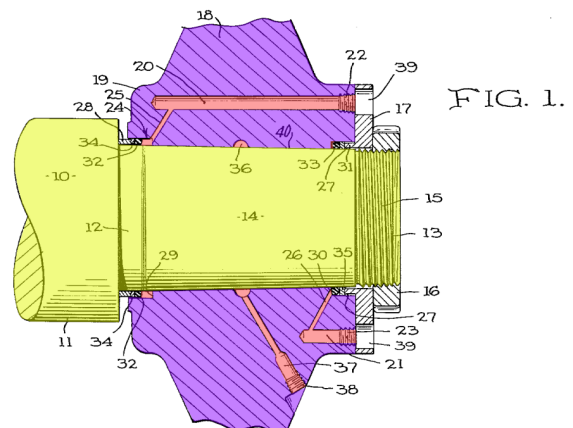
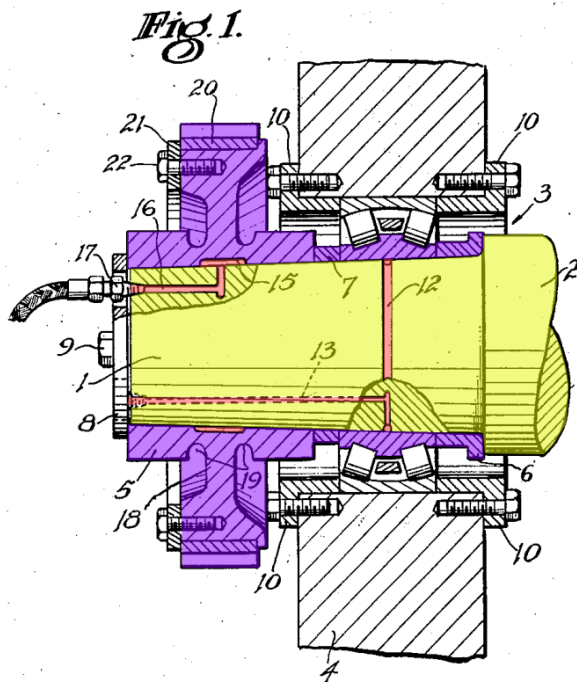


FIG. 1.

I note that not only does R.E. Sillett

<sup>23</sup> US 4,019,344 to Calistrat 3:36-43



disclose a tapered interference joint setup, it also features a fluid pathway which is used to help make or break the tapered interference joints, as is well known.

I note that not only does C.A. Harless disclose a tapered interference joint setup, it also features a fluid pathway which is used to help make or break the tapered interference joints, as is well known.

US 4,829,718 to Behm (1989). Grinding Wheel Assembly and Method

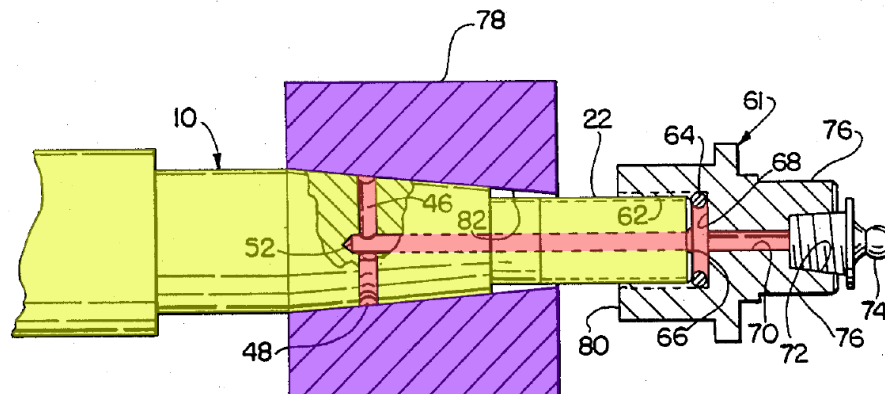


FIG. 2

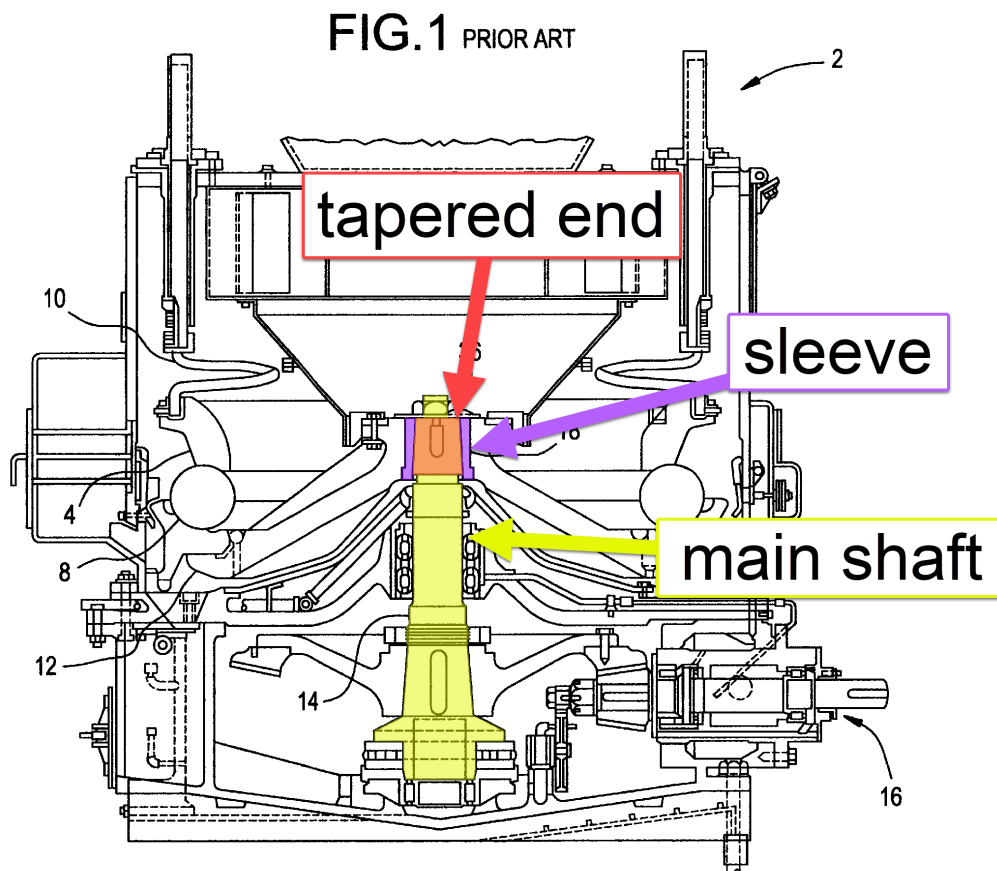
40. As shown above, tapered interference joints are extremely common and ordinary in mechanical machine design.

41. An additional example of a tapered interference joint as used with a rock crushing apparatus is shown below:

**U.S. Patent Publication No. 6,270,026 to Piepho et al**

42. Piepho, discussed above, also describes a prior art rock crusher with a sleeve that is friction fitted to the upper portion of the shaft, see Piepho 3:23-32.

The rock crusher shaft and sleeve arrangement in FIG. 1 of the '026 patent is shown below.

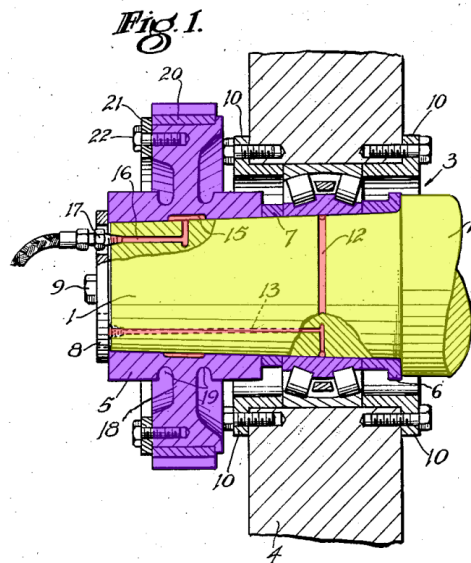


**C. Pressurized Fluid Groove for Mounting and Dismounting Components were Known**

**US 2,840,399 to C.A. Harless Et Al**

43. US 2,840,399 to C.A. Harless issued June 24, 1958. This is well in advance of the filing date of the '090 patent. As such, the C.A. Harless reference is also prior art to the '090 patent.

44. Harless describes using pressurized oil for attachment of gears and bearings to tapered shaft ends. Harless discloses grooves being indented on both the shaft and the sleeve and also discloses multiple grooves for a sleeve on a tapered section. The oil is supplied through a conduit that extends axially within the shaft and then radially towards the surface of the shaft.



45. As shown above, Harless is aimed at fixedly attaching and detaching components such as sleeves to tapered shaft ends, as facilitated by the use of fluid power elements, just the same as the '090 patent. Thus, Harless would be

considered analogous art and would be within the purview of a POSITA. Further, Harless highlights that even in 1958, the technology of using hydraulic means to aid in making and breaking tapered interference joints was already well-known.

**US 8,302,754 to Yagi**

46. US 8,302,754 to Katsuki Yagi (hereafter, the '754 patent, or Yagi) filed on July 23, 2009. This is also well in advance of the priority date of the '090 patent. Yagi is reasonably pertinent to one of the problems the inventor was trying to solve and is thus in the same field of endeavor.

47. Yagi addresses coupling and decoupling tapered coupling structures by pumping oil into the interstitial area between the tapered shaft and sleeve utilizing a plurality of grooves and oil passages.

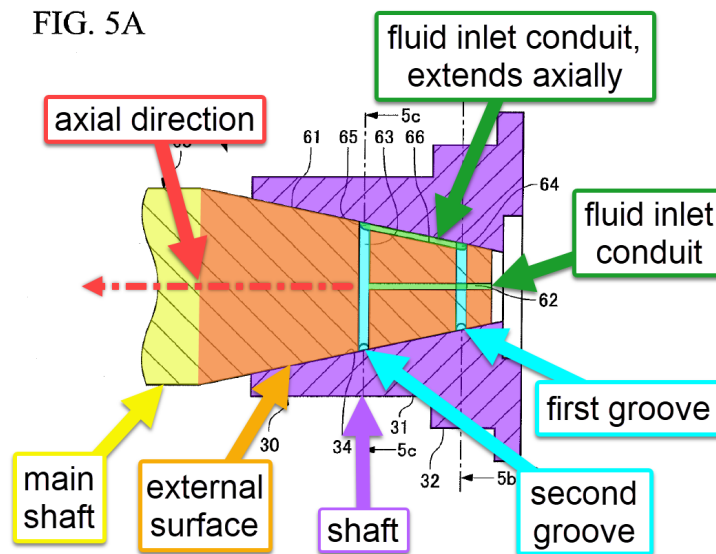
“In the **tapered coupling structure** (hereinafter, sometimes referred to simply as a coupling structure), when the tapered shaft is coupled to the hub, or when the tapered shaft is decoupled from the hub, **oil is fed to the coupling surfaces of the tapered shaft and the hub to increase the diameter of the hub, by which coupling and decoupling are enabled.** For this purpose, the coupling structure is configured so that an oil passage is provided in the tapered shaft (or the hub), and **an oil groove** connecting with the oil passage is provided in the outer peripheral surface of the tapered shaft (or the inner peripheral surface of the hub) **to feed oil to the coupling surfaces via the oil passage and oil groove.**”<sup>24</sup>

48. Yagi explicitly discloses a port in the end of a shaft through which pressurized hydraulic oil is introduced to a hydraulic conduit running in an axial direction in the shaft. Cross holes connect the axial conduit with a circumferential

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<sup>24</sup> Yagi 1:26-37, emphasis added

groove around the shaft. A groove on the surface of the shaft connects the first circumferential groove to a second circumferential groove. Yagi discloses the tapered end of the shaft with the taper extending to the extreme end of the shaft.



### US 4,829,718 to Behm

49. Behm describes a grinding wheel mounting apparatus and method of demounting characterized by a shaft with a tapered end portion and a wheel adaptor with a tapered axial bore for mounting on the shaft. Behm further teaches a fluid passage “for directing pressurized fluid to a point within the confines of the area of contact so that the pressure of such fluid may exert both radial and axial forces on the adaptor to effect its release from the shaft.”<sup>25</sup> Behm further teaches a removal fitting proportioned to permit only loosening of the object mounted to the

<sup>25</sup> ‘718 to Behm at Abstract

shaft until the fitting itself is removed. This provides a “safety factor in that the pulley 26 cannot fall from the shaft 10 until the removal fitting 61 is removed from the shaft.”<sup>26</sup>

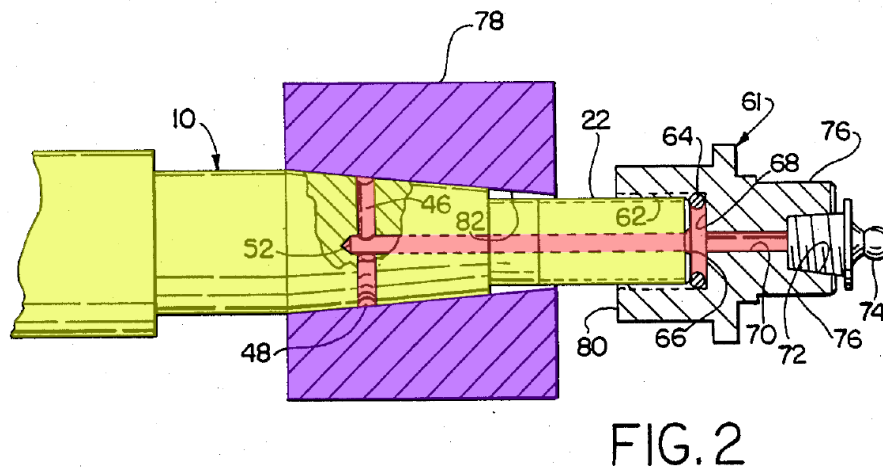
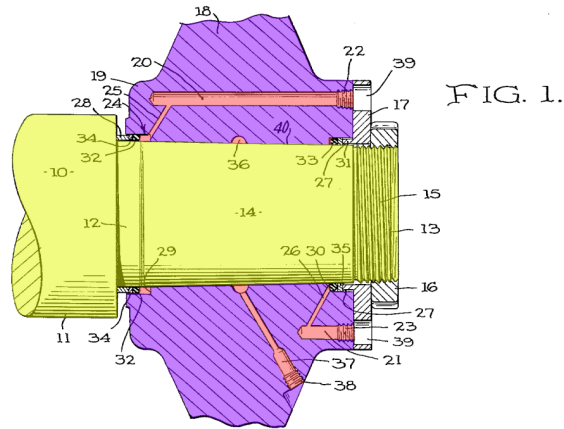


FIG. 2

**US 3,228,102 to R.E. Sillett**

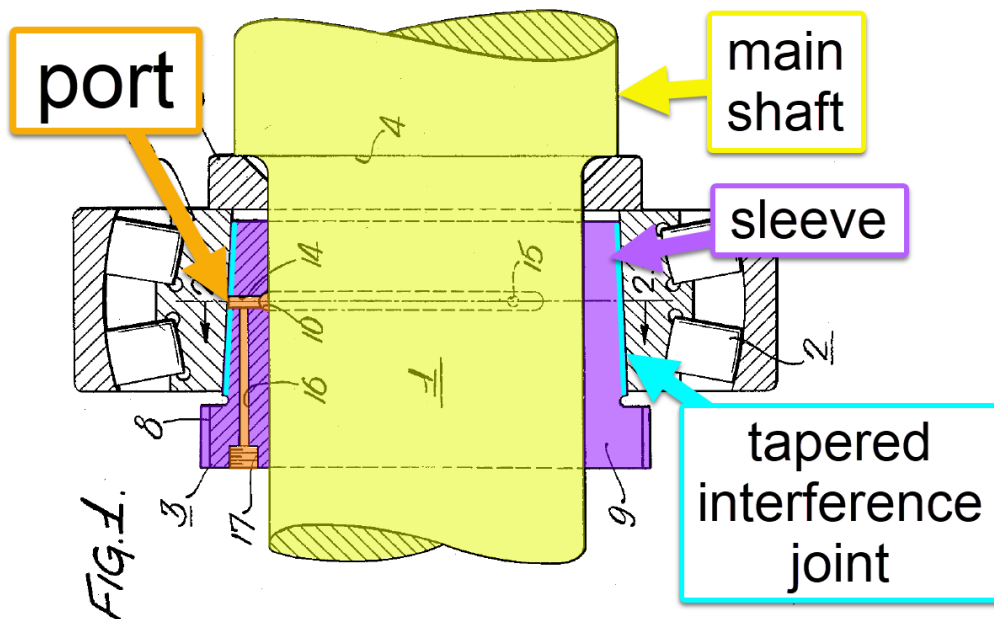
50. Sillett teaches (in 1966) a means for assembling and disassembling mating parts which may have a heavy interference fit on a tapered shaft. Sillett teaches that the bore can be through the sleeve or component mounted on the shaft, and can direct pressurized fluid to bores at different locations along the length of the shaft. Clearly, it was well known by the priority date of the '090 that pressurized fluid could be introduced to the mating surface on a tapered shaft through the shaft or through the sleeve/hub/object mounted on the shaft to make or break the interference fit.

<sup>26</sup> '718 to Behm 4:57-62



**U.S. Patent Publication No. 2,764,437 to A. E. Bratt**

51. Grooves configured to receive pressurized fluid for the mounting and dismounting of components were known in the art. For example, U.S. Patent Publication No. 2,764,437 ('437 patent or Pat '437) to A. E. Bratt, (Bratt) describes a prior art system for producing an interference joint between two components and a means of making and separating said components. Pat '437 is not listed as a cited reference for the '090 patent. I understand Bratt is prior art to the '090 patent because it was filed May 31, 1951, and issued in September 1956, which is before the earliest filing date for the '090 patent in 2014. The grooves configured to receive pressurized fluid for the mounting and dismounting of components is shown below in FIG. 1 of the '437 patent.



27

52. As shown above, A.E. Bratt discloses pressurizing oil into the tapered interference joint through the port.<sup>28</sup> Specifically, pumping sufficiently pressurized oil into the port in this tapered interference joint facilitates the creates of the joint as it lubricates the mating components allowing them to be moved into their final positions more readily. Further, the pumping of sufficiently pressurized oil into the port will apply a force that will tend to push the joint apart due to the direction of the tapering of the joint.

**Public Literature “Accurate mounting of bearings, propellers and gears has never been quicker...”**

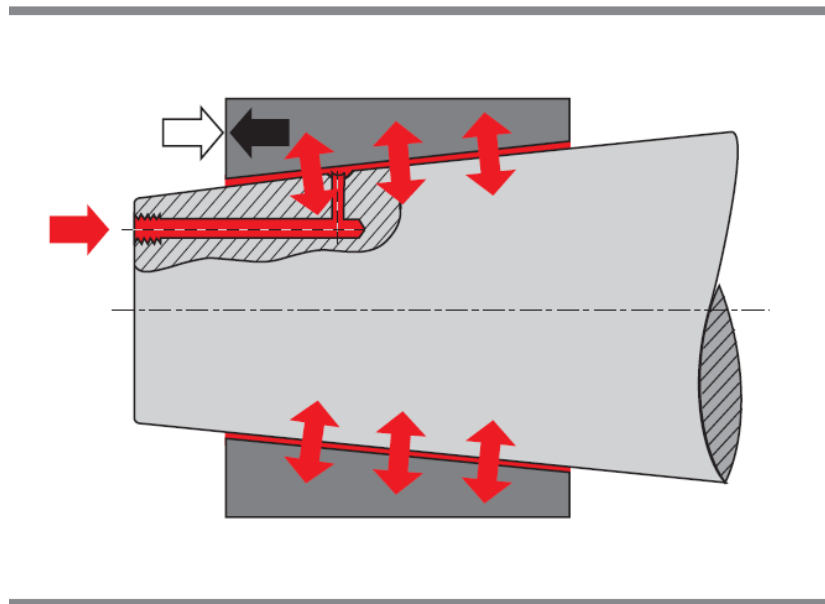
53. Public literature titled “Accurate mounting of bearings, propellers and

<sup>27</sup> US 2,764,437 to A.E. Bratt, rotated and annotated

<sup>28</sup> US 2,764,437 to A.E. Bratt 1:19-21, 29-34, 69-72, 2:6-29, emphasis added

gears has never been quicker...” by SKF Maintenance Products is another example of grooves configured to receive pressurized fluid for the mounting and dismounting of components that was known in the art. I understand “Accurate mounting of bearings, propellers and gears has never been quicker...” is prior art to the '090 patent because it has been available to the public since 2003, which is before the earliest filing date for the '090 patent in 2014.

54. The grooves configured to receive pressurized fluid for the mounting and dismounting of components can be seen on page 2 of “Accurate mounting of bearings, propellers and gears has never been quicker...” as shown in the image below.



*Mounting and dismounting,  
directly on a tapered shaft*

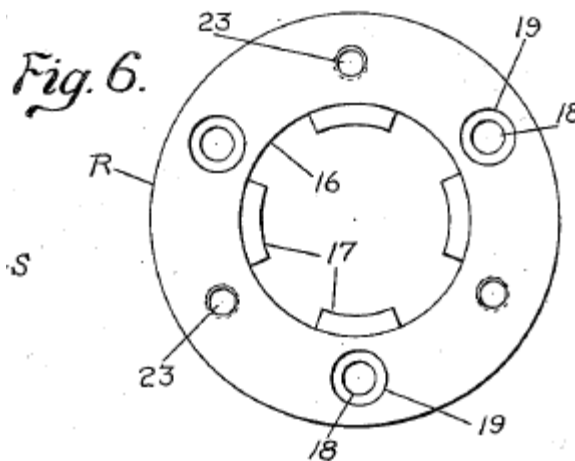
**D. Using Screws to Seat and Unseat Press Fits was Known**

55. In addition to using hydraulics to help seat and unseat bearings and bushings, it was also known to use screws and strategically placed threaded holes and through holes to push or pull a bushing into or out of engagement. There are multiple examples in the prior art.

**US 2,381,697 to Shepard**

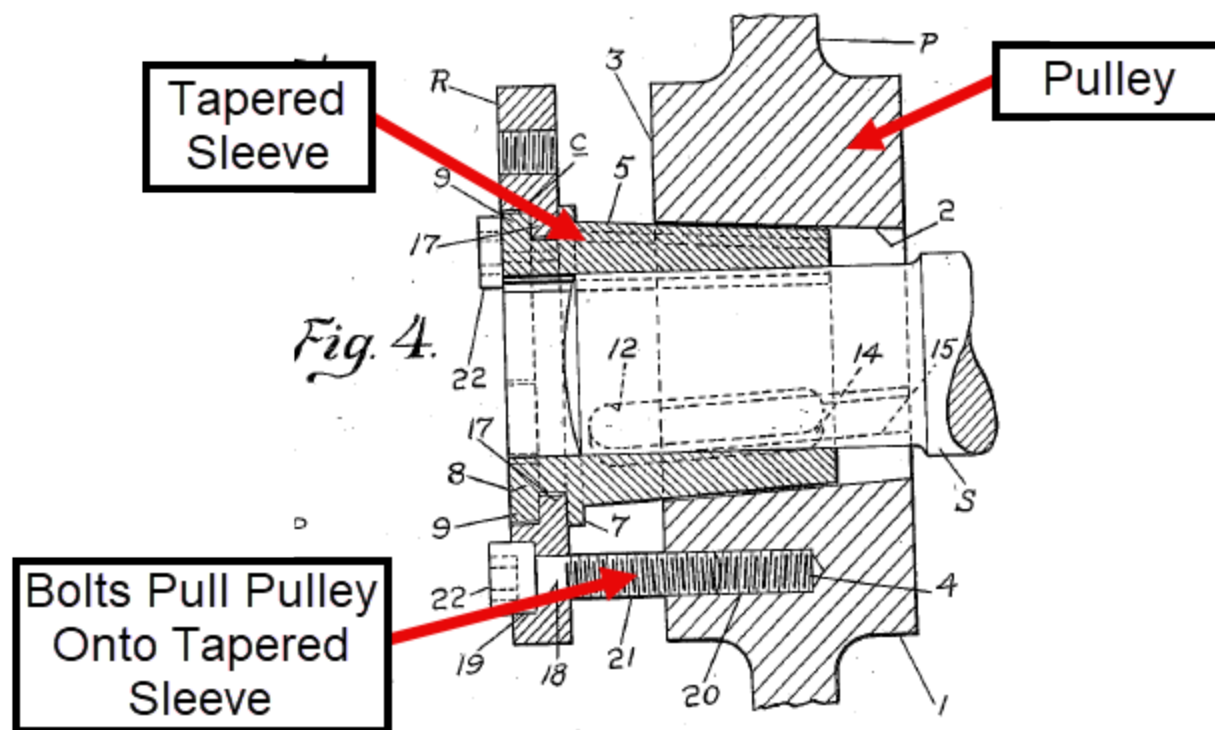
56. US 2,381,697 to F. B. Shepard (hereinafter “Shepard”) was filed April 27, 1944 and is titled HUB STRUCTURE. Shepard relates to using a tapered sleeve to lock a pulley, gear, or the like onto a shaft and to facilitate release therefrom as well. Shepard is reasonably pertinent to the problem the inventor was trying to solve and is prior art.

57. Specifically Shepard teaches a plate “R” with a plurality of holes arranged in a circular pattern. The holes include openings 18 and 23 as shown below.



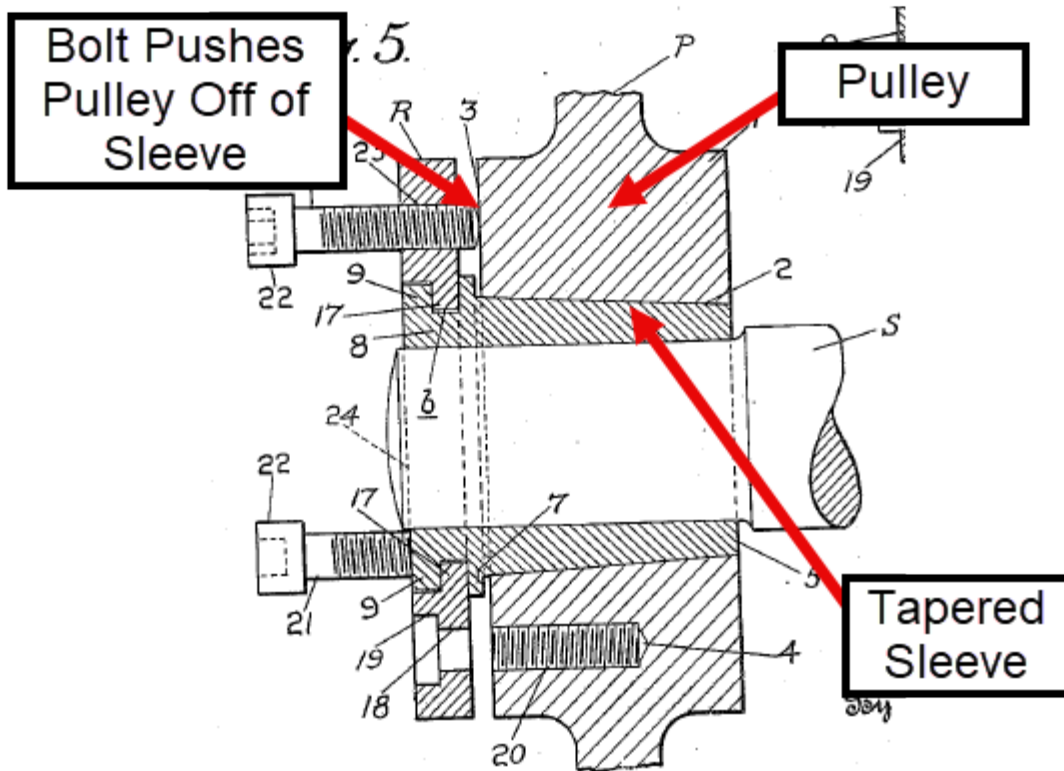
58. Shepard teaches that “In the present embodiment of the invention, these openings 18 are shown as three in number and these openings 18 are adapted to register with the properly positioned threaded sockets 20 in the face 3. A headed bolt 21 is inserted through each of the openings 18 and threads within the registering sockets 20... whereby as the bolt 21 is threaded within its socket, the ring R together with its lugs 17 will contact with the adjacent high extremity of the sleeve or bushing 5 inwardly of the extension 8 and force said sleeve or bushing 5 within the bore 2 of the body 1, whereby the pulley P or the like will be effectively locked as desired upon the shaft S.”<sup>29</sup> In this manner Shepard teaches using bolts to pull the pulley P onto the tapered portion of the sleeve locking it in place.

<sup>29</sup> Shepard 2:31-48



59. Similarly, Shepard teaches that bolts can be used to push the pulley off of the tapered sleeve. “When it is desired to remove the pulley P or the like, the bolts 21 are removed and threaded through the openings 23, one of said openings being centrally positioned between each part of adjacent openings 18. As these bolts 21 are threaded inwardly through the openings 23, they will have contact with the face 3 of the central portion of the pulley P or the like with the resultant pulling out of the sleeve of bushing 5 which in turn releases the grip on the shaft S to allow the pulley P or the like to be freely removed by hand and without requiring special tools.”<sup>30</sup>

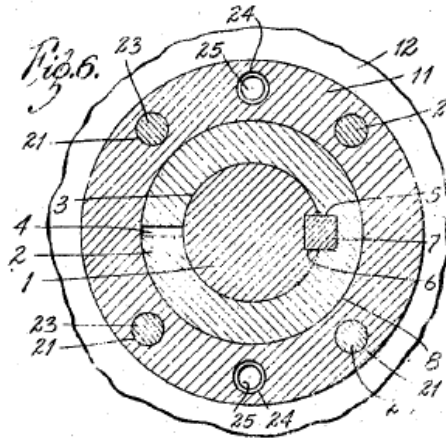
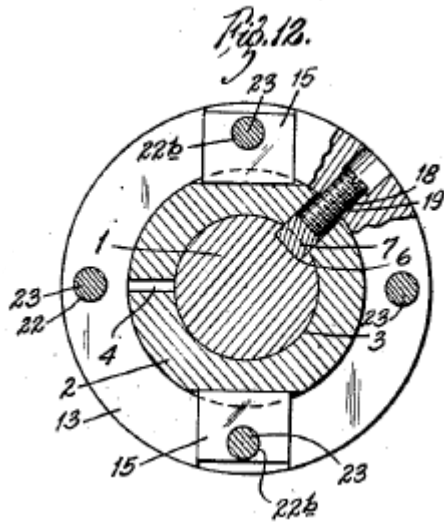
<sup>30</sup> Shepard 2:49-61



### US 2,377,046 to Siegerist

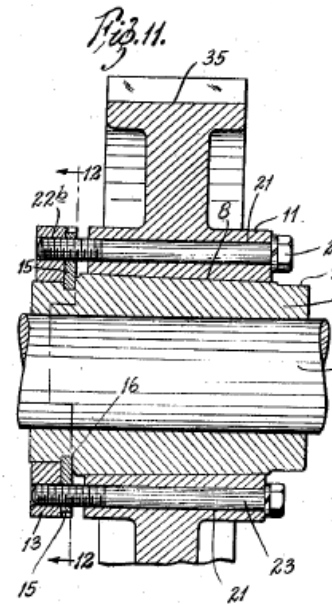
60. The US Patent 2,377,046 to Siegerist (hereinafter Siegerist) was filed on February 23, 1944. Siegerist is titled “Mounting for Sheaves and the Like” and is directed to ways of mounting and demounting components, such as a sleeve, on a shaft, and is reasonably pertinent to the problem the inventor of the '090 patent was trying to solve. Siegerist is prior art to the '090 Patent.

61. Siegerist teaches a ring 13 (Figure 12 below) with a plurality of circularly spaced bores. It further teaches hub 11 of the sheave to be mounted on the shaft (similar to the sleeve) with circularly spaced holes 21 and 24 as shown in Figure 6 below.



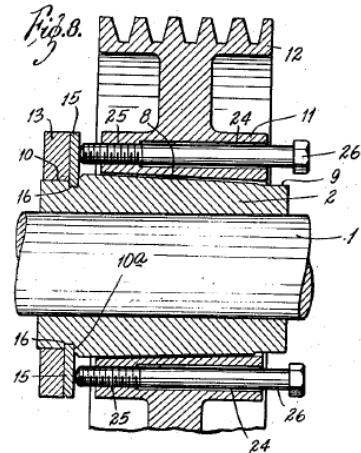
62. Siegerist further teaches that the sheave can be mounted on the tapered sleeve by tightening cap screws 23 that extend through holes 21 and into the ring holes 22. This is shown below.

The hub 11 of the sheave 12 has plain holes 21 extending therethrough parallel to the axis of the shaft 1 and said ring 13 has threaded holes 22 also parallel to said axis. The hub holes 21 and ring holes 22 are brought into alinement and the hub 11 is drawn tight on the bushing 2 by means of cap screws 23 extending through the hub holes 21 and the ring holes 22. The bushing 2 may contract within the hub 11 of the sheave 12 without bending said screws 23 and without affecting the proper seating of the hub on the tapered seat of the bushing.



<sup>31</sup> Siegerist 2:19-30

Said hub 11 may also be provided with holes 24 parallel to said shaft axis and alining with said locking keys 15, the portions 25 of said holes adjacent to said keys being threaded, whereby jack screws 26 may be mounted in said holes and brought into engagement with said keys 15 so as to demount said sheave from the seat, as shown in Fig. 8.



32

63. Siegerist teaches that by using a plurality of circularly oriented and spaced holes, an item (such as a sleeve) can be mounted or dismounted on a tapered shaft by using bolts to pull it onto or push it off of the shaft.

### **US 2,519,958 to Firth**

64. The US Patent 2,519,958 to Firth (hereinafter Firth) was filed on November 21, 1947. Firth is titled “Wheel Mounting” and is directed to ways of mounting and demounting wheels or pulleys on a shaft, and is reasonably pertinent to the problem the inventor of the ’090 patent was trying to solve. Firth is prior art to the ’090 Patent.

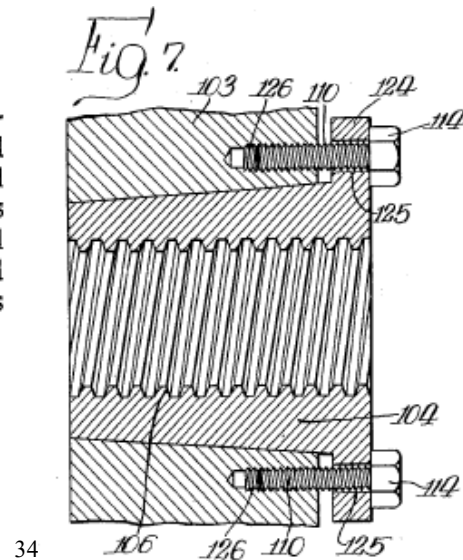
65. Firth teaches a wheel hub that is mounted on a tapered bushing. “said

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<sup>32</sup> Siegerist 2:31-38

bushing fitting the tapered bore of the hub and connected with the hub screws 110 for drawing the hub on the bushing to compress it tight on the shaft, thereby establishing a driving connection for high torque transmission.”<sup>33</sup>

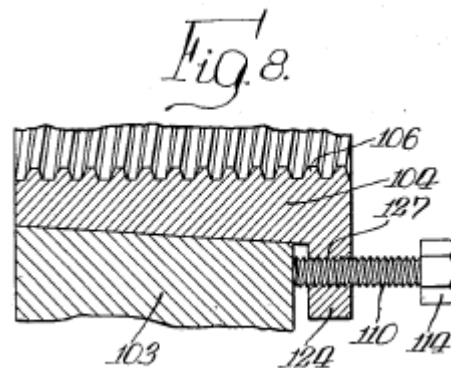
In this instance the bushing has its large end extended and formed with a flange 124 to which said screws 110 are anchored, these being cap screws passing loosely through said flange in unthreaded holes 125 and screwed into the hub in threaded screw-holes 126, with the heads 114 of said screws abutting said flange.



34

66. Firth further teaches that the compression fit can be dewedged or released by using a bolt to create a compressive force between the tapered sleeve and the hub of the wheel. This is shown below.

For dewedging or releasing the bushing from the hub, two of the three screws shown are withdrawn from the hub and passed through the bushing flange 124 in threaded engagement therewith in threaded screw-holes 127 and tightened against the hub in the manner shown in Fig. 8.



35

<sup>33</sup> Firth 7:22-27

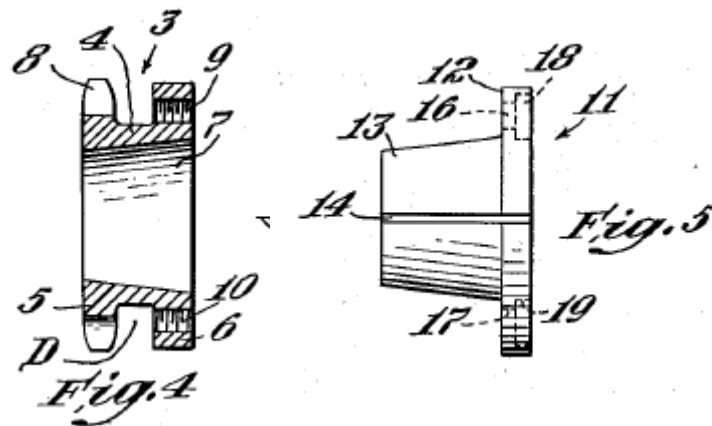
<sup>34</sup> Firth 2:30-36

<sup>35</sup> Firth 2:36-42

67. Firth teaches that by using a plurality of circularly oriented and spaced holes, an item (such as a sleeve) can be mounted or dismounted on a tapered shaft by using bolts to pull it onto or push it off of the shaft.

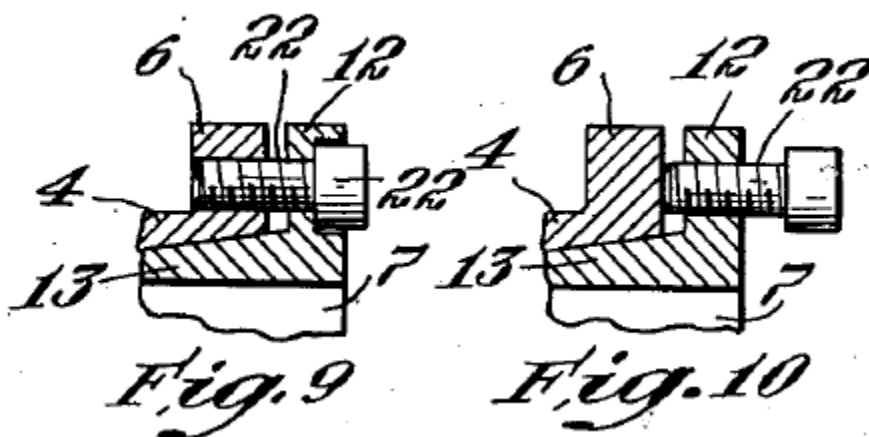
**US 2,668,454 to Schumb**

68. The US Patent 2,668,454 to Schumb (hereinafter Schumb) was filed on October 22, 1952. Firth is titled “Mounting for Sprockets, Pinions or the Like” and is directed to ways of mounting and demounting sprockets or pinions on a shaft. Schumb specifically discloses mounting a pinion (Figure 4) on a tapered bushing on a shaft (Figure 5) and is reasonably pertinent to the problem the inventor of the '090 patent was trying to solve. Schumb is prior art to the '090 Patent.



69. Schumb teaches that “Figs. 9 and 10 are fragmentary, radial sections through the assembled toothed element and bushing illustrating respectively the way of drawing the parts toward each other and of separating them from each

other.”<sup>36</sup> Figures 9 and 10 of Schumb are shown below.



70. Schumb teaches that by using a plurality of circularly oriented and spaced holes, an item (such as a sleeve) can be mounted or dismounted on a tapered shaft by using bolts to pull it onto or push it off of the shaft.

## VI. THE '090 PATENT

### A. Specification of the '090 Patent

71. In the '090 patent, Bergman discloses “A gyratory crusher main shaft and a main shaft assembly for positioning within a gyratory crusher and in particular, although not exclusively, to a main shaft having an axial upper end region that tapers radially inward and comprises at least one groove to receive a pressurized fluid to facilitate mounting and demounting of a sleeve at the shaft.” Pat '090, 1:14-19. The '090 patent includes an embodiment of a gyratory crusher and main shaft assembly in FIG. 1. The '090 patent includes an embodiment of a

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<sup>36</sup> Schumb 3:25-29

main shaft comprising of one groove to receive pressurized fluid for mounting and demounting of a sleeve at the shaft in FIG. 2.

72. FIG. 1 of the '090 patent is shown below. The gyratory crusher includes a crusher head 103 mounted upon an elongate shaft 107. Pat '090, 4:43-45. "An upper end region of a shaft 113 comprises an axial taper to define an upper conical section. The cone 113 tapers inwardly in the bottom to top direction away from head 103".

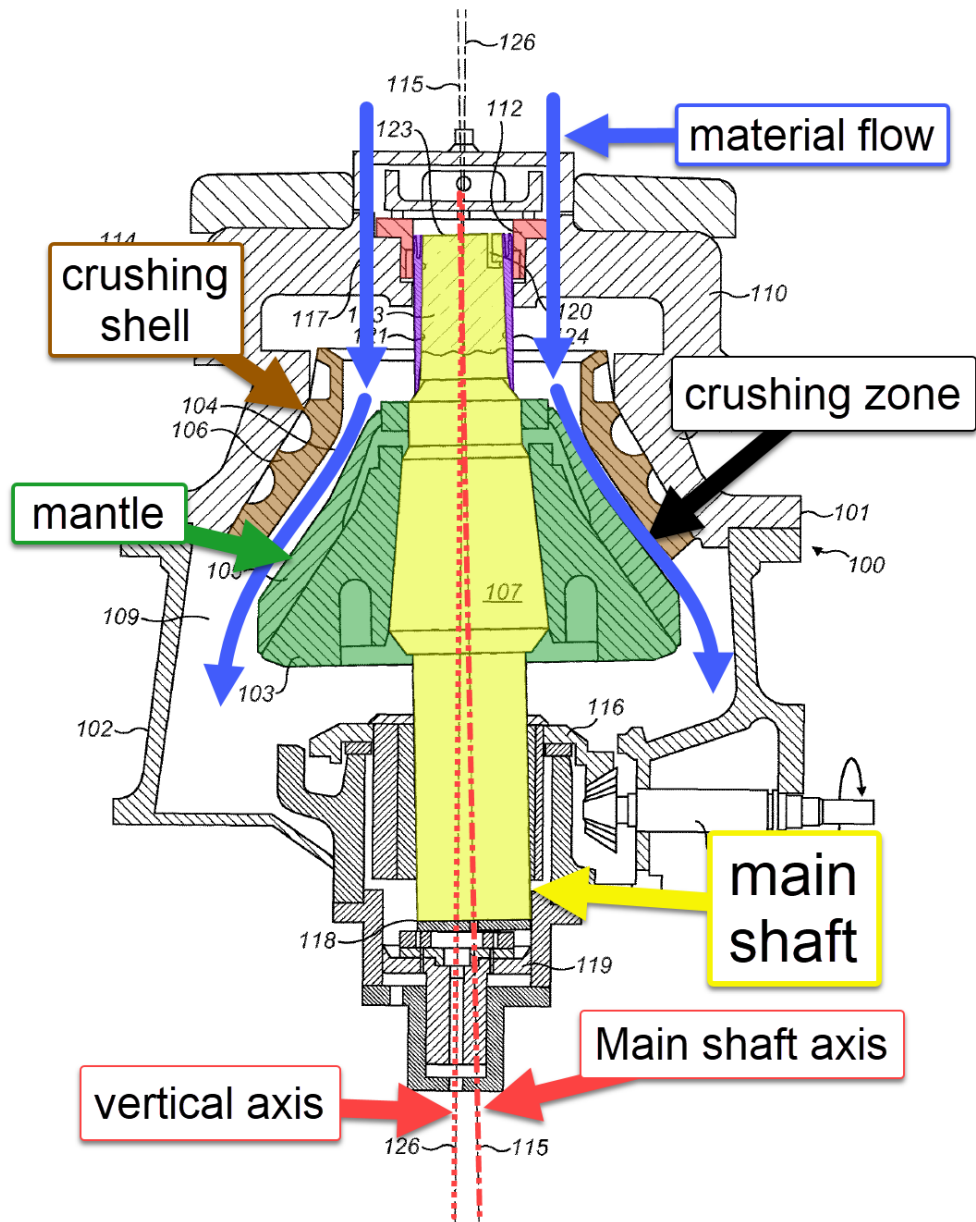


FIG. 1

73. FIG. 2 of the '090 patent is shown below.



- 1d1.** at least one groove indented at the external surface and positioned at the tapered axial region,
- 1d2.** the at least one groove being arranged to receive a pressurised[sic] fluid to facilitate mounting and dismounting of the shaft sleeve at the shaft body.
- 2P.** The main shaft as claimed in claim 1,
- 2a.** 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.
- 3P.** The main shaft as claimed in claim 2,
- 3a.** 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.
- 4P.** The main shaft as claimed in claim 3,
- 4a.** wherein the at least one groove extends in a circumferential direction around the shaft body.
- 5P.** The main shaft as claimed in claim 4,
- 5a.** wherein the at least one groove extends substantially or completely circumferentially around the shaft body.
- 6P.** The main shaft as claimed in claim 5,
- 6a.** further comprising a plurality of grooves at the external surface.
- 7P.** The apparatus as claimed in claim 6,
- 7a.** further comprising a first groove extending in a circumferential direction around the shaft body and a second groove extending in a circumferential direction around the shaft body, the first groove being separated axially from the second groove and coupled in fluid communication.
- 8P.** The main shaft as claimed in claim 7,

**8a.** 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.

**9P.** A gyratory crusher main shaft assembly for a crusher comprising:

**9a1.** a shaft body having a radially outward facing external surface, and

**9a2.** a first end and a second end,

**9a3.** 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,

**9a4.** a shaft sleeve mounted on the tapered axial region,

**9a5.** and at least one groove indented at the external surface and positioned at the tapered axial region,

**9a6.** the at least one groove being arranged to receive a pressurised[sic] fluid to facilitate mounting and dismounting of the sleeve at the shaft body; and

**9b.** 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.

**10P.** The assembly as claimed in claim 9,

**10a1.** 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,

**10a2.** 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.

**11P.** The assembly as claimed in claim 10,

**11a.** wherein the end retainer includes a recess extending circumferentially at the perimeter region to allow axial movement of the sleeve into the recess.

**12P.** The assembly as claimed in claim 9,

**12a.** 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.

**13P.** The assembly as claimed in claim 9,

**13a.** 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.

**14P.** A gyratory crusher comprising;

**14a1.** a main shaft including a shaft body having a radially outward facing external surface,

**14a2.** 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,

**14a3.** 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,

**14a4.** 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

pressurized fluid to facilitate mounting and dismounting of the sleeve at the shaft body.

### C. Amended Claims

75. During the course of these proceedings, Patent Owner has submitted an Contingent Motion to Amend, and a Revised Contingent Motion to Amend.

The first motion to amend proposed substitute claims which were addressed in my second declaration. The revised motion to amend proposed further revisions to the substitute claims. The following chart highlights the claim elements that have been altered to date. Additions and changes from one alteration to the next are underlined.

| Original                                                                                                                                                                                                                                                             | First Amendment                                                                                                                                                                                                                                                | Second Amendment                                                                                                                                                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Claim 1</b>                                                                                                                                                                                                                                                       | <b>Claim 1 became 15</b>                                                                                                                                                                                                                                       | <b>Claim 15</b>                                                                                                                                                                          |
| <b>1a.</b> a shaft body having a radially outward facing external surface, and a first end and a second end;                                                                                                                                                         | (no change)                                                                                                                                                                                                                                                    | <b>15a.</b> 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> |
| <b>1d.</b> 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[sic] fluid to facilitate mounting and dismounting of the shaft sleeve at the shaft body. | <b>15d.</b> <u>a plurality of grooves</u> indented at the external surface and positioned at the tapered axial region, the <u>plurality of grooves</u> being arranged to receive a pressurised (sic) fluid to facilitate mounting and dismounting of the shaft |                                                                                                                                                                                          |

|                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                       | sleeve at the shaft body,                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                        |
| (not in original claims)                                                                                                                                                                                                                                              | <u>15e. 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</u>                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                        |
| (not in original claims)                                                                                                                                                                                                                                              | <u>15f. a fluid inlet conduit extending axially from the second end and provided in fluid communication with the first groove, wherein the fluid inlet conduit extends internally within the shaft body only to the first groove,</u>                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                        |
| (not in original claims)                                                                                                                                                                                                                                              | <u>15g. wherein the first groove and the second groove are coupled in fluid communication.</u>                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Claim 2</b>                                                                                                                                                                                                                                                        | <b>Claim 2 became 16</b>                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                        |
| The main shaft as claimed in claim 1, 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. | The main shaft as claimed in claim 15, <u>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.</u> | The main shaft as claimed in claim 15, <u>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</u> |

|                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                    | <u>axially extending channel</u><br><u>indented at the external</u><br><u>surface of the shaft body</u><br><u>to couple the first groove</u><br><u>and the second groove in</u><br><u>fluid communication; and</u><br><u>an internal oil path</u><br><u>extending within the</u><br><u>shaft body only to the</u><br><u>first groove, the internal</u><br><u>oil path consisting of: a</u><br><u>first conduit extending</u><br><u>axially toward the first</u><br><u>end from the fluid inlet;</u><br><u>and a second conduit</u><br><u>extending from the first</u><br><u>conduit toward the</u><br><u>radially outward facing</u><br><u>external surface of the</u><br><u>shaft body to the first</u><br><u>groove.”</u> |
| <b>Claim 3</b>                                                                                                                                                                                                         | <b>Claim 3 became 17</b>                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <p>The main shaft as claimed in claim 2, 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.</p> | <p>The main shaft as claimed in claim 15, <u>wherein the first groove and the second groove are positioned at an equal distance from the cross-sectional area center of the shaft sleeve such that when the pressurised (sic) fluid is supplied to the first groove and the second groove, an expansion force is distributed substantially uniformly along the axial length of the sleeve.</u></p> | <p>The main shaft as claimed in claim 15, wherein the first groove <u>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</u></p>                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Claim 4</b>                                                                                                                                                                                                         | <b>Claim 4 became 18</b>                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

|                                                                                                                                                    |                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The main shaft as claimed in claim 3, wherein the at least one groove extends in a circumferential direction around the shaft body.                | The main shaft as claimed in claim 15, wherein <u>the plurality of grooves</u> extend in a circumferential direction around the <u>tapered axial region</u> shaft body.                                                              |                                                                                                                                                                                                                                |
| <b>Claim 5</b>                                                                                                                                     | <b>Claim 5 became 19</b>                                                                                                                                                                                                             |                                                                                                                                                                                                                                |
| The main shaft as claimed in claim 4, wherein the at least one groove extends substantially or completely circumferentially around the shaft body. | The main shaft as claimed in claim 15, wherein the <u>plurality of grooves</u> extend substantially or completely circumferentially around the shaft body.                                                                           |                                                                                                                                                                                                                                |
| <b>(not in original claims)</b>                                                                                                                    | <b>Claim 20</b>                                                                                                                                                                                                                      |                                                                                                                                                                                                                                |
|                                                                                                                                                    | <u>The main shaft as claimed in claim 15, 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.</u> | The main shaft as claimed in claim 15, <u>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.</u> |
| <b>Claim 9</b>                                                                                                                                     | <b>Claim 9 became 21</b>                                                                                                                                                                                                             | <b>Claim 21</b>                                                                                                                                                                                                                |
| <b>9a.</b> a shaft body having a radially outward facing external surface, and a first end and a second end,                                       | (no change)                                                                                                                                                                                                                          | <b>21a.</b> 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>                                       |
|                                                                                                                                                    |                                                                                                                                                                                                                                      | <b>21b.</b> 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,                                                                                                                                                                                      |
|                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                           | <b>21c</b> a shaft sleeve mounted on the tapered axial region, and                                                                                                                                                                                                                                                                                                                                                         |
| <b>9d.</b> 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; and                                                                                                                                                 | <b>21d.</b> <u>wherein the shaft sleeve is</u> fitted over the tapered axial region, the <u>shaft</u> sleeve having a tapered wall thickness, such that the wall thickness at a second end of the <u>shaft</u> sleeve is greater than the wall thickness at a first end of the sleeve; and                                                                                                                | <b>21d.</b> 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; <del>and</del>                                                                                                                                            |
| <b>Claim 10.</b> The assembly as claimed in claim 9, 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 | <b>(added dependent claim)</b><br><b>21e.</b> 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 <u>axial</u> region, the perimeter region positioned to radially overlap the <u>shaft</u> sleeve at the second end of the sleeve to inhibit axial separation of the <u>shaft</u> | <b>21e.</b> <u>wherein the shaft</u> <del>[[a]]</del> sleeve <u>is</u> fitted over the tapered axial region, the <u>shaft</u> sleeve having a tapered wall thickness, such that the wall thickness at a second end of the <u>shaft</u> sleeve is greater than the wall thickness at a first end of the <u>shaft</u> sleeve, <u>wherein the first end of the shaft sleeve is a lowermost extremity of the shaft sleeve.</u> |

|                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| of the sleeve from the shaft body.                                                                                                                                                                          | sleeve from the shaft body,                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                |
| <b>Claim 11.</b> The assembly as claimed in claim 10, wherein the end retainer includes a recess extending circumferentially at the perimeter region to allow axial movement of the sleeve into the recess. | <b>(added dependent claim)</b><br><b>21f.</b> wherein the end retainer includes a recess extending circumferentially at the perimeter region to allow axial movement of the <u>shaft sleeve</u> into the recess,                                                                                                               |                                                                                                                                                                                                                                                                                                                                |
| (not in original claims)                                                                                                                                                                                    | <b><u>21g.</u></b> wherein the recess defines an annular gap between the end retainer and the second end of the shaft sleeve when an underside surface of the end retainer is positioned in contact with the second end of the shaft body.                                                                                     |                                                                                                                                                                                                                                                                                                                                |
| <b>(not in original claims)</b>                                                                                                                                                                             | <b>Claim 22</b>                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                |
|                                                                                                                                                                                                             | <u>The assembly as claimed in claim 21, wherein the end retainer comprises a first plurality of bores distributed circumferentially around the end retainer and configured to align with a plurality of sleeve bores in the second end of the shaft sleeve such that the end retainer can be attached to the shaft sleeve.</u> | <u>The assembly as claimed in claim 21, wherein the end retainer comprises a first plurality of bores distributed circumferentially around the end retainer and configured to align with a plurality of sleeve bores in the second end of the shaft sleeve such that the end retainer can be attached to the shaft sleeve.</u> |
| <b>(not in original claims)</b>                                                                                                                                                                             | <b>Claim 23</b>                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                |

|                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                   | <p><u>The assembly as claimed in claim 21, wherein the end retainer comprises a surface opposite the underside surface of the end retainer configured to mate against the second end of the shaft sleeve when the end retainer is inverted, and wherein the end retainer is configured to force the shaft sleeve axially over the tapered axial region when a plurality of attachment members extending through a second plurality of bores in the end retainer and into a plurality of corresponding shaft bores in the second end of the shaft body are tightened.</u></p> | <p><u>The assembly as claimed in claim 21, wherein the end retainer comprises a surface opposite the underside surface of the end retainer configured to mate against the second end of the shaft sleeve when the end retainer is inverted, and wherein the end retainer is configured to force the shaft sleeve axially over the tapered axial region when a plurality of attachment members extending through a second plurality of bores in the end retainer and into a plurality of corresponding shaft bores in the second end of the shaft body are tightened.</u></p> |
| <b>Claim 12</b>                                                                                                                                                                                                                                                                                   | <b>Claim 12 became 24</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <p>The assembly as claimed in claim 9, 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.</p> | <p>(no change)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p>The assembly as claimed in claim 21, <u>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</u></p>                                                                                                                                                                                             |

|                                                                                                                                                                                                                                                                             |                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                             |                           | <u>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</u> |
| <b>Claim 13</b>                                                                                                                                                                                                                                                             | <b>Claim 13 became 25</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| The assembly as claimed in claim 9, 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. | (no change)               | The assembly as claimed in claim 21, <u>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.</u>                                                                                                                                                                                                                                                                                                 |
| <b>Claim 14</b>                                                                                                                                                                                                                                                             | <b>Claim 14 became 26</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>14a.</b> a main shaft including a shaft body having a radially outward facing external surface, a                                                                                                                                                                        | (no change)               | <b>26.</b> A gyratory crusher comprising:<br><b>26a.</b> a main shaft including a shaft body                                                                                                                                                                                                                                                                                                                                                                                                                                 |

|                                                                                                                                                                                                                                           |             |                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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,                                                                                  |             | 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>                                                                         |
|                                                                                                                                                                                                                                           |             | <b>26b.</b> 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; |
| <b>14c.</b> 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; and | (no change) | <b>26c.</b> 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                                     |
|                                                                                                                                                                                                                                           |             | <b>26d.</b> 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, |
| (not in original claims) | <u>26e. wherein the shaft sleeve is configured such that when positioned on the shaft body, the shaft sleeve is independent of a crushing head and a crushing shell.</u> | <u>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.</u>                                           |

## VII. CLAIM CONSTRUCTION

76. It is my understanding that claim construction has not been completed in the present matter. As such, I understand that the claim terms are to be given their meaning as they would be understood by a POSITA in view of the intrinsic evidence. I understand that unless the intrinsic record indicates otherwise, claim terms are to be given their plain and ordinary meaning as they would be understood by a POSITA. Consequently, I have used the plain and ordinary meaning in my analysis.

## VIII. INVALIDITY OF THE CLAIMS OF THE '090 PATENT

77. A POSITA would be motivated to combine the tapered joint of Piepho with the teachings of Coxhill as Piepho teaches it is preferable. In addition to this, a POSITA would understand that a tapered joint is preferable to a cylindrical joint at least because they are easier to install and remove. A POSITA would have reasonable expectation of success in making the combination as both cylindrical and tapered interference fit joints were common in the prior art and had been used for decades. This combination is nothing more than a simple combination of known elements according to known methods to yield predictable results.

78. A POSITA would be motivated to combine Coxhill in view of Piepho, and further in view of Harless to gain multiple advantages as taught in the prior art. Harless teaches the advantages of using hydraulic means for making and breaking tapered interference joints.

*“... the invention is concerned with the shrink fitting of gears and similar members on shafts. This has been accomplished heretofore by heating or refrigerating one of the members, this being a procedure of limited applicability, and even where applicable having a tendency to involve over stressing the web of a gear or similar member.*

***Elements such as bearings and coupling sleeves have been fitted to shafting by expanding the elements hydraulically,** but it has not been possible to shrink fit a member such as a gear in this way, due to the excessive pressure required to expand the portion of the gear hub in radial alignment with the web.*

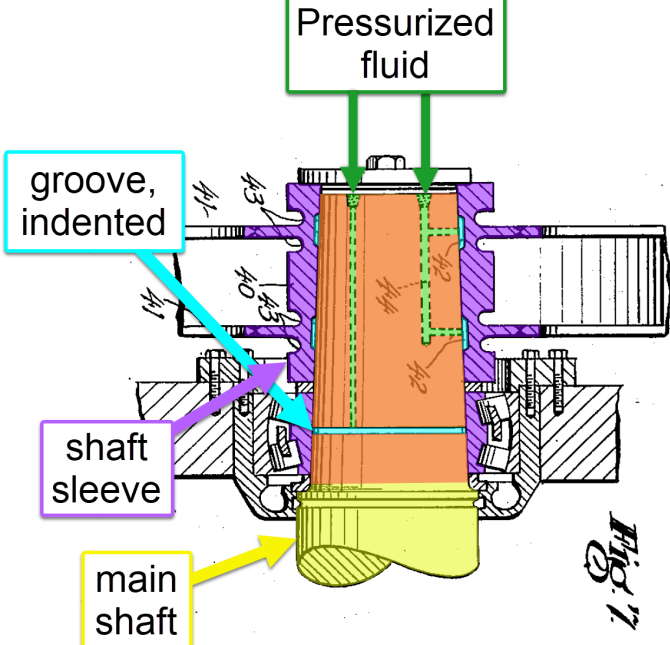
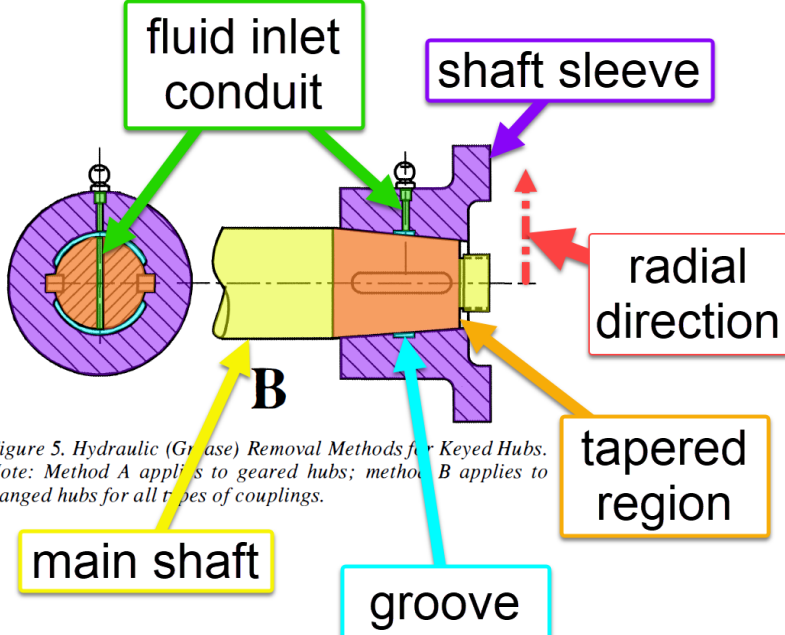
***It is an object of the invention to provide for the attachment of a gear or other drive member to a tapered shaft,** by expanding certain portions of the hub of the gear, while avoiding the excess pressure necessary to expand the web or any other radially extending part of the gear. A further object of the invention is to provide for attaching a bearing and a gear or other drive member to a shaft as concentrically as possible, and without creating unbalanced strain conditions in the gear.*

***A still further object of the invention is to provide an attachment permitting removal of a gear or other drive member without the use of a gear puller or similar equipment.***<sup>37</sup>

79. The prior art teaches many different arrangements for implementing tapered interference joints. A POSITA will understand that the various tapered joint designs represent design choices that are available for them to make. For example, the prior art teaches at least two different ways in which pressurized fluid such as oil or grease can be delivered to circumferential grooves to hydraulically expand a hub or sleeve for installation or removal. The Harless reference teaches the delivery of the fluid through conduits inside the main shaft. Meanwhile, other prior art teaches delivering the pressurized fluid through a radial port through the sleeve itself. Examples of these options are shown below for clarity:

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<sup>37</sup> US 2,840,399 to C.A. Harless 1:18-42, emphasis added

|                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p style="text-align: center;">C.A. Harless</p>                                                                                                                                  | <p>As shown, Harless discloses a well-known method of delivering pressurized fluid to grooves which are used to hydraulically expand a hub and a bearing so as to make or break a tapered interference fit.</p> |
|  <p><i>Figure 5. Hydraulic (Grease) Removal Methods for Keyed Hubs. Note: Method A applies to geared hubs; method B applies to flanged hubs for all types of couplings.</i></p> | <p>As shown, a technical paper dating back to 1993, titled “Hydraulic Removal of Coupling Hubs – Keyed and Keyless” shows both the option of feeding fluid through the sleeve.</p>                              |

80. As shown above, a POSITA would recognize that it is a design choice

<sup>38</sup> US 2,840,399 to C.A. Harless, Figure 7, annotated

<sup>39</sup> T22153-160.pdf, pg. 6, annotated

as to whether the fluid is routed through the shaft or through the sleeve. Further, making this design choice would amount to nothing more than combining known elements using known methods to produce predictable results. The manner in which fluid is delivered to the grooves is commonly implemented through either the shafting itself or through the sleeve mounted on the shafting.

81. It was well known in the art that the circumferential groove and the bore could be formed in either the sleeve or the shaft.<sup>40</sup> As it is well known that the sleeves wear out and are replaceable, a POSITA would be motivated to form the groove and conduit in the shaft, as the shaft can be used with multiple sleeves and would only have to be manufactured once, where the groove and conduit would have to be manufactured in each replaceable sleeve.

82. A POSITA would further be motivated to implement the well-known hydraulic processes for making and breaking interference fits as they are well known to protect the shaft from damage,<sup>41</sup> they are able to be used in more locations as they do not require presses and gear pullers,<sup>42</sup> does not require the maintenance that presses and gear pullers do,<sup>43</sup> and make removing components on a tapered shaft particularly easy.<sup>44</sup>

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<sup>40</sup> See Harless or T91-10 (Figure 7)

<sup>41</sup> Behm 1:13-15, 1:35-42

<sup>42</sup> Sillett 1:15-24

<sup>43</sup> Sillett 1:35-40

<sup>44</sup> Harless 3:15-22

# Obviousness of Claim 15 of the '090 Patent over Coxhill in view of Piepho and Yagi

| Challenged Claim                                                          | Obvious by Prior Art?                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Claim 15</b>                                                           |                                                                                                                                                                                                                                                                                                                                                                                          |
| <p><b>15P.</b> A gyratory crusher main shaft of a crusher comprising:</p> | <p><b>YES:</b> Although the preamble is generally not considered limiting, Coxhill disclose a gyratory crusher main shaft of a crusher.</p> <p><i>“In a <b>gyratory crusher</b> the crusher head is mounted on a drive shaft which is driven by an eccentric. The eccentric is continually rotated to cause the head to gyrate for effecting the crushing of material.” abstract</i></p> |
|                                                                           |                                                                                                                                                                                                                                                                                                                                                                                          |

<sup>45</sup> US 4,037,800 to Coxhill Fig. 1 annotated

As can be seen above, Figure 1 of Coxhill shows a cross section of a conventional gyratory crusher. The central cone is part of the main shaft which is mounted on an eccentric drive which creates the gyrational crushing motion as it is driven. Specifically, Coxhill states,

*“The invention pertains to gyratory crushers for reducing material to desired sizes. More particularly, the invention pertains to a gyratory cone type crusher in which the crushing head is carried on a shaft which is rotatably driven by an eccentric so that the head is gyrated upon rotation of the eccentric.” Coxhill 1:6-12*

Beyond this, as discussed previously, Piepho is also a rock crushing apparatus. In particular, Piepho is designed to crush coal.

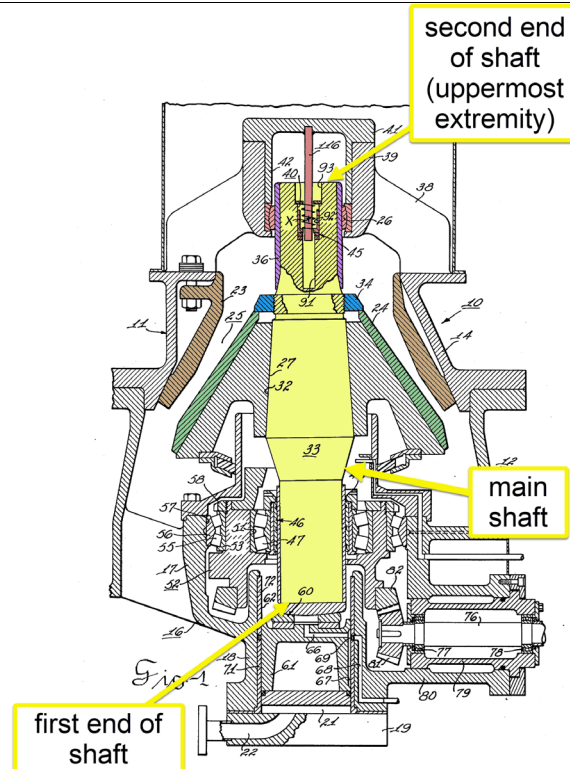
*“The present invention relates in general to an improved main Shaft for a coal pulverizer, and more particularly to an improved main shaft for use in B&W Type E and EL pulverizers”<sup>46</sup>*

**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;

**YES:** Coxhill discloses a shaft body having a radially outward facing external surface, and a first end and a second end that is the uppermost extremity of the shaft.

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<sup>46</sup> US 6,270,026 to Piepho 1:5-8



47

*“The **upper portion** of the **crusher shaft 33** is fitted with a bearing sleeve 36 and is received in the pivot bearing member 26.”<sup>48</sup>*

*“The **lower end** of the **crusher head shaft 33** is provided with a bearing sleeve assembly 46 which is journaled in the inner race of a radial bearing 47.”<sup>49</sup>*

As can be seen above, the shaft body of Coxhill has a radially outward facing external surface with a first and second end. This second shaft end is the uppermost extremity.

**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

**YES:** Coxhill in view of 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 section area of the shaft body at the tapered axial region

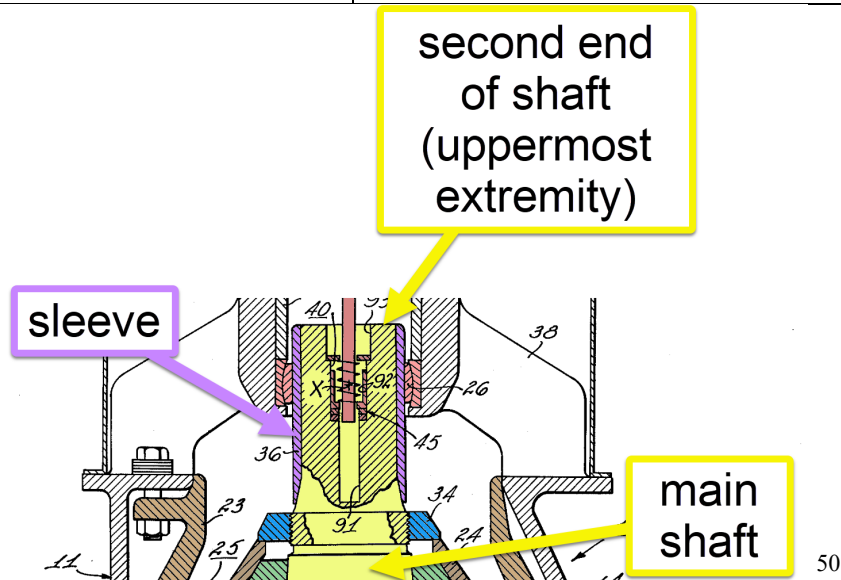
<sup>47</sup> US 4,037,800 to Coxhill Figure 1 annotated

<sup>48</sup> US 4,037,800 to Coxhill 2:29-31 emphasis added

<sup>49</sup> US 4,037,800 to Coxhill 2:41-43 emphasis added

end to the second end;

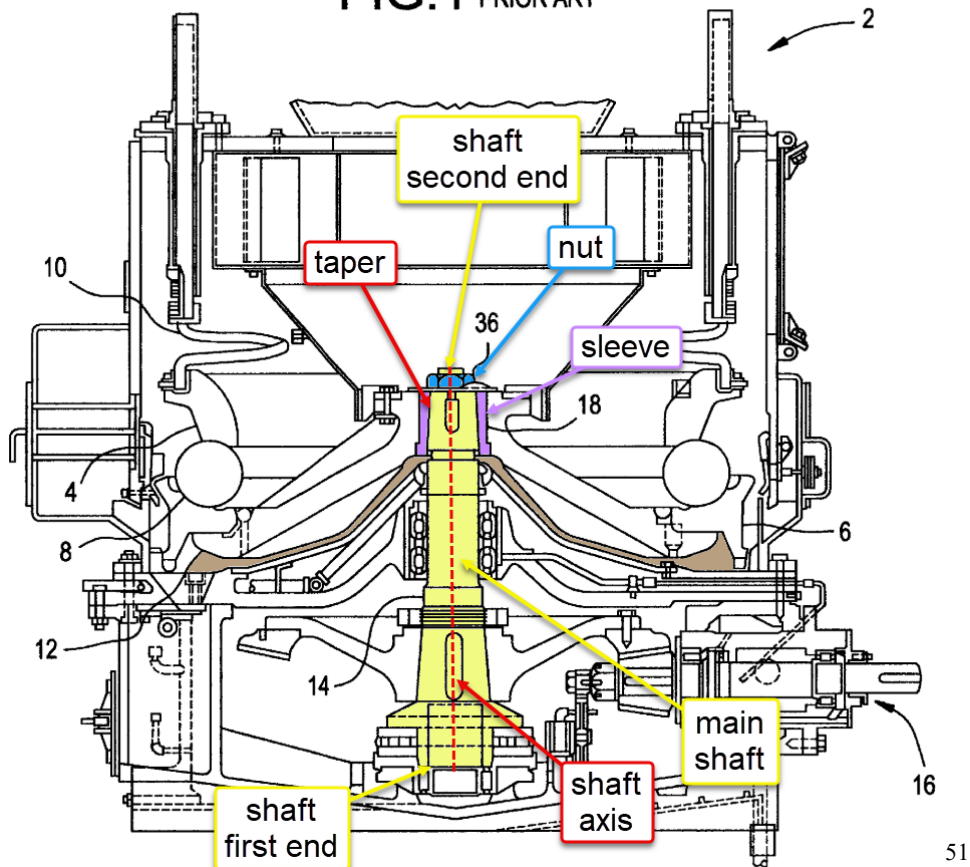
decreases in a direction from the first end to the second end;



As shown above, the main shaft of Coxhill has an axial region starting at the second end (uppermost extremity) and covered by a sleeve.

<sup>50</sup> US 4,037,800 to Coxhill Figure 1 cropped and annotated

FIG.1 PRIOR ART



As shown above, the main shaft of Piepho also has a first and second end. Piepho further has a region near the second end that is tapered and covered by a sleeve. Further, the taper of the shaft is in an axial direction. Due to this taper, the cross-sectional area of the shaft body decreases in a direction from the first end toward the second end as shown above.

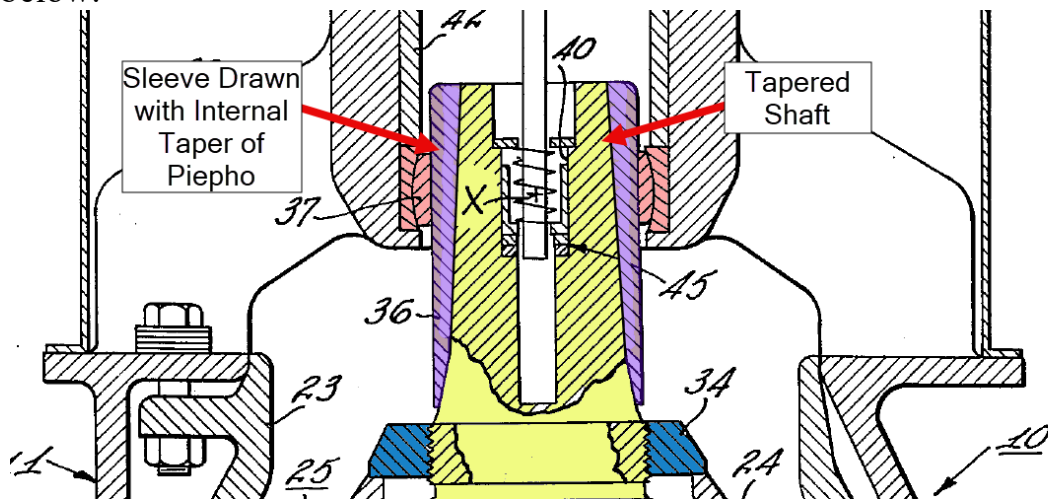
*"The present invention provides an intervening material between the shaft end (25) and the mating bore in yoke bushing (18) fitted within the bore of yoke (12) to prevent fretting damage. For accurate alignment and for reliable Support of the yoke, this joint (21) must be capable of accepting radial, axial, and bending or overturning loads. **Preferably, the joint (21) is a tapered joint with the tapered end (25) of shaft (14).**"*<sup>52</sup>

The tapered region of Piepho does not extend to the extreme end of the shaft due to the nut retainer which interacts with other components of the crusher. A POSITA modifying Coxhill with the taper of Piepho would implement the taper

<sup>51</sup> US 6,270,026 to Piepho Figure 1 annotated

<sup>52</sup> US 6,270,026 to Piepho 3:23-31, emphasis added.

to the very extremity of the shaft, where the sleeve contacts the shaft as shown below.



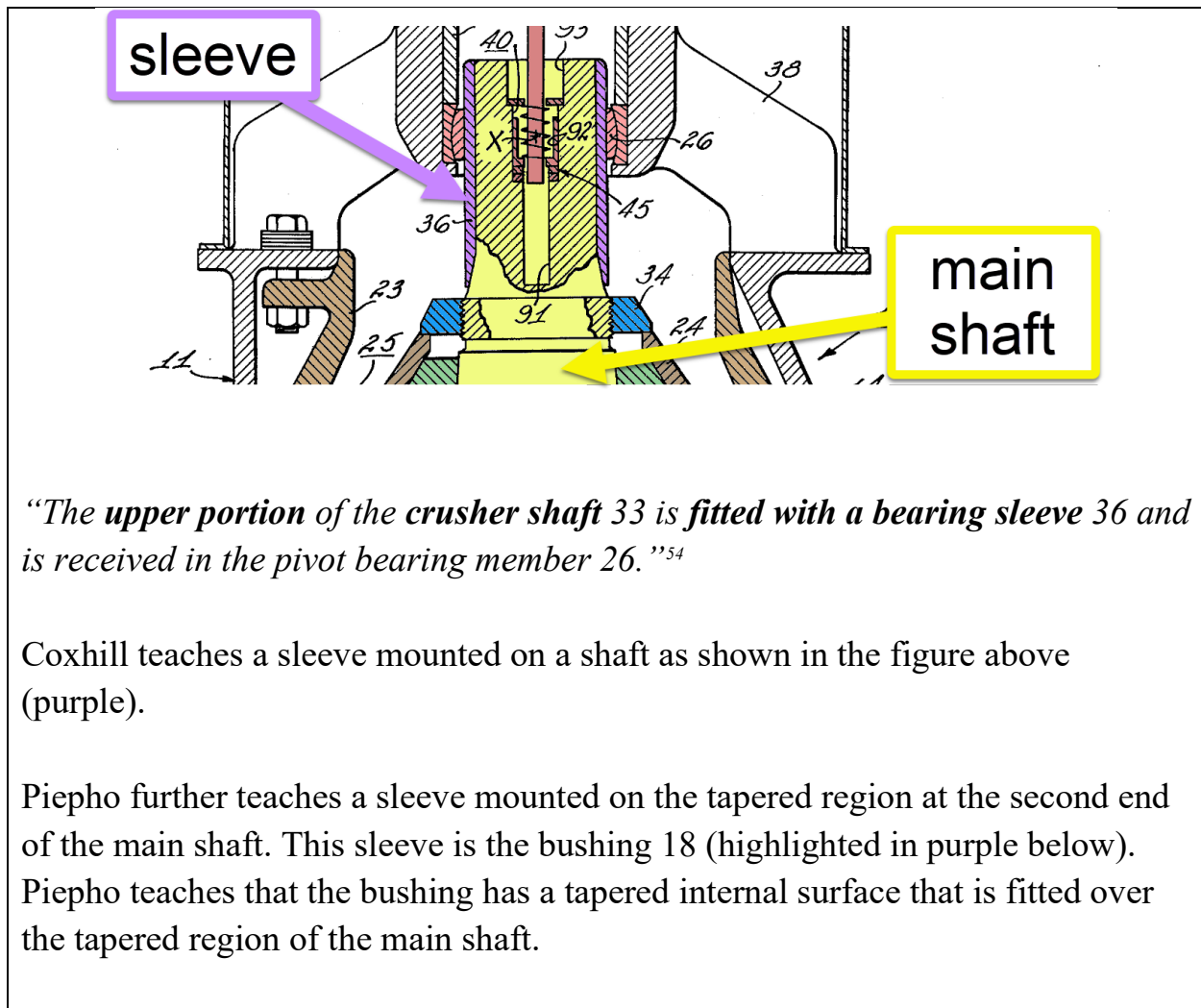
53

A POSITA would have been motivated to combine the tapered end on the main shaft of Piepho with the main shaft on Coxhill. This combination would have been nothing more than combining known elements according to known methods to yield predictable results. A POSITA would be further motivated, as Piepho describes, as the tapered shaft aids in accurate alignment which is notoriously more difficult with purely cylindrical shafting. Notably, the shaft of Coxhill does not include threads for a nut above the sleeve, thus a POSITA would recognize that the taper would extend from the upper most extremity of the shaft.

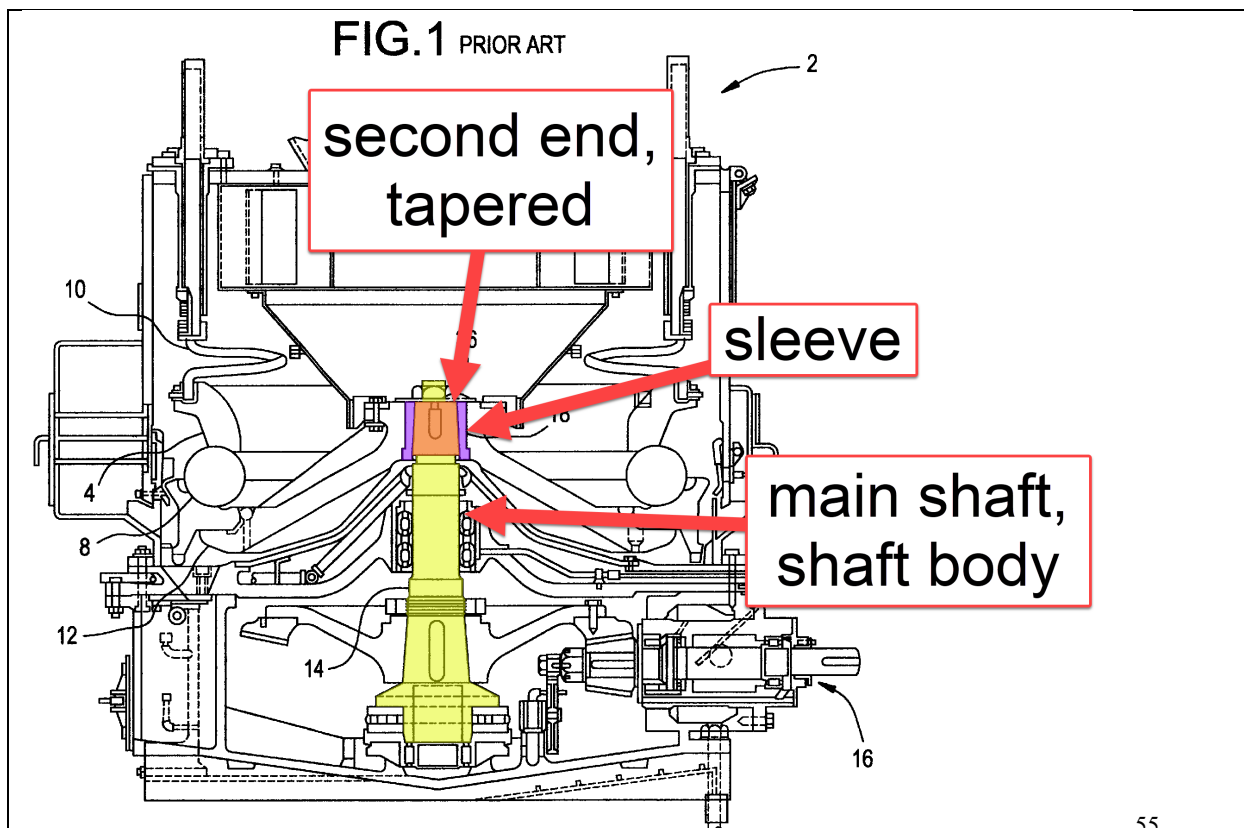
**15c.** a shaft sleeve mounted on the tapered axial region; and

**YES:** Both Coxhill and Piepho discloses a shaft sleeve mounted on the tapered axial region. Coxhill in view of Piepho shows a sleeve mounted on the tapered axial region from the second end.

<sup>53</sup> US 4,037,800 to Coxhill Figure 1 cropped and annotated and modified



<sup>54</sup> US 4,037,800 to Coxhill 2:29-31 emphasis added



55

*“The present invention provides an intervening material between the shaft end (25) and the mating bore in yoke bushing (18) fitted within the bore of yoke (12) to prevent fretting damage. For accurate alignment and for reliable Support of the yoke, this joint (21) must be capable of accepting radial, axial, and bending or overturning loads. Preferably, the joint (21) is a tapered joint with the tapered end (25) of shaft (14).”*<sup>56</sup>

A POSITA would be motivated to combine Coxhill’s shaft with a sleeve fitted onto the second end with Piepho’s teachings of a sleeve fitted over the tapered section of a second end of the main shaft. A POSITA would have a reasonable expectation of success in making the combination as it is nothing more than combining prior art elements according to known methods to yield predictable results. A POSITA would be further motivated to combine these references and use a tapered sleeve on a tapered shaft as it aids in alignment and makes it easier to install and detach as the distance the sleeve needs to travel while expanded is smaller compared to a sleeve with a cylindrical interference fit.

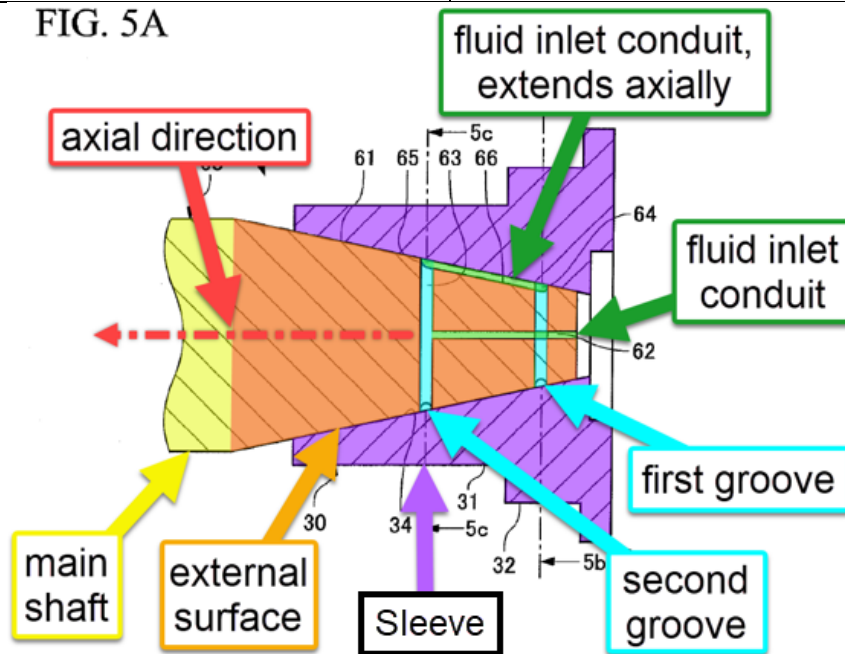
<sup>55</sup> US 6,270,026 to Piepho Figure 1, annotated

<sup>56</sup> US 6,270,026 to Piepho 3:23-31, emphasis added.

**15d.** a plurality of grooves indented at the external surface and positioned at the tapered axial region, the plurality of grooves being arranged to receive a pressurised (sic) fluid to facilitate mounting and dismounting of the shaft sleeve at the shaft body,

**YES:** Coxhill in view of Piepho, and in further view of Yagi, discloses a plurality of grooves indented at the external surface and positioned at the tapered axial region. The grooves in Yagi are arranged to receive pressurized fluid to facilitate mounting and dismounting of the shaft sleeve on the shaft.

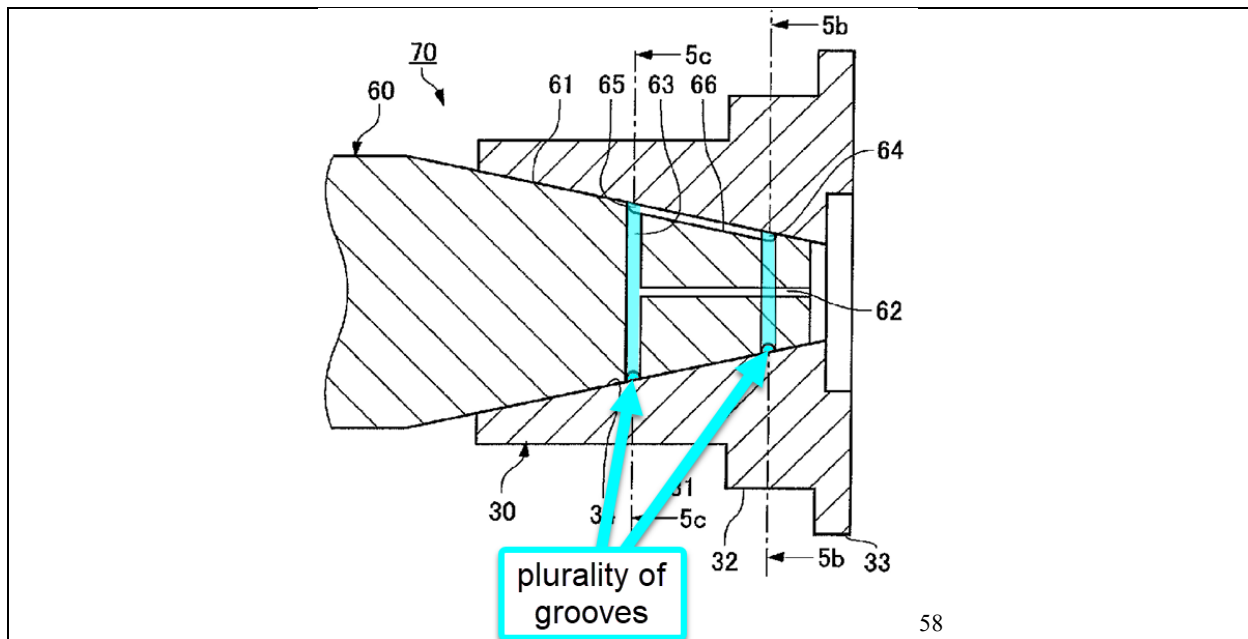
FIG. 5A



57

Yagi teaches a plurality of grooves in the shaft.

<sup>57</sup> Yagi Figure 5A, annotated



*“The radial oil passage 63 communicates with the terminal end of the axial oil passage 62, and both ends thereof are open to the outer peripheral surface of the taper part 61. Therefore, oil fed from a hydraulic pressure source, not shown, flows in the axial oil passage 62 and the radial oil passage 63 in order, and flows out to the outer peripheral surface of the taper part 61. At a position at which the radial oil passage 63 is open on the outer peripheral surface of the taper part 61, a second oil groove 65 is formed along the circumferential direction of the taper part 61. The oil flowing out of the opening of the radial oil passage 63 flows in the second oil groove 65, by which the oil is permeated in the circumferential direction of the outer peripheral surface of the taper part 61. In the outer peripheral surface of the taper part 61, there is provided a connecting oil groove 66 one end of which communicates with the second oil groove 65 and which extends in the axial direction toward the frontend of the tapered shaft 60. The other end of the connecting oil groove 66 communicates with a first oil groove 64.”<sup>59</sup>*

Yagi teaches that multiple grooves allow the oil to permeate a larger region more easily. From Yagi a POSITA would understand that the number of oil grooves as taught is merely a design choice. A POSITA would be motivated to implement the well-known hydraulic processes for making and breaking interference fits, for example between the sleeve and the shaft, as they are well known to protect the shaft from damage,<sup>60</sup> they are able to be used in more locations as they do not require presses and gear pullers,<sup>61</sup> does not require the maintenance that presses

<sup>58</sup> Yagi Figure 5A, annotated

<sup>59</sup> Yagi 6:44-63

<sup>60</sup> Behm 1:13-15, 1:35-42

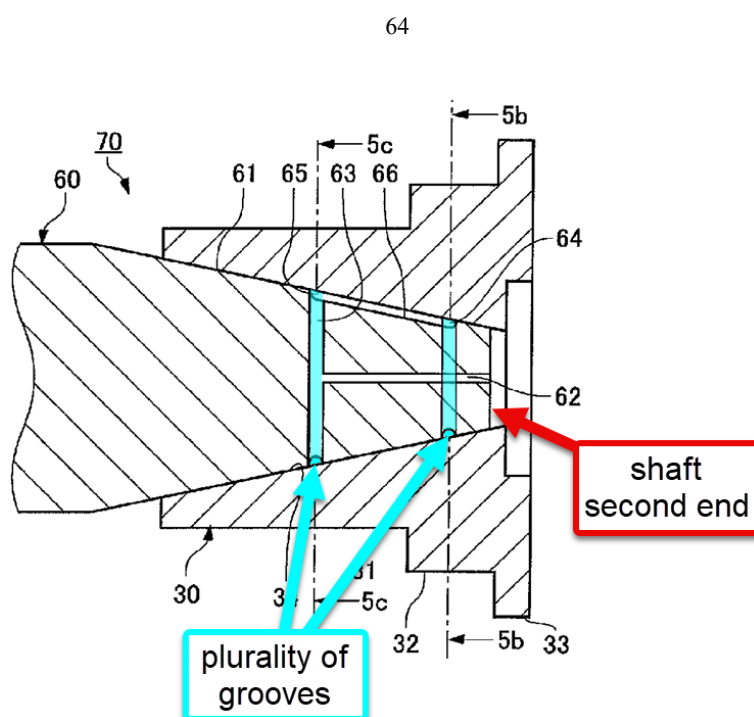
<sup>61</sup> Sillett 1:15-24

and gear pullers do,<sup>62</sup> and make removing components on a tapered shaft particularly easy.<sup>63</sup>

**15e.** 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

**YES:** As shown in the figures below, Coxhill in view of Piepho and Yagi discloses a first groove closer to the second end of the shaft relative a second groove.

Yagi disclose a first groove and a second groove where the first groove is closer to the second end of the shaft.



**15f.** a fluid inlet conduit extending axially from the second end and provided in fluid communication with the first groove, wherein the fluid inlet conduit extends internally within the shaft body only to the first groove,

**YES:** Coxhill in view of Piepho and in further view of Yagi and ordinary skill in the art discloses a fluid inlet conduit extending axially from the second end and provided in fluid communication with the first groove wherein the fluid inlet conduit extends internally within the shaft body only to the first groove.

<sup>62</sup> Sillett 1:35-40

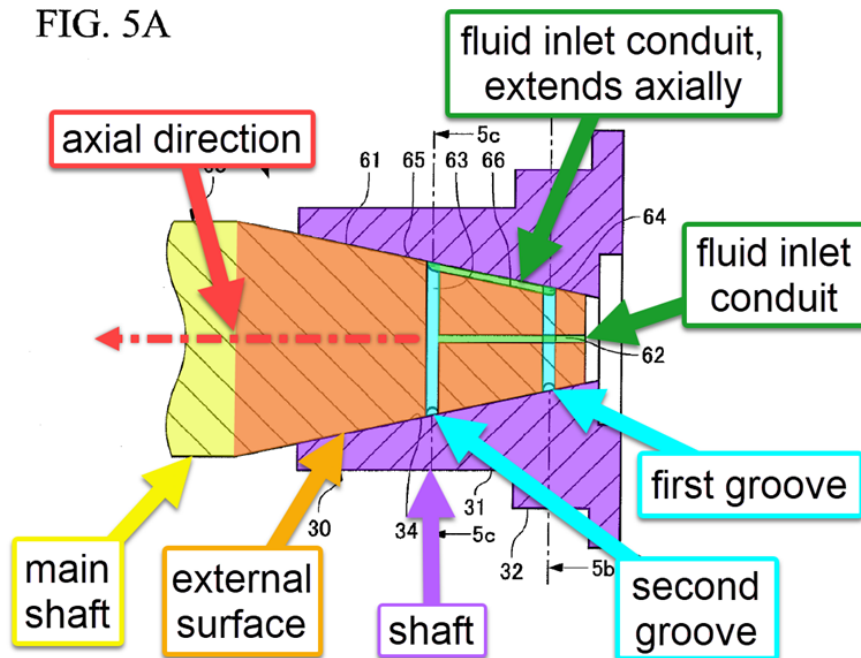
<sup>63</sup> Harless 3:15-22

<sup>64</sup> Harless Figure 7, annotated

<sup>65</sup> Yagi Figure 5A, annotated

Yagi further teaches a fluid inlet at the second end of a shaft and a fluid channel to the second groove that is furthest from the second end of the shaft. There is a first groove closer to the second end of the shaft that is connected to the second groove by an axially running groove on the surface of the shaft as shown below.

FIG. 5A



66

*"The tapered shaft 60 comprises a taper part 61, and an axial oil passage 62 is formed along the axial direction of the tapered shaft 60 from the front end surface of the taper part 61. Also, in the radial direction of the taper part 61, a radial oil passage 63 is formed. The radial oil passage 63 communicates with the terminal end of the axial oil passage 62, and both ends thereof are open to the outer peripheral surface of the taper part 61. Therefore, oil fed from a hydraulic pressure source, not shown, flows in the axial oil passage 62 and the radial oil passage 63 in order, and flows out to the outer peripheral surface of the taper part 61.*

*In the outer peripheral surface of the taper part 61, there is provided a connecting oil groove 66 one end of which communicates with the second oil groove 65 and which extends in the axial direction toward the frontend of the tapered shaft 60. The other end of the connecting oil groove 66 communicates with a first oil groove 64."*<sup>67</sup>

While Yagi explicitly teaches one embodiment connecting from the port to what would be the second groove internally, and then to the first groove on the outside of the shaft, Yagi also recognizes that a POSITA could make appropriate changes:

<sup>66</sup> Yagi Figure 5A, annotated

<sup>67</sup> Yagi 6:40-63



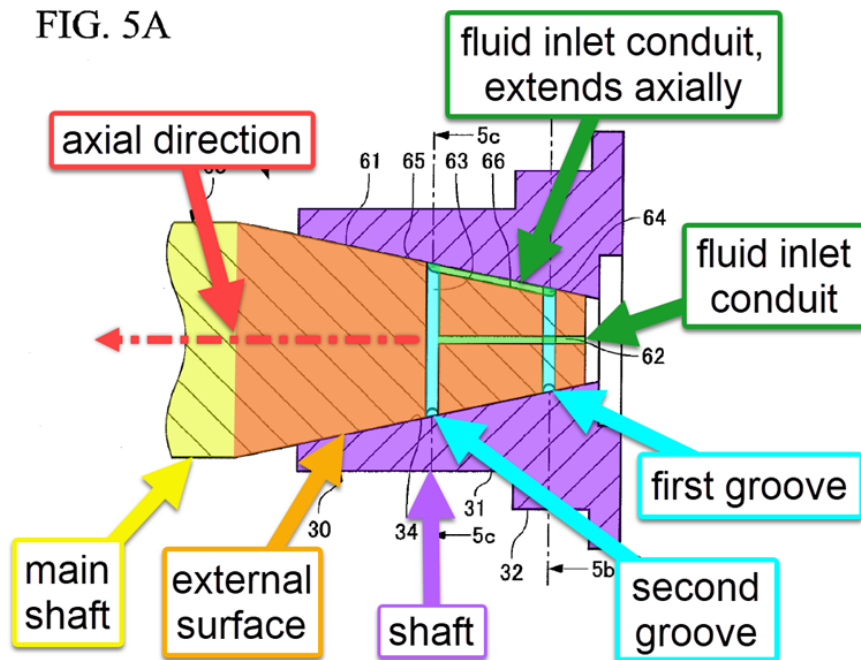
very least this would be “obvious to try” as it is choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success.

**15g.** wherein the first groove and the second groove are coupled in fluid communication.

**YES:** Coxhill in view of Piepho and Yagi discloses a first and second groove coupled in fluid communication.

Yagi teaches two circumferential grooves with an axial groove in the surface of the shaft putting the two circumferential grooves in fluid communication.

FIG. 5A



70

*“At a position at which the radial oil passage 63 is open on the outer peripheral surface of the taper part 61, a second oil groove 65 is formed along the circumferential direction of the taper part 61. The oil flowing out of the opening of the radial oil passage 63 flows in the second oil groove 65, by which the oil is permeated in the circumferential direction of the outer peripheral surface of the taper part 61.*

*In the outer peripheral surface of the taper part 61, there is provided a connecting oil groove 66 one end of which communicates with the second oil groove 65 and which extends in the axial direction toward the frontend of the tapered shaft 60. The other end of the connecting oil groove 66 communicates with a first oil groove 64.”<sup>71</sup>*

Yagi teaches a “connecting oil groove 66” that extends axially along the outside of the tapered shaft to communicate fluid between the first and second grooves.

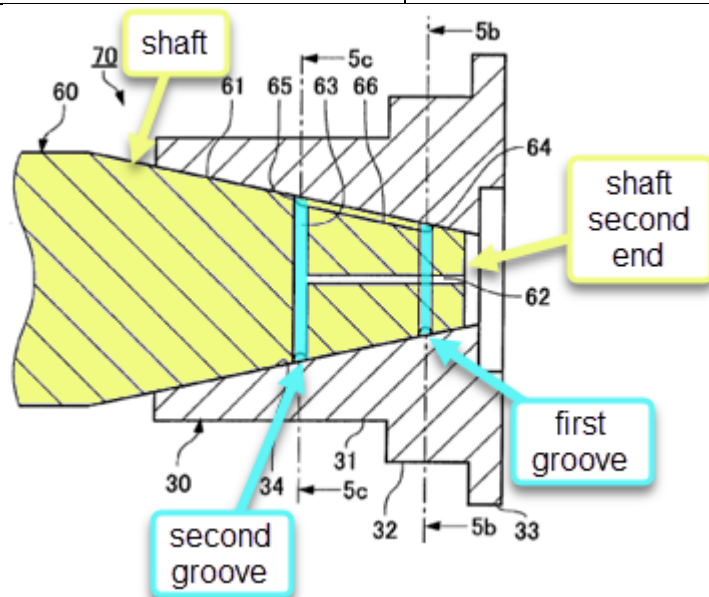
<sup>70</sup> Yagi Figure 5A, annotated

<sup>71</sup> Yagi 6:51-63

(highlighted in green above). A POSITA would understand that the method used to connect multiple grooves is a well understood design choice. A POSITA would be motivated to use the teachings of Yagi in combination to connect the first and second grooves on the exterior of the shaft to simplify machining and reduce cost.

### **Obviousness of Claim 16 of the '090 Patent over Coxhill in view of Piepho and Yagi**

| Claim 16                                                                                                                                                                                     |                                                                                                                                                                                                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>16P.</b> The main shaft as claimed in claim 15,                                                                                                                                           | <b>YES:</b> As shown above, Coxhill in view of Piepho and Yagi discloses the main shaft as claimed in claim 15.                                                                                                   |
| <b>16a.</b> 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 | <b>YES:</b> Coxhill in view of Yagi, discloses two grooves with a first groove closer to the second end of the shaft and the second groove further from the second end of the shaft relative to the first groove. |



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As shown above, Yagi has a first and second groove. The first groove is closer to the second end of the shaft relative to the second groove.

<sup>72</sup> US 8,302,754 to Yagi Figure 5A, annotated

As previously explained, a POSITA would be motivated to combine Coxhill with Yagi due to the benefits of removal of the protective sleeve via oil being pumped into the grooves. Multiple grooves allow the oil to penetrate to the entire tapered surface more easily.

**16b.** 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.

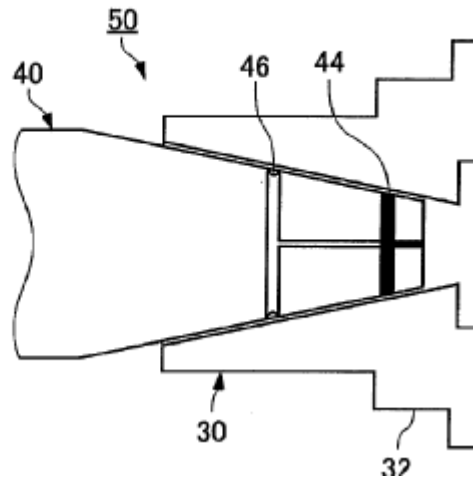
**YES:** Coxhill in view of Piepho and Yagi, render this limitation obvious. Yagi discloses an oil path consisting of a fluid inlet positioned at the second end, the first groove, the second groove, an axially extending channel indented at the external surface of the shaft body to couple first groove and the second groove in fluid communication. In one embodiment Yagi teaches an internal oil path that extends only to the first groove, and in another embodiment teaches an internal oil path that extends to the second groove. The design choice to port to one or the other grooves does not make any material difference to the functionality of the device and is merely a design decision. At the very least the specific oil path described in this element would be obvious to try as it is choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success.



As can be seen in the figure above and is evident in the description, Yagi includes each feature in the claim, but ports to the second groove rather than the first. Yagi has an axially extending channel indented into the external surface connecting the first and second grooves in fluid communication. There is a fluid path from a fluid inlet to one of the two grooves. This path has a conduit extending axial from that inlet connecting to a second conduit running radially to the groove on the external surface of the shaft body.

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FIG. 6B



Yagi teaches an internal fluid channel that connects from the port at the second end to either the first or second groove. A POSITA would be motivated to connect to the first groove as the drill depth from the end would be less, and be easier to manufacture and would cost less.

The purpose of the fluid conduit and grooves is to provide fluid pressure to the entire tapered axial region in order to expand the sleeve and compress the shaft. Multiple concentric grooves allow this pressure to be distributed along the length of the tapered axial region. How the fluid arrives at these grooves is merely a design choice that would be well known by a POSITA. For instance, the grooves could all be connected from a port in the end of the shaft with a conduit that connects to both grooves internal to the shaft. Alternatively, a POSITA would understand that a port in the end of the shaft could be connected to a first groove internal to the shaft and a second groove connected to the first groove by a groove on the external surface of the shaft or by an internal shaft connected to the first groove and an external channel connected to the second groove. At the very least this would be “obvious to try” as it is choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success.

Yagi includes several variations of porting options including those shown above. As explained previously, the choice to run the fluid path to either the first or second grooves is merely a design decision. This decision will not affect the function as the fluid is incompressible. The choice will not affect the intended purpose to assist in removal of the sleeve in any way.

A POSITA would be motivated to port to the first groove as this requires less

machining. It is well known that the deeper the hole drilled the more difficult the drilling process becomes. The difficulties of deep hole drilling would be known by a POSITA.

*“Deep hole drilling is a complex process which is characterized by a high metal removal rate and hole accuracy... When the hole depth increases, the demands on both tools and machining techniques increase [1].”*<sup>78</sup>

Yagi also mentions one advantage of the external groove rather than two radial grooves is the ease of machining a groove compared to drilling a hole. A POSITA would be aware of these tradeoffs and would make this design choice based on the known tradeoffs.

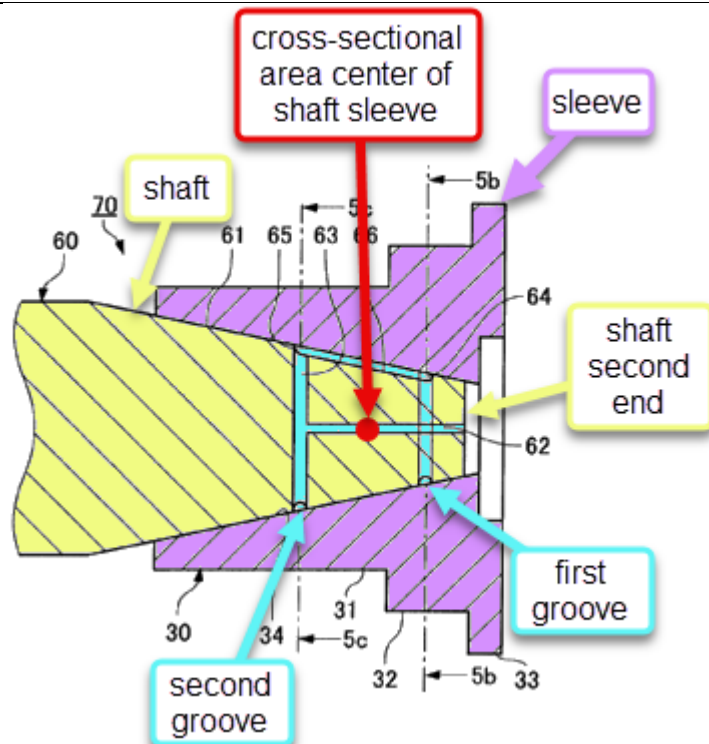
*“Also, the feed of oil from the second oil groove 65 to the first oil groove 64 is accomplished via the connecting oil groove 66. This connecting oil groove 66 can be machined easily as compared with the first radial oil passage 43 in the second embodiment.”*<sup>79</sup>

### **Obviousness of Claim 17 of the '090 Patent over Coxhill in view of Piepho and Yagi**

| Claim 17                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>17P.</b> The main shaft as claimed in claim 15,                                                                                                                                                                                                                                                                  | <b>YES:</b> As shown above, Coxhill in view of Piepho and Yagi discloses the main shaft as claimed in claim 15.                                                        |
| <b>17a.</b> wherein the first groove is <u>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</u> | <b>YES:</b> Coxhill in view of Piepho and Yagi, discloses two grooves with one groove to one side of the center of the sleeve and the second groove on the other side. |

<sup>78</sup> <http://www.diva-portal.org/smash/get/diva2:874814/FULLTEXT01.pdf#:~:text=With%20an%20increased%20hole%20depth%20the%20demands,hole%20which%20requires%20a%20specialized%20drilling%20technique>. Pg.6

<sup>79</sup> US 8,302,754 to Yagi 7:21-25



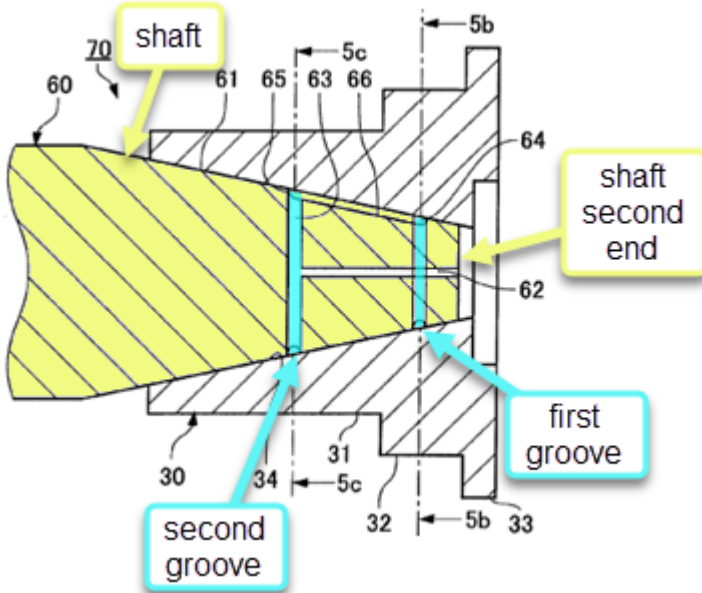
80

As seen in the figure above, the cross-sectional area center of the sleeve of Yagi is between the two oil grooves. The first groove is positioned on the side closer to the second end of the shaft. The second groove is positioned on the further side of the cross-sectional area center of the sleeve. A POSITA would understand that the best way to evenly distribute the oil would be to space the two grooves one either side of the cross-sectional area center of the sleeve.

### **Obviousness of Claim 18 of the '090 Patent over Coxhill in view of Piepho and Yagi**

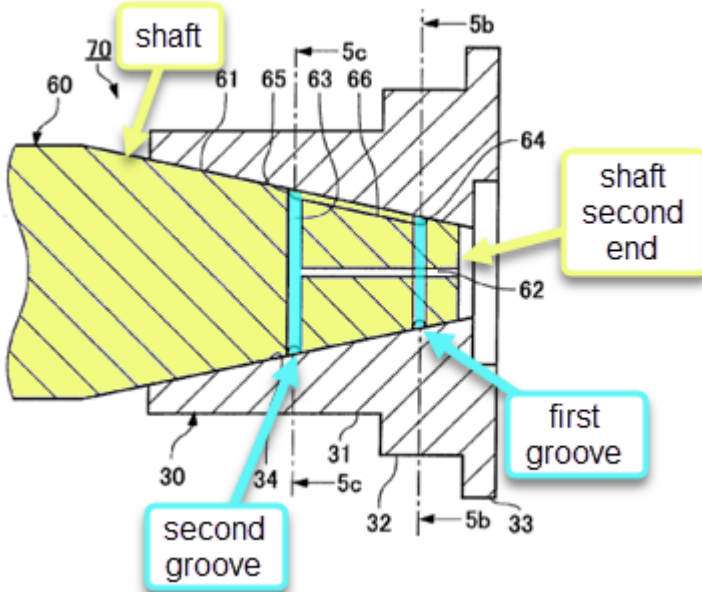
| Claim 18                                                                                  |                                                                                                                 |
|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| <b>18P.</b> The main shaft as claimed in claim 15,                                        | <b>YES:</b> As shown above, Coxhill in view of Piepho and Yagi discloses the main shaft as claimed in claim 15. |
| <b>18a.</b> wherein <u>the plurality of grooves</u> extend in a circumferential direction | <b>YES:</b> Coxhill in view of Piepho and Yagi disclose that the plurality of                                   |

<sup>80</sup> US 8,302,754 to Yagi Figure 5A, annotated

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| around the <u>tapered axial region</u> shaft body.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | grooves extend in a circumferential direction around the shaft body. |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                      |
| <p>As has been explained previously, Yagi also teaches a plurality of grooves that extend circumferentially around the shaft body, as shown above.</p> <p>This combination of Coxhill in view of Piepho and Yagi is the result of combining known elements using known methods to produce predictable results. A POSITA would be further motivated to combine these elements to simplify the equipment and process for making and breaking interference fits as discussed above, and would have every expectation of success as the technology was already well developed and documented.</p> |                                                                      |

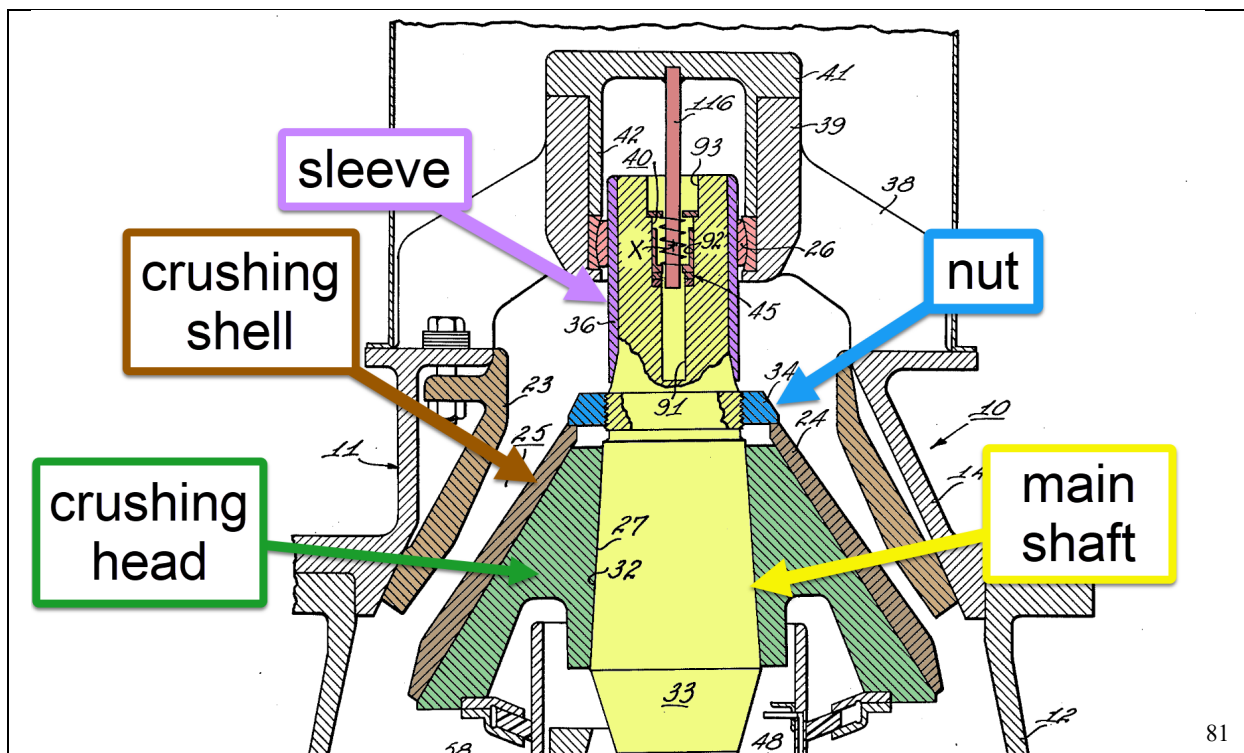
### **Obviousness of Claim 19 of the '090 Patent over Coxhill in view of Piepho and Yagi**

| <b>Claim 19</b>                                                                        |                                                                                                                     |
|----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| <b>19P.</b> The main shaft as claimed in claim 18,                                     | <b>YES:</b> As shown above, Coxhill in view of Piepho and Yagi discloses the main shaft as claimed in claim 18.     |
| <b>19a.</b> wherein the <u>plurality of grooves</u> extend substantially or completely | <b>YES:</b> As shown and described above, Coxhill in view of Piepho and Yagi disclose that the plurality of grooves |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| circumferentially around the shaft body.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | extend completely around the shaft body. |
|  <p>As has been explained previously, Yagi also teaches a plurality of grooves completely circumferentially around the shaft body, as shown above.</p> <p>This combination of Coxhill in view of Piepho and Yagi is the result of combining known elements using known methods to produce predictable results. A POSITA would be further motivated to combine these elements to simplify the equipment and process for making and breaking interference fits as discussed above, and would have every expectation of success as the technology was already well developed and documented.</p> |                                          |

### **Obviousness of Claim 20 of the '090 Patent over Coxhill in view of Piepho and Yagi**

| Claim 20                                                                                                                                                                                                                |                                                                                                                                                                                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The main shaft as claimed in 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. | <b>YES:</b> Coxhill in view of Piepho and Yagi disclose a shaft sleeve that, when positioned on the shaft body, is separated from and not fastened to a crushing head and crushing shell. |



81

*"The upper portion of the crusher shaft 33 is **fitted with a bearing sleeve 36** and is received in the pivot bearing member 26."*<sup>82</sup>

*"A **nut 34** is **threadedly engaged on the crusher shaft 33** at a position adjacent the upper end of the crusher head 24 and serves to lock the crusher head in operative position on the shaft 33."*<sup>83</sup>

As can be seen above, the shaft sleeve of Coxhill is only connected to the shaft and is separated from and not fastened to the crushing head and crushing shell. Coxhill explains that the crusher head is retained by a nut that is threaded onto the shaft.

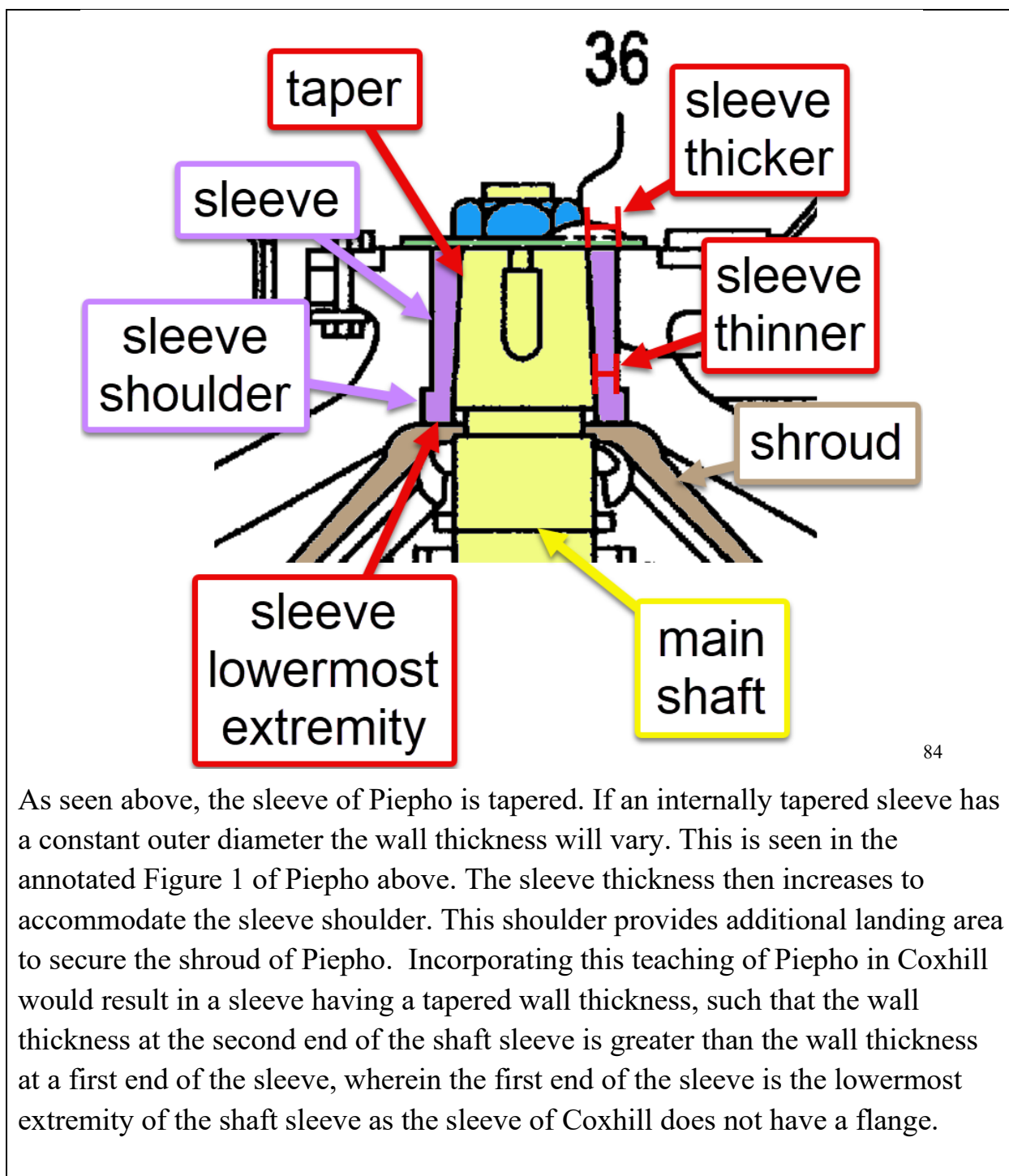
<sup>81</sup> US 4,037,800 to Coxhill Fig. 1 cropped and annotated

<sup>82</sup> US 4,037,800 to Coxhill 2:29-31 emphasis added

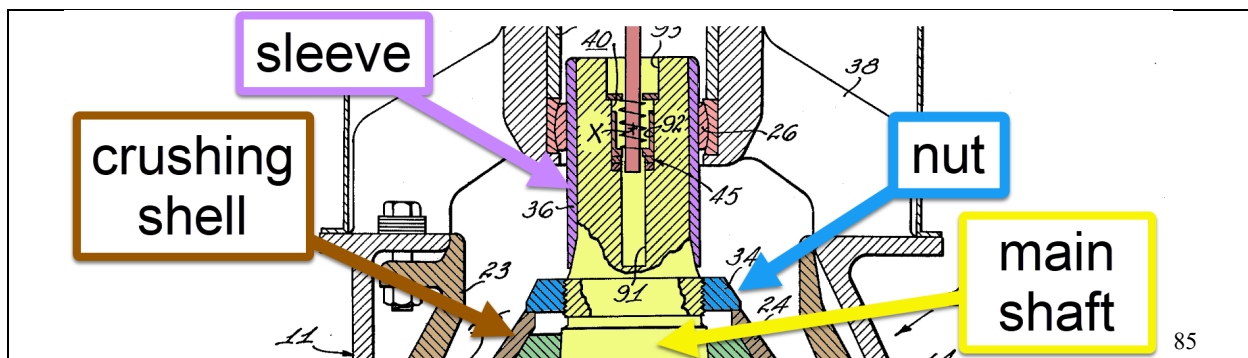
<sup>83</sup> US 4,037,800 to Coxhill 2:26-29

**Obviousness of Claim 21 of the '090 Patent over Coxhill in view of Piepho, Harless and Shepard**

| <b>Challenged Claim</b>                                                                                                                                                                                                                                                                                                                                              | <b>Obvious by Prior Art?</b>                                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Claim 21</b>                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                        |
| <b>21P.</b> A gyratory crusher main shaft assembly for a crusher comprising:                                                                                                                                                                                                                                                                                         | <b>YES:</b> While the preamble to a claim is generally not considered limiting, see claim element 15P.                                                                                                                                                                 |
| <b>21a.</b> 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>                                                                                                                                                                             | <b>YES:</b> See element 15a above.                                                                                                                                                                                                                                     |
| <b>21b.</b> 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,                                                                        | <b>YES:</b> See element 15b.                                                                                                                                                                                                                                           |
| <b>21c.</b> a shaft sleeve mounted on the tapered axial region, and                                                                                                                                                                                                                                                                                                  | <b>YES:</b> See element 15c.                                                                                                                                                                                                                                           |
| <b>21d.</b> wherein the 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, <u>wherein the first end of the shaft sleeve is a lowermost extremity of the shaft sleeve;</u> and | <b>YES:</b> Coxhill in view of Piepho discloses 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. |
| As explained previously, Piepho utilizes a tapered sleeve for ease of assembly and disassembly. A POSITA would be motivated to adopt the tapered sleeve of Piepho and implement it in Coxhill for this advantage.                                                                                                                                                    |                                                                                                                                                                                                                                                                        |

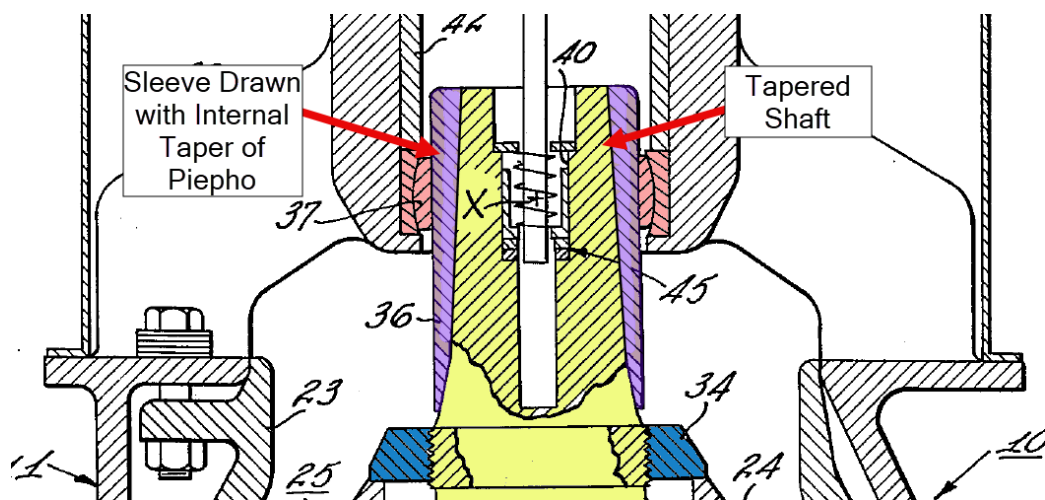


<sup>84</sup> US 6,270,026 to Piepho Figure 1 Cropped and Annotated



85

The sleeve of Coxhill does not retain the shroud, or crushing shell. Thus, Coxhill does not require the sleeve shoulder of Piepho. A POSITA combining Coxhill with the tapered sleeve of Piepho would naturally alter only the internal surface and leave the external surface a simple cylinder. This modification is illustrated below.



86

As the sleeve of Coxhill has a uniform cross section, apart from the chamfers on the ends of the cylinder, a POSITA would naturally continue the adopted taper of Piepho to the lowermost extremity of the shaft sleeve. Coxhill in view of Piepho would have a tapered sleeve wall thickness such that the wall thickness at a second end of the shaft sleeve would be greater than the wall thickness at a first end of the sleeve.

**21e.** an end retainer releasably mounted at the second end of the shaft body and having a perimeter region extending

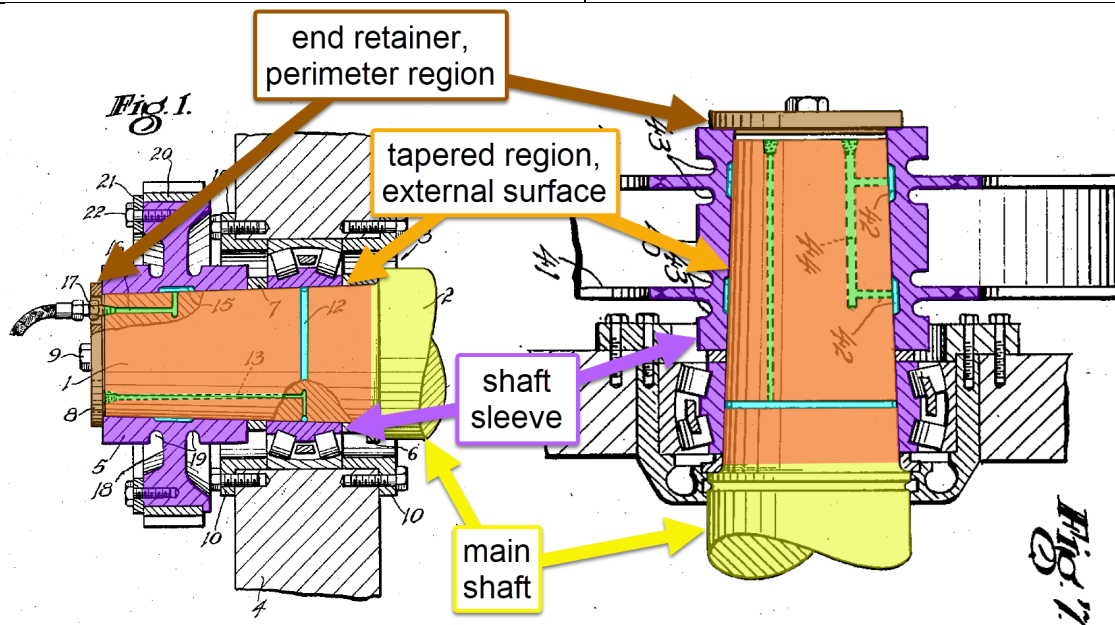
**YES:** Coxhill in view of Harless discloses a main shaft assembly further comprising an end retainer releasably

<sup>85</sup> US 4,037,800 to Coxhill Fig. 1 cropped and annotated

<sup>86</sup> US 4,037,800 to Coxhill Fig. 1 cropped, modified and annotated

radially outward beyond the external surface at the tapered axial region, the perimeter region positioned to radially overlap the shaft sleeve at the second end of the sleeve to inhibit axial separation of the shaft sleeve from the shaft body,

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.



## C.A. Harless

87

As shown above, Harless discloses an end retainer mounted at the second end (topmost as previously shown) of the main shaft. Figures 1 and 7 of Harless are shown above. As can be seen in the figure, the end retainer is fastened to the end of the tapered region of the main shaft and extends radially outward beyond the external surface of the tapered region. This design feature helps to retain and apply force to the sleeve components as shown above, consistent with the specification:

*"The hub of the gear 5. and the inner race of the bearing 3 are located axially of the shaft by means of spacer rings 6 and 7 and a cap plate or washer 8 attached to the end of the shaft as by means of screws 9."*<sup>88</sup>

<sup>87</sup> US 2,840,399 to C.A. Harless Figures 1 and 2, annotated

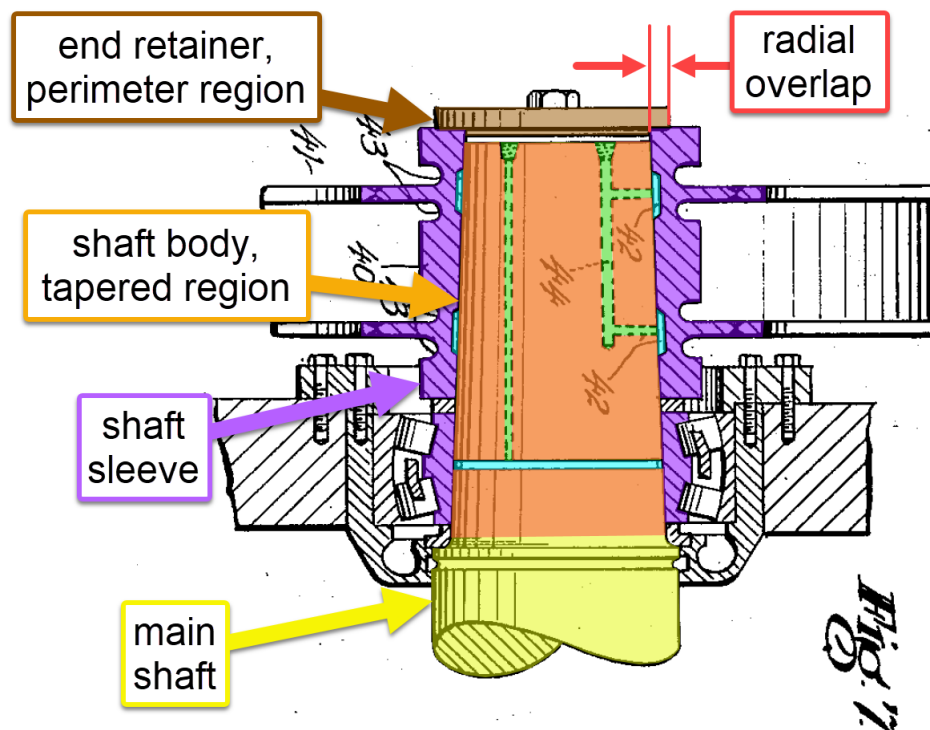
<sup>88</sup> US 2,840,399 to C.A. Harless 1:66-69, emphasis added

*"The invention may also be applied to double webbed gears where both webs extend radially, and such an application is shown in Figure 7.*

...

*The construction and operation is otherwise the same as in the embodiments previously described.*"<sup>89</sup>

This combination of Coxhill in view of Piepho and Harless is the result of combining known elements using known methods to produce predictable results. It is well-known and customary to include a retainer such as shown in Harless in an assembly using a tapered interference joint.



As shown above, the perimeter region of the end retainer (the outermost surface) extends radially beyond the tapered region of the main shaft of Harless, and thus it overlaps with the sleeve components. This overlap acts to inhibit the axial separation of the sleeve components from the shaft body.

*"The hub of the gear 5. and the inner race of the bearing 3 are located axially of the shaft by means of spacer rings 6 and 7 and a cap plate or washer 8 attached to the end of the shaft as by means of screws 9."*<sup>90</sup>

This combination of Coxhill in view of Piepho and Harless is the result of combining known elements using known methods to produce predictable results.

<sup>89</sup> US 2,840,399 to C.A. Harless 4:16-18, 22-23

<sup>90</sup> US 2,840,399 to C.A. Harless 1:66-69

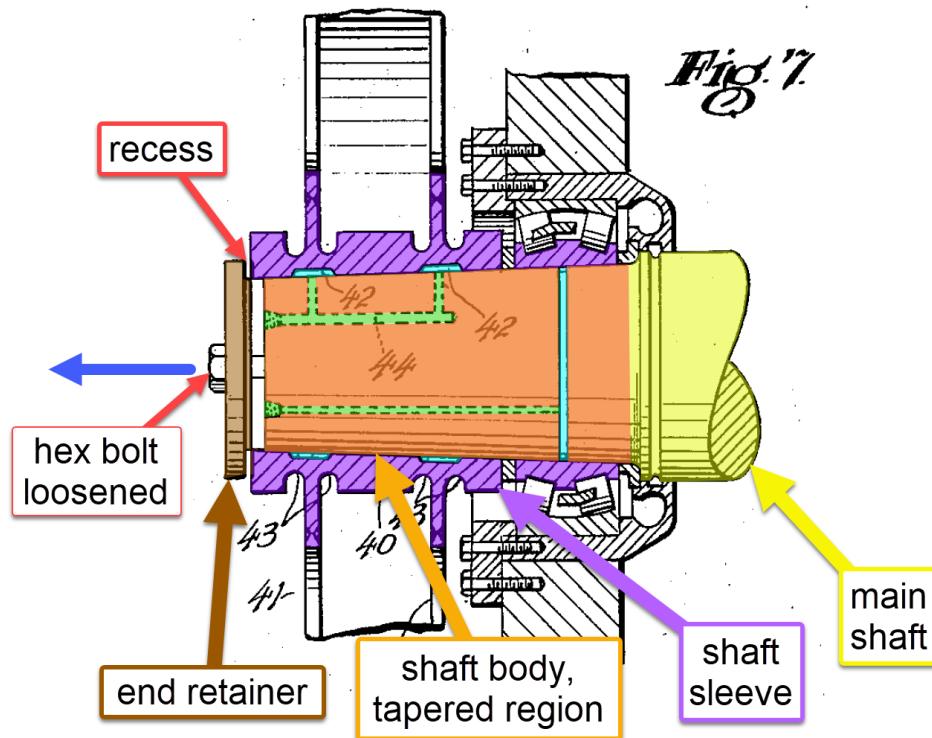
**21f.** wherein the end retainer includes a recess extending circumferentially at the perimeter region to allow axial movement of the shaft sleeve into the recess,

**YES:** Harless discloses that the end retainer includes a recess extending circumferentially at the perimeter region to allow axial movement of the sleeve into the recess.

Harless discloses a removal process as follows:

*"To remove a gear, it is only necessary to back off the bolts 9 slightly and introduce oil under pressure through the bore 16 so as to expand the gear hub, whereupon the gear will slide back against the washer 8 with no difficulty and may then be removed."*<sup>91</sup>

As described above, in order to remove a component such as a sleeve or a bearing, a user must first partially back off the retaining bolt in the end retainer. As shown in the figures of the patent, particularly Figure 7, the end retainer has an undercut shoulder. A POSITA would understand that this undercut shoulder allows the end retainer to seat itself in a centered condition. Shown below, I have adjusted Figure 7 to show what will happen when a user follows the instructions described in the citation above:



92

<sup>91</sup> US 2,840,399 to C.A. Harless 3:18-22

<sup>92</sup> I note that I added the bolt shank in under the end retainer, just as a POSITA would understand it to be there, and as it is clearly illustrated in companion figures such as Figures 3, 4, 5, and 8.

As shown above, when the hex bolt is partially loosened (as described in the specification), it allows the end retainer to shift away from the sleeve. When this shift happens, a recess is left between the end retainer sleeve. A POSITA would understand that this recess extends circumferentially at the perimeter region of the end retainer. As a user continues to follow the instructions outlined in the specification of Harless, pressurized oil will be pumped into the bore (16 in Figure 1 which is 44 in Figure 7 above). The pressurized oil will act to release the interference fit between the sleeve and the tapered portion of the shaft and shift it into the recess under the end retainer. A POSITA would be motivated to follow these instructions, not only because they are given in conjunction with the apparatus of Harless, but because it is well-known that partially backing off the end retainer allows the tapered interference fit to be broken but keeps the components from falling off the shaft itself and potentially being damaged from striking the ground.<sup>93</sup>

This combination of Coxhill in view of Piepho and Harless is the result of combining known elements using known methods to produce predictable results.

Harless discloses that the bolts holding the washer can be backed off slightly creating a recess the extends circumferentially at the perimeter region such that the sleeve is retained when pressure is applied to slide the sleeve off the shaft.

*“The arrangement of the invention is also highly advantageous in facilitating removal and replacement of a gear. To remove a gear, it is only necessary to back off the bolts 9 slightly and introduce oil under pressure through the bore 16 so as to expand the gear hub, where upon the gear will slide back against the washer 8 with no difficulty and may then be removed.”<sup>94</sup>*

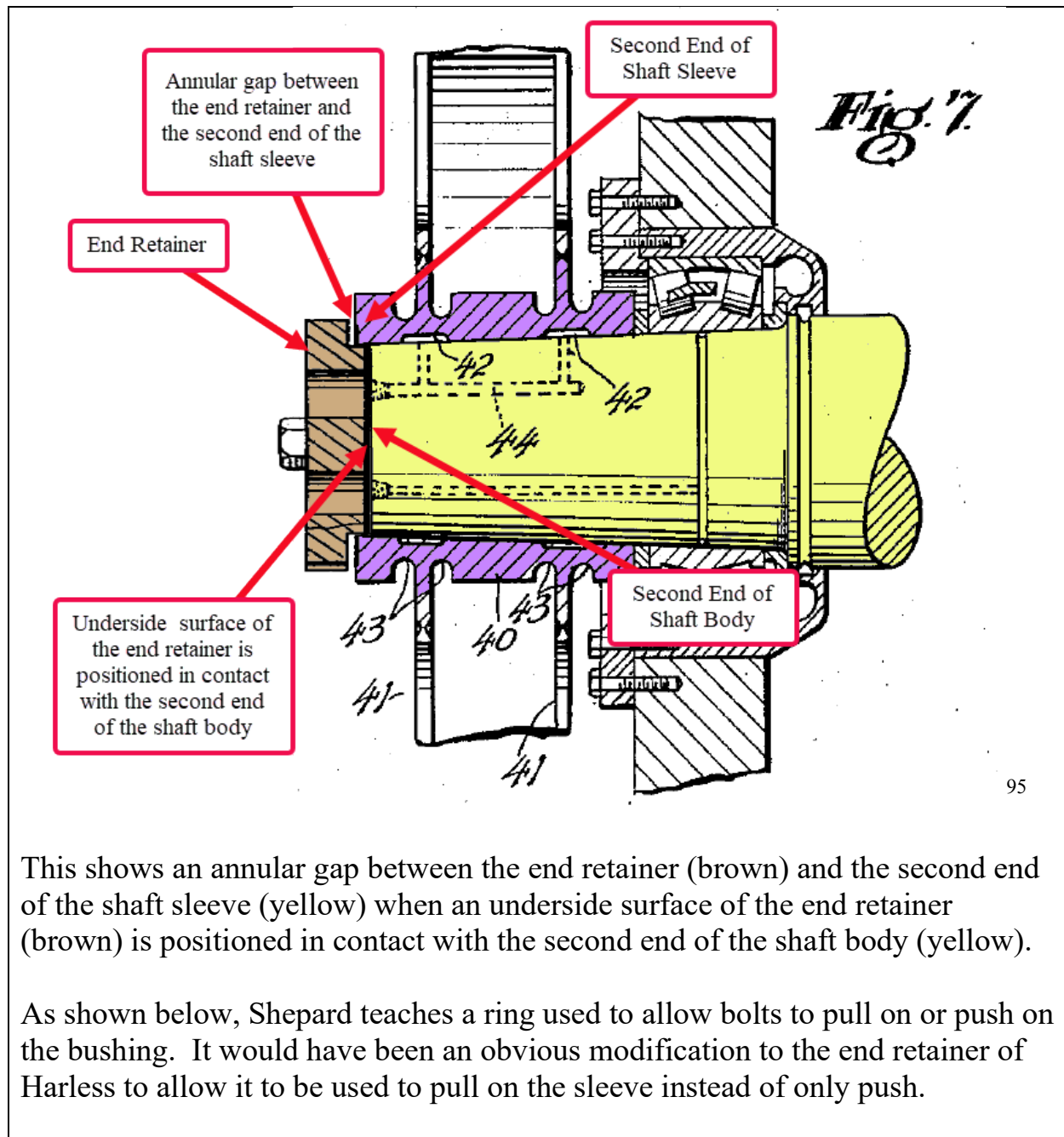
**21g. wherein the recess defines an annular gap between the end retainer and the second end of the shaft sleeve when an underside surface of the end retainer is positioned in contact with the second end of the shaft body.**

**YES:** While this is not shown explicitly, it would have been obvious in view of Harless and Shepard. Harless teaches a gap between an end retainer and the sleeve to both allow the sleeve to move axially to release the press fit and yet be retained. Shepard teaches a ring with holes that allow bolts to pull a sleeve into or out of engagement. A POSITA would be motivated to make a simple

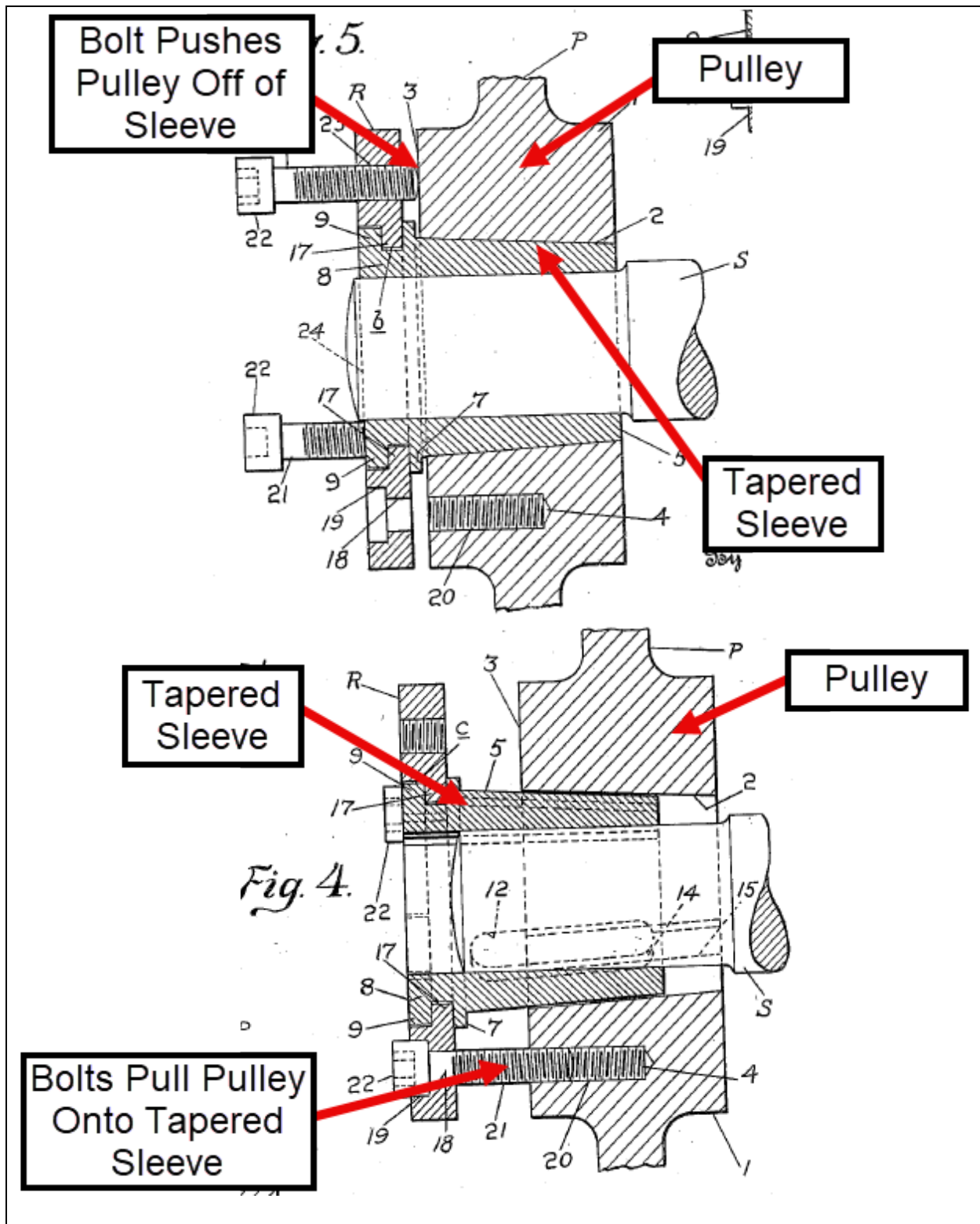
<sup>93</sup> 718 to Behm at 4:57-62

<sup>94</sup> US 2,840,399 to C.A. Harless 3:16-22

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <p>modification of an end retainer that has such a gap when in contact with the shaft to provide a structure that allows the bolt to develop tension and pull the sleeve off of the shaft when the hydraulic pressure alone is insufficient. Such methods of pulling or pushing a sleeve or bushing were well known in the art as described in this declaration. It would be obvious for a POSITA to try such an end washer. It would be a predictable solution to pull on the sleeve and there would be more than a reasonable expectation of success.</p> |
| <p>As discussed previously, Harless uses a washer and bolt to during the installation and removal of the sleeve. This installation method performs the same function as the process described in the '090 patent. Harless actually discloses an end retainer that a POSITA would be motivated to try and would make a simple substitution to eliminate the issues described above. In the following figure, I have substituted an end retainer (brown) of the shape shown in Fig. 5 of Harless on Fig. 7 of Harless.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

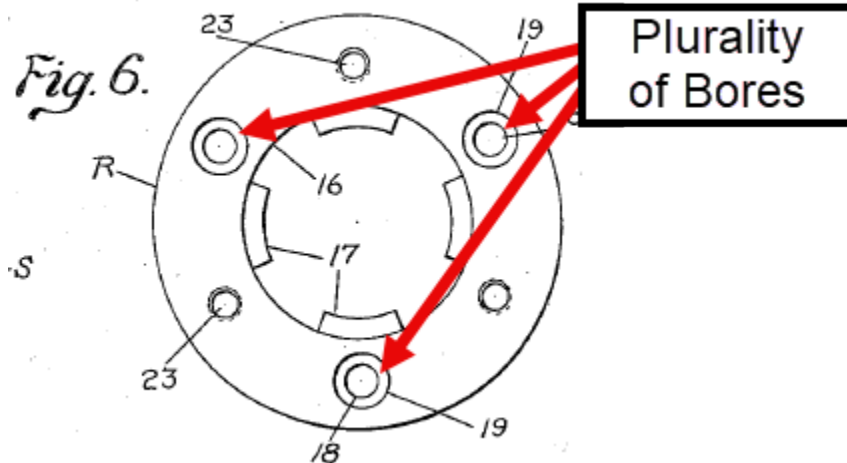


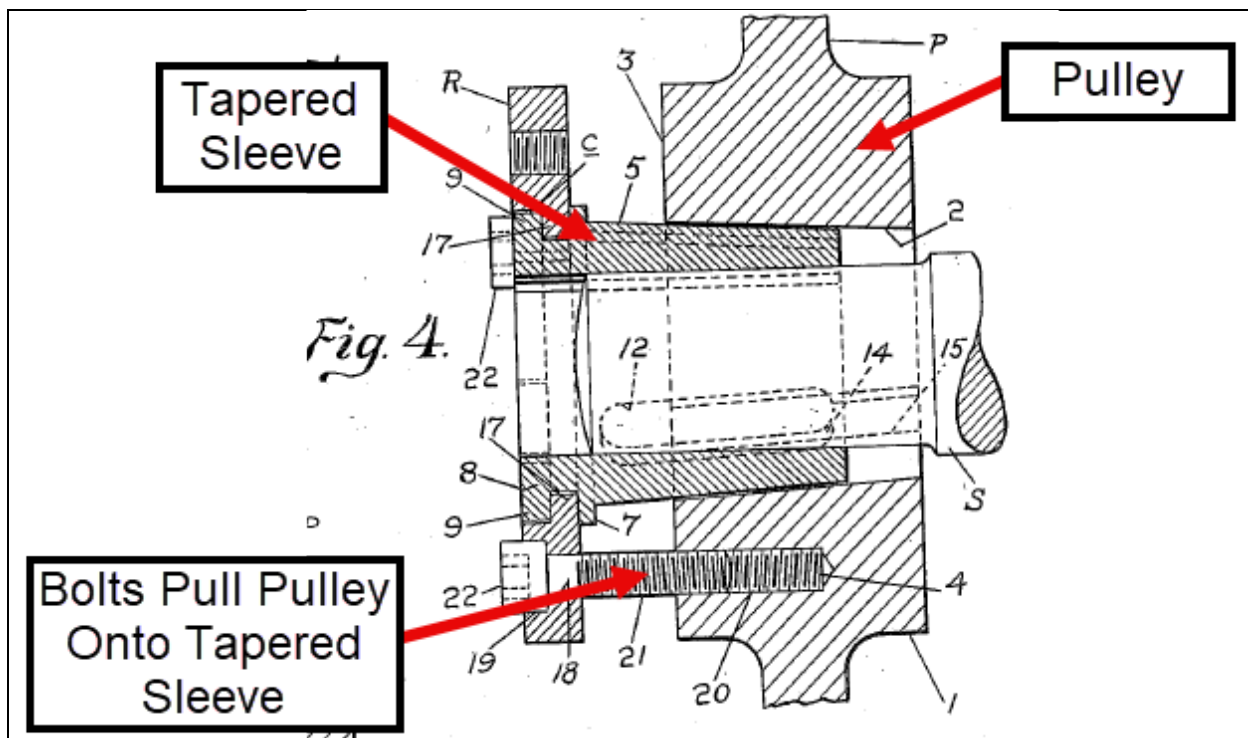
<sup>95</sup> Harless Figure 7, annotated with Figure 5 end retainer



**Obviousness of Claim 22 of the '090 Patent over Coxhill in view of Piepho,  
Harless and Shepard**

| Claim 22                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>22P.</b> <u>The assembly as claimed in claim 21,</u>                                                                                                                                                                                                                                               | <b>YES:</b> As shown above, the combinations have all the limitations of claim 21.                                                                                                                                                                                                                                                                                                                 |
| <b>22a.</b> <u>wherein the end retainer comprises a first plurality of bores distributed circumferentially around the end retainer and configured to align with a plurality of sleeve bores in the second end of the shaft sleeve such that the end retainer can be attached to the shaft sleeve.</u> | <b>YES:</b> Coxhill in view of Peipho, Harless and Shepard discloses a pluralities of holes distributed circumferentially in the end retainer to attach to the shaft sleeve. It is a known technique to use bolts with aligned bores to attach two separate parts together, or to push or pull on the sleeve. This technique is common in the mechanical arts and would be well known to a POSITA. |





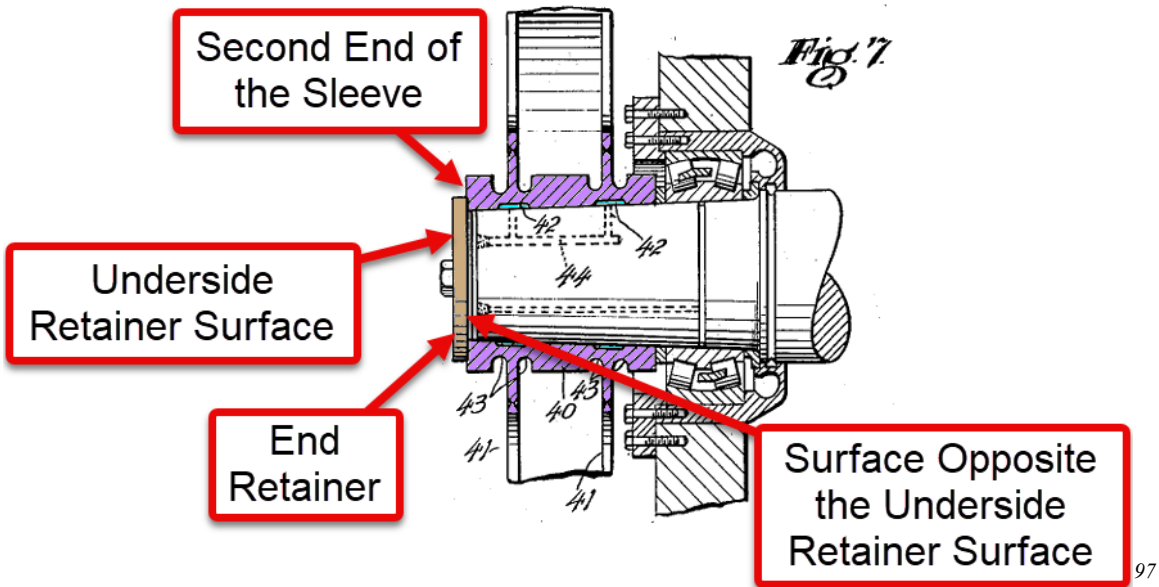
Shepard teaches that “In the present embodiment of the invention, these openings 18 are shown as three in number and these openings 18 are adapted to register with the properly positioned threaded sockets 20 in the face 3. A headed bolt 21 is inserted through each of the openings 18 and threads within the registering sockets 20... whereby as the bolt 21 is threaded within its socket, the ring R together with its lugs 17 will contact with the adjacent high extremity of the sleeve or bushing 5 inwardly of the extension 8 and force said sleeve or bushing 5 within the bore 2 of the body 1, whereby the pulley P or the like will be effectively locked as desired upon the shaft S.”<sup>96</sup>

Aligning bolt holes to secure two parts together would be obvious to a POSITA.

**Obviousness of Claim 23 of the '090 Patent over Coxhill in view of Piepho, Harless and Shepard**

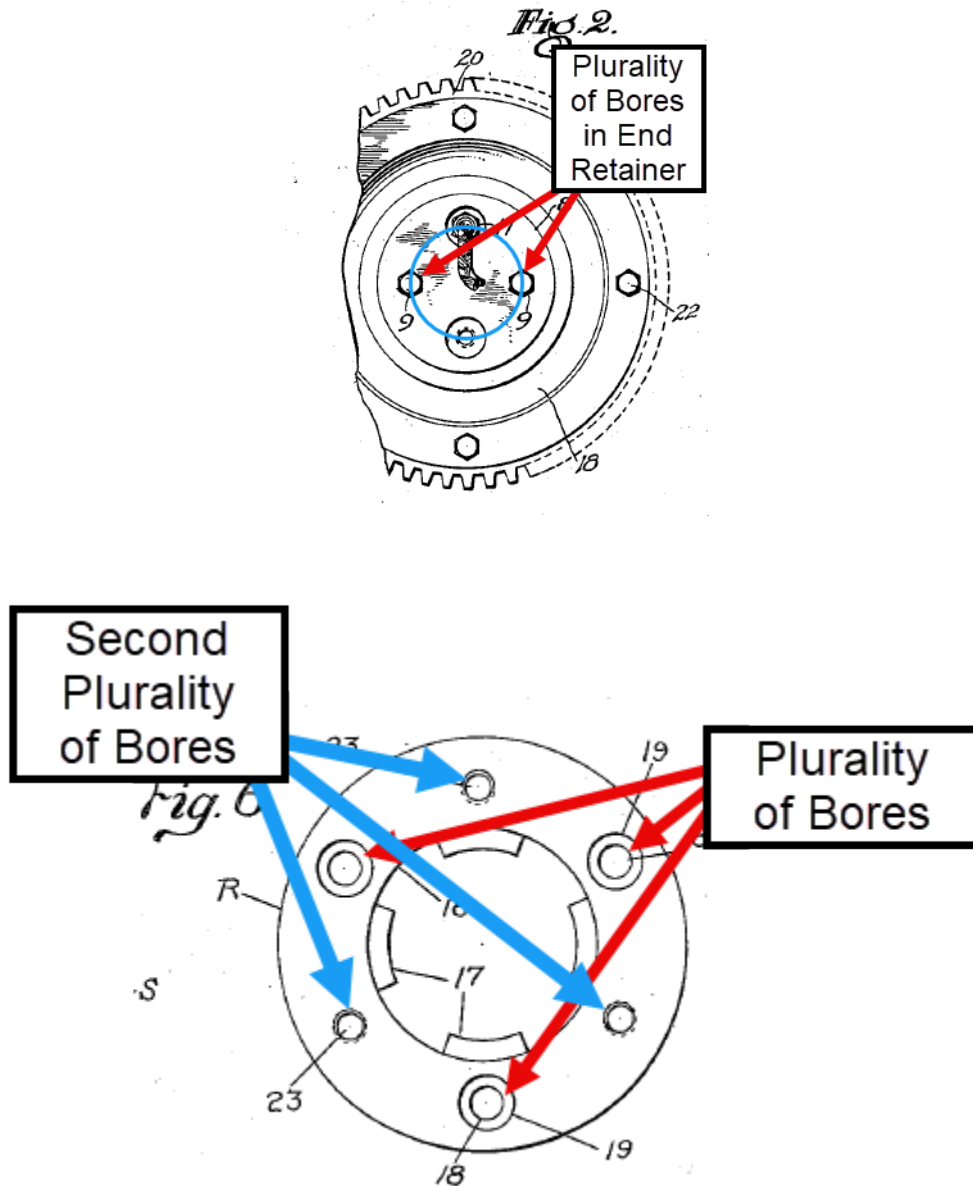
| Claim 23                                         |                                                               |
|--------------------------------------------------|---------------------------------------------------------------|
| <b>23P.</b> The assembly as claimed in claim 22, | <b>YES:</b> As shown above, the combinations disclose all the |

<sup>96</sup> Shepard 2:31-48

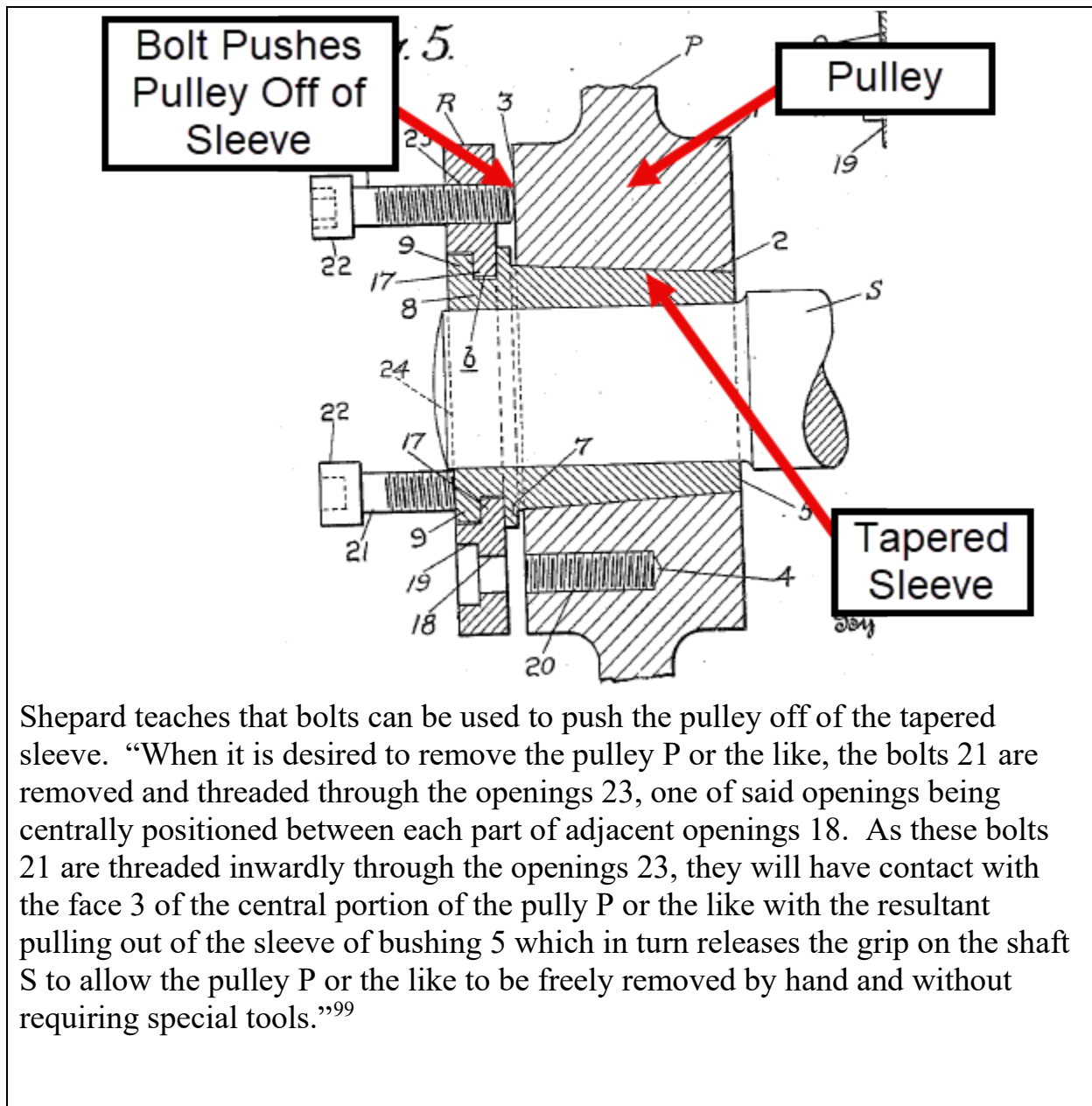
|                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                          | limitations claim 22.                                                                                                                                                                                                                                                                                                                                                                  |
| <b>23a1.</b> <u>wherein the end retainer comprises a surface opposite the underside surface of the end retainer configured to mate against the second end of the shaft sleeve when the end retainer is inverted, and</u>                                                                                                                 | <b>YES:</b> Harless discloses an end retainer configured to mate against the second end of the shaft sleeve when the end retainer is inverted.                                                                                                                                                                                                                                         |
| <p>Both sides of the washer, or end retainer of Harless are flat. Therefore, both sides would be configured to mate against the flat end surface of the Harless shaft sleeve.</p>                                                                     |                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>23a2.</b> <u>wherein the end retainer is configured to force the shaft sleeve axially over the tapered axial region when a plurality of attachment members extending through a second plurality of bores in the end retainer and into a plurality of corresponding shaft bores in the second end of the shaft body are tightened.</u> | <b>YES:</b> Harless in view of Shepard or ordinary skill in the art discloses an end retainer configured to force the shaft sleeve axially over the tapered axial region when a plurality of attachment members extending through a second plurality of bores in the end retainer and into a plurality of corresponding shaft bores in the second end of the shaft body are tightened. |
| <p>As shown in Fig. 2 of Harless, there are a plurality of attachment members (bolts) extending through bores in the end retainer and into a plurality of corresponding shaft bores in the shaft. The washer, or end retainer forces the</p>                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                        |

<sup>97</sup> Harless Figure 7, annotated

shaft sleeve axially over the tapered axial region when an attachment member extending through a bore in the washer into a bore in the second end of the shaft body is tightened. Harless teaches that “that axial movement of the gear may be accomplished by tightening the bolts 9, so as to cause the washer 8 to move the gear axially of the shaft”<sup>98</sup>



<sup>98</sup> Harless 2:52-54



Shepard teaches that bolts can be used to push the pulley off of the tapered sleeve. “When it is desired to remove the pulley P or the like, the bolts 21 are removed and threaded through the openings 23, one of said openings being centrally positioned between each part of adjacent openings 18. As these bolts 21 are threaded inwardly through the openings 23, they will have contact with the face 3 of the central portion of the pulley P or the like with the resultant pulling out of the sleeve of bushing 5 which in turn releases the grip on the shaft S to allow the pulley P or the like to be freely removed by hand and without requiring special tools.”<sup>99</sup>

**Obviousness of Claim 24 of the '090 Patent over Coxhill in view of Piepho, Harless, Shepard and Yagi**

**Claim 24**

<sup>99</sup> Shepard 2:49-61

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>24P.</b> The assembly as claimed in claim 21,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>YES:</b> As shown above, the combinations have all the limitations of claim 21. |
| <b>24a.</b> <u>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</u> | <b>Yes:</b> See Claim 16 above.                                                    |

**Obviousness of Claim 25 of the '090 Patent over Coxhill in view of Piepho, Harless, Shepard and Yagi**

| <b>Challenged Claim</b>                                                                                                                                                                             | <b>Obvious by Prior Art?</b>                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>25P.</b> The assembly as claimed in claim 21,                                                                                                                                                    | <b>YES:</b> As shown above, the combinations have all the limitations of claim 21. |
| <b>25a.</b> <u>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.</u> | <b>Yes:</b> See Claim 20 above.                                                    |

**Obviousness of Claim 26 of the '090 Patent over Coxhill in view of Piepho and Yagi**

| <b>Challenged Claim</b>                                                                                                                                                                                                                                                                                                                                          | <b>Obvious by Prior Art?</b>                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <b>26P.</b> A gyratory crusher comprising;                                                                                                                                                                                                                                                                                                                       | <b>YES:</b> While the preamble is generally not considered limiting Coxhill discloses a gyratory crusher. |
| <b>26a.</b> 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>                         | <b>YES:</b> See element 15a above.                                                                        |
| <b>26b.</b> 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; | <b>YES:</b> See element 15b above.                                                                        |
| <b>26c.</b> 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; and</u>                                     | <b>YES:</b> See element 15c above.                                                                        |
| <b>26d.</b> at least one groove indented at the external surface and positioned at                                                                                                                                                                                                                                                                               | <b>YES:</b> See element 15d above.                                                                        |

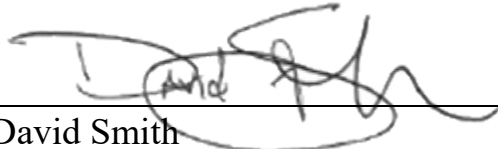
|                                                                                                                                                                                         |                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 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 <sub>2</sub>     |                                 |
| <b>26e.</b> wherein the sleeve is configured such that when positioned on the shaft body, the sleeve is <u>separated from and not fastened to</u> a crushing head and a crushing shell. | <b>YES:</b> See claim 20 above. |

## IX. CONCLUSION

83. For these reasons, it is my opinion that challenged claims of the '090 patent would have been obvious to a person of ordinary skill in the art.

84. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that 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.

Executed on November 25, 2025 in Meridian Idaho.

  
 \_\_\_\_\_  
 David Smith