

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GD ENERGY PRODUCTS LLC
Petitioner,

v.

KERR MACHINE COMPANY
Patent Owner.

Case No. PGR2025-00031
Patent No. 12,152,582

EXPERT DECLARATION OF WILLIAM D. MARSCHER, P.E.

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I, William D. Marscher P.D., do hereby declare as follows:

I. Introduction

1. I am employed as the CEO and Senior Consultant of the machinery consulting and independent rotating machinery company Mechanical Solutions, Inc. (“MSI”), performing engineering work in the field of fluid systems and their rotating and reciprocating machinery, particularly pumps, compressors, and turbines.

2. I have been retained by Edell, Shapiro and Finnan, LLC (hereinafter “the Edell Firm”), to provide various opinions regarding U.S. Patent No. 12,152,582 (“the ‘582 Patent” or “Foster”). I understand that my declaration is being submitted in connection with a Petition for Post-Grant Review of Foster. Unless otherwise noted, the statements made herein are based on my personal knowledge and, if called to testify with regards to this declaration, I could and would do so competently and truthfully.

3. I have been retained in this matter by the Edell Firm as a technical expert in the field of the design, structure, and operation of pumps and related machinery. I am being compensated for my work in this matter at my usual and customary rate of \$550.00 per hour, paid to the company I am employed by, Mechanical Solutions, Inc. (MSI). I have no personal or financial stake or interest in the outcome of this post-grant review or any related action. My compensation in no way depends upon my testimony or the outcome of this post grant review.

4. I have been advised that the Edell Firm represents GD Energy Products, LLC (hereinafter "Petitioner") in this matter and that Kerr Machine Company (hereinafter "Patent Owner") is the owner of Foster. I have no personal or financial stake or interest in Patent Owner, Petitioner, or Foster.

5. I reserve the right to supplement and/or amend my opinions in this declaration based on future positions taken by Patent Owner or its experts, additional documents, testimony or other information provided by Patent Owner or its witnesses, any orders from the Board, or as otherwise necessary.

II. Qualifications

6. My qualifications for forming the opinions set forth in this expert report are summarized here and explained in more detail in my *curriculum vitae* which is attached as Exhibit A to this Declaration. Exhibit A includes a full list of my publications and other professional contributions and achievements, and a list of the cases in which I have testified at deposition, hearing, or trial.

7. In 1970, I received my Bachelor of Science degree in Mechanical Engineering from Cornell University. Then in 1972, I received by Master of Engineering degree in Mechanical Design also from Cornell University. I also earned a Master of Science degree in Applied Mechanics from Rensselaer Polytechnic Institute in 1976.

8. After receiving my Bachelor of Science degree in Mechanical Engineering, I worked as a senior engineer, for the Bendix Fuel Injection and Fuel Pumps Divisions (now a Honeywell division), a senior engineer for Pratt & Whitney commercial aircraft engine division, Director of Mechanics (mechanical engineering) for Worthington Pump HQ, and Manager of Engineering Mechanics for Dresser Worthington Pump Division (later Ingersoll-Dresser Pump and now Flowserve) after its acquisition of Worthington. I was chief mechanical engineer for Worthington and Dresser Pump, at a time when each respective company was one of the world's largest manufacturers of slurry pumps, with applications including coal slurries, sewage, pulp & paper, and even sauerkraut. I was an active participant in supervising design and development of these pumps for Worthington, as well as their analysis and on-site field testing. Later, I became vice president of the independent pump and turbomachinery developer Concepts NREC, from which 28 years ago, I spun off Mechanical Solutions, Inc. as an independent pump and turbomachinery technology company.

9. For 24 years, I have been one of the U.S. voting representatives on the International Standards Organization ("ISO") committee concerning, among other issues, pump dynamic behavior and acceptance standards. I am a past president of the Society of Tribologists & Lubrication Engineers, the primary technical society worldwide for the study of bearings, sealing, wear, and erosion issues in machinery,

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and prior to this was the chairperson of the STLE Wear Technical Committee, and of the Sealing Technical Committee, the main concern of which was pump and compressor seals. For the past 44 years, I have been a voting member of the ASTM Wear & Erosion Standards Committee. I am also the past Board of Directors Chairperson for the Machinery Failure Prevention Technology Society (MFPT) of the Vibration Institute. And, I am a 22-year member of the Texas A&M Pump Users Symposium Advisory Committee (essentially the Board of Directors for the Symposium). I am a charter Standards Partner for the Hydraulic Institute (“HI”), the trade association for the pump industry, became the Vice Chair of the pump vibration technical committee for HI, and was HI Standards Partner of the Year for 2018, based on my significant roles in the ANSI 9.6.4 and new 9.6.8 standards. In 2018, I also won the Vibration Institute MFPT Frarey Award for Machinery Diagnostics Excellence.

10. I contributed to and served as a reviewer for the first and second editions of the U.S. Department of Energy (“DOE”) and Hydraulic Institute’s pump sourcebook titled, *Improving Pumping System Performance—A Sourcebook for Industry*, the second edition of which was published in 2006.

11. I have also written twelve handbook chapters for various major engineering handbooks, which focus on pump and turbomachinery mechanical issues, including sealing, and component wear and erosion. For instance, the chapter

that I authored for Vol. 18 of the ASM Materials Handbook focused on pump erosion and wear. Further, I previously was the associate editor of the Society of Tribologists and Lubrication Engineers' Tribology Transactions magazine for 18 years.

12. I am an inventor on six U.S. Patents and one European Patent, with two patents directed toward turbomachinery seals. I have also taught short courses and tutorials on a number of pump topics at leading institutions in the United States and around the world. I am a registered and licensed Professional Engineer in New Jersey (License No. 40626).

III. Legal Standards

13. While I am not an attorney, I am been informed by counsel of certain legal principles I should apply in reaching my opinions in this matter. Also, as an inventor, expert witness and otherwise in the course of my work, I have experience studying and analyzing patents and patent claims from the perspective of a person of ordinary skill in the art (POSITA).

A. Claim Construction

14. I understand that claim terms are to be interpreted from the point of view of a POSITA (also referred to herein as the "skilled artisan") at the time the application leading to the patent was filed. I further understand that claim terms are generally to be given their ordinary meaning, considered in light of the claim language, patent specification, and prosecution history. I further understand that a

patentee may act as its own lexicographer and depart from the ordinary and customary meaning by defining a term with reasonable clarity, deliberateness, and precision, but that there is a presumption that a claim term still carries its ordinary and customary meaning.

B. Person of Ordinary Skill in the Art

15. I understand that a POSITA is a hypothetical person who is presumed to have known the relevant art at the time of the invention. He or she is a person of ordinary creativity who understands the scientific and engineering principles applicable to the pertinent art. I am familiar with the knowledge and capabilities of one of ordinary skill in the art in the field of Foster at the time of the effective filing date of the patent: July 14, 2017.

16. I understand that whether a patent claim would have been obvious is determined through the point of view of a person of ordinary skill in the art at the time of the invention. I have applied this standard in my analysis.

C. Validity

17. I understand that the Petitioner must show that there is a reasonable likelihood of success with regard to challenging any of the claims. I understand that the Petitioner bears the burden of proving any instituted grounds of invalidity by a preponderance of the evidence. I understand that a "preponderance" means "more likely than not." I understand that general and conclusory assertions, without

underlying factual evidence, may not support a conclusion that something is "more likely than not." Rather, the preponderance of the evidence standard requires that a reasonable finder of fact be convinced that the existence of a specific material fact is more probable than the non-existence of that fact. The preponderance of the evidence standard does not support speculation regarding specific facts and is instead focused on whether the evidence more likely than not demonstrates the existence or non-existence of specific material facts.

18. I also understand that, in performing a proper unpatentability analysis, an expert must do more than simply provide quotes from the evidentiary record along with conclusory allegations of unpatentability. To the contrary, an expert's conclusions regarding unpatentability must be supported by actual analysis and reasoning set forth in the expert declaration, such that the theoretical and factual foundation for the expert's conclusions can be properly evaluated.

19. I understand that a patent claim is invalid as anticipated if "the claimed invention was patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention." 35 U.S.C. § 102(a)(1).

20. I also understand that a patent claim is invalid as anticipated if "the claimed invention was described in a patent issued under section 151, or in an application for patent published or deemed published under section 122(b), in which

the patent or application, as the case may be, names another inventor and was effectively filed before the effective filing date of the claimed invention.” 35 U.S.C. § 102(a)(2).

21. I understand that anticipation requires that every limitation in a claim be found in a single prior art reference, either explicitly or inherently. I also understand that a reference can anticipate a claim even if it does not expressly spell out all the limitations arranged or combined as in the claim, if a person of skill in the art, reading the reference, would immediately understand the claimed arrangement or combination was disclosed. I also understand that a prior art reference must be enabling so that the claimed subject matter may be made or used by one skilled in the art.

22. I understand that a patent claim may be found unpatentable as obvious under 35 U.S.C. § 103 only if the Petitioner establishes by a preponderance of the evidence that, as of the priority date, the subject matter of the claim, considered as a whole, would have been obvious to a person having ordinary skill in the field of the technology (the "art") to which the claimed subject matter belongs.

23. I understand that the analysis of whether a claim is obvious depends on a number of necessary factual inquiries, for example, (1) the scope and content of the prior art; (2) the differences between the claimed subject matter and the prior art;

(3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness.

24. I understand that the claimed invention must be considered as a whole in analyzing obviousness or nonobviousness. In determining the differences between the prior art and the claims, the question under the obviousness inquiry is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been obvious. Relatedly, I understand that it may be appropriate to consider whether there is evidence of a "teaching, suggestion, or motivation" to combine the prior art teachings in the prior art, the nature of the problem or the knowledge of a person having ordinary skill in the art.

25. I have also been informed that some examples of rationales that may support a conclusion of obviousness include:

- a) Combining prior art elements according to known methods to yield predictable results;
- b) Simply substituting one known element for another to obtain predictable results;
- c) Using known techniques to improve similar devices (or product) in the same way (*e.g.*, obvious design choices);
- d) Applying a known technique to a known device (or product) ready for improvement to yield predictable results;

- e) Choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success—in other words, whether something is "obvious to try";
- f) Using work in one field of endeavor to prompt variations of that work for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; and
- g) Arriving at a claimed invention as a result of some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings.

26. I have also been informed that other rationales to support a conclusion of obviousness may be relied upon, for instance, that common sense (where substantiated) may be a reason to combine or modify prior art to achieve the claimed invention.

27. I understand that one indicator of nonobviousness is when prior art "teaches away" from combining certain known elements. For example, a prior art reference teaches away from the patent's particular combination if it leads in a different direction or discourages that combination, recommends steps that would not likely lead to the patent's result, or otherwise indicates that a seemingly inoperative device would be produced.

28. I understand that an obviousness determination also requires that a person of ordinary skill in the art would have had a reasonable expectation of success in making any modifications to the cited references.

29. I further understand that certain objective indicia can be important evidence regarding whether a patent is obvious or nonobvious, including the existence of a long-felt but unsolved need, unexpected results, commercial success, copying, and industry acceptance or praise. Evidence of such objective indicia must be considered when present. It is generally an error to reach a conclusion on obviousness before considering the evidence of secondary considerations, and then evaluating the latter solely in terms of whether it may fill any gaps in the initial conclusion on obviousness. On the other hand, such evidence is not a requirement for patentability, and the absence of such evidence is a neutral factor in the analysis of obviousness or nonobviousness.

30. I also understand that a prior art reference must be enabled to anticipate a patent. That is, I understand that the prior art reference's description must be such that a person of ordinary skill in the field of the invention can practice the subject matter based on the reference without undue experimentation.

31. Finally, I understand that the obviousness analysis cannot be based on “hindsight.” The skilled artisan must view prior art at the time the invention was made and without using the disclosure of the subject patent as a guide.

IV. Background

A. Person of Ordinary Skill in the Art

32. In my opinion a POSITA at the time of the invention would have a minimum of a bachelor's degree in mechanical or petrochemical engineering, or a comparable engineering discipline, and a minimum of 3-5 years of work experience in the design and/or manufacturing of reciprocating pumps and valves, including fluid ends and/or comparable high pressure fluid components, for industrial applications, including for use in the oil and gas industry. All of my opinions set forth herein are provided from the perspective of a POSITA at the time of the alleged invention of Foster.

B. Background of the Relevant Art

33. The subject matter of Foster is a type of reciprocating pump known as a plunger pump. Reciprocating pumps are a class of positive displacement pumps widely used in various industries for transferring fluids by utilizing a back-and-forth (reciprocating) motion. These pumps are known for their ability to handle high pressures and deliver precise flow rates, making them suitable for applications ranging from water supply to oil and gas production. Reciprocating pumps operate by converting mechanical energy into hydraulic energy. The reciprocating motion of a piston or plunger within a cylinder creates alternating low and high-pressure zones, facilitating fluid intake and discharge. This action results in a steady,

pulsating flow of fluid. Piston pumps utilize pistons mounted on a crankshaft to create reciprocating motion. Plunger pumps employ plungers that move within a sleeve or barrel, often used for higher pressure applications.

34. A reciprocating pump primarily comprises two main sections: the fluid end and the power end. The power end of a reciprocating pump is responsible for converting mechanical energy into the reciprocating motion that drives the fluid end. It comprises all components that generate and transfer the necessary force to move the piston or plunger, including a motor or engine that provides the initial mechanical energy to drive the pump. The motors can be electric motors, diesel engines, or other types depending on the application and power requirements.

35. The motor or engine connects to a crankshaft that converts rotational motion from the motor into the reciprocating motion of the piston or plunger. Connecting rods link the crankshaft to the piston or plunger, transmitting the motion and force necessary for reciprocation.

36. The fluid ends in reciprocating pumps house the pumping mechanisms responsible for pressurizing and directing the fluid. They are typically robust, high-strength structures made from materials like forged steel, stainless steel, or other corrosion- and wear-resistant alloys.

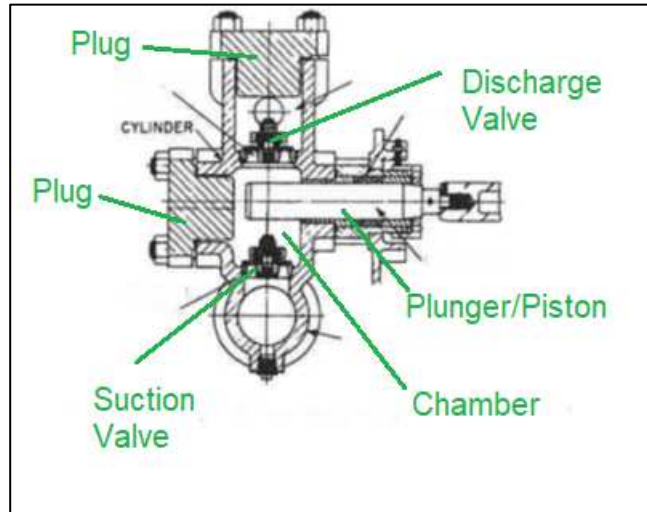
37. Fluid ends contain an internal chamber into which the fluid enters and exits in response to reciprocation of the plunger/piston. These chambers are designed

to handle high pressures and facilitate efficient fluid flow. Suction valves arranged within the fluid end allow fluid to enter the chamber during the intake stroke and prevent backflow during the discharge stroke. Discharge valves arranged within the fluid end permit fluid to exit the chamber during the discharge stroke and seal off the chamber during the intake stroke. These valves are often spring-loaded and seated to maintain tight seals under pressure.

38. The reciprocating motion of plungers or pistons inside the fluid end creates the pumping action. These components are often made of hardened materials to resist wear and can be coated for enhanced durability. Packing seals in stuffing boxes surround the plunger or piston to prevent fluid leakage and maintain pressure. These seals require periodic maintenance or replacement.

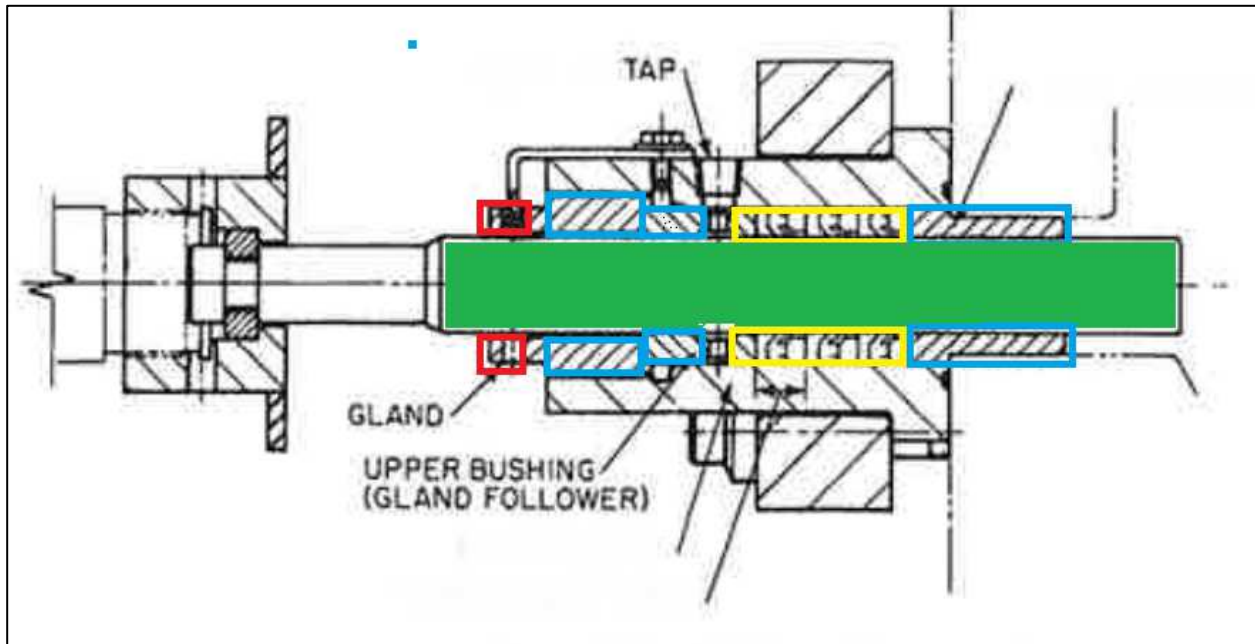
39. Illustrated below is a typical reciprocating horizontal power pump fluid end cross-section, which I have taken from Chapter 3 of the Pump Handbook edited by my Worthington colleague Igor Karassik and annotated for clarity. As illustrated, the conventional fluid end includes an internal chamber, a piston or plunger driven by the power end, suction and discharge valves, and plugs covering the bores formed during the construction of the fluid end and that provide access to the valves and internal chamber. When the plunger/piston is retracted by the power end (*i.e.*, the intake stroke), fluid is drawn into the chamber via the suction valve, and when the

plunger/piston is extended (*i.e.*, the discharge stroke), the fluid is driven out of the chamber via the discharge valve.



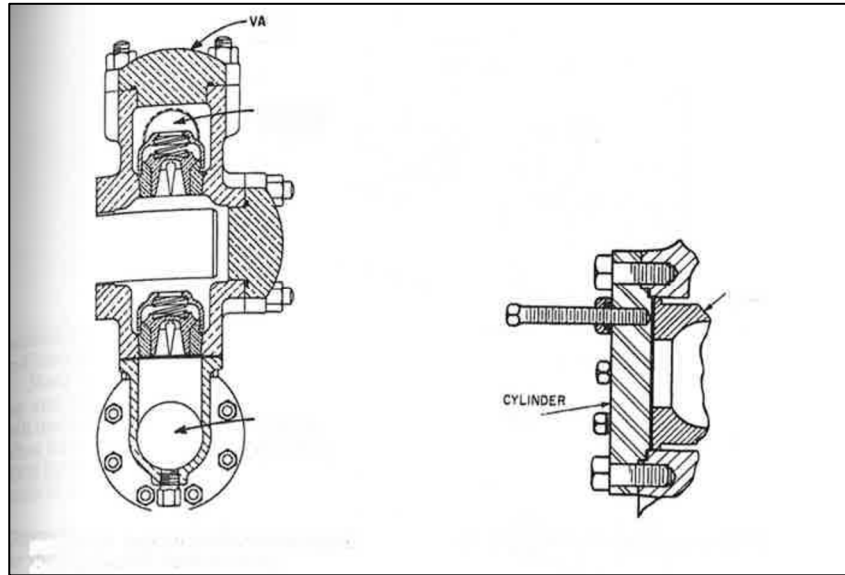
Karassik Chapter 3 (EX1010), p. 22, Fig. 1, showing liquid end of a typical horizontal power (plunger) pump, from Flowserve (annotated).

40. As shown in the figure below (also from Karassik) the conventional fluid end includes a sealing stuffing box (blue). The stuffing box includes seals (yellow) that engage with the plunger/piston (green) to provide a fluid tight barrier around the reciprocating plunger/piston, preventing fluid from traveling around the piston/plunger instead of out the discharge bore. The packing (*i.e.*, the seals) are maintained within the stuffing box via a nut or gland (red) arranged at the power-end side of the stuffing box.



Karassik Chapter 3 (EX1010), p, 26, Fig. 7, showing a typical plunger pump stuffing box (from Flowserve) (annotated).

41. As shown in the figure below (also from Karassik), the conventional fluid end includes covers for the bores formed in the fluid end. These covers may take the form of plates. The plate closure may include a bolted component that may have a protrusion that closely fits within the bore, while the flange of the component is bolted to the pump frame (body), bolted by either screws, or by studs and nuts.



Karassik Chapter 3 (EX1010), p. 29, Fig. 12 & 13, showing a separate suction with an integral discharge manifold (left, from Gardner-Denver), and an installed plunger cover (right, from Foster-Wheeler).

42. Reciprocating pumps can be single acting, meaning they have a single reciprocating plunger or piston. Reciprocating pumps can be constructed as multiplex pumps. Multiplex pumps, such as duplex (two plungers/pistons) or triplex (three plungers/pistons) configurations, use multiple plungers/pistons operating in staggered sequences. This design reduces flow pulsation significantly, providing smoother and more continuous fluid delivery. Multiplex pumps also handle higher pressures and flow rates more efficiently, making them ideal for demanding applications like hydraulic fracturing, industrial cleaning, and chemical injection.

C. Overview of Foster

43. Foster (“the ‘582 Patent” EX1001) is entitled “Fluid End Assembly” issued on November 26, 2024. EX1001, 1. Kerr filed the application that issued as

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Foster on May 22, 2023, as a track one (*i.e.*, prioritized examination) (“the ‘582 Application”). The ‘582 Application is a continuation of Application No. 17/882,267, filed on August 5, 2022, now U.S. Patent No. 11,655,812, which is a continuation of Application No. 16/876,414, filed on May 18, 2020, now U.S. Patent. No. 11,408,419, which is a continuation of Application No. 16/035,126, filed on July 13, 2018, now U.S. Pat. No. 10,670,013. The ‘582 Application further claims priority to Provisional Application No. 62/562,588, filed on September 25, 2017, Provisional Application No. 62/536,297, filed on July 24, 2017, Provisional Application No. 62/532,574, filed on July 14, 2017. Accordingly, I have used July 14, 2017, as the date of the alleged invention for purposes of my opinions.

44. As suggested by its title, the Foster is directed to a “fluid end assembly” and more specifically, according to its Abstract:

A fluid end **having its fluid flow bores sealed without threading a retaining nut into the walls of each bore**. The fluid ends may be assembled using a plurality of different kits that each comprise a fluid end body, a component, a retainer element, and a fastening system. The retainer element holds the component within each of the bores formed in the fluid end body and the fastening system secures the retainer element to the body. The fastening system comprises a plurality of externally threaded studs, washers and nuts in some embodiments. In other embodiments, the fastening system comprises a plurality of screws.

EX1001, Abstract (emphasis supplied).

45. Accordingly, the purported novelty of Foster appears to be in the removal of retaining nuts that thread into the bores of the fluid end. Therefore, of

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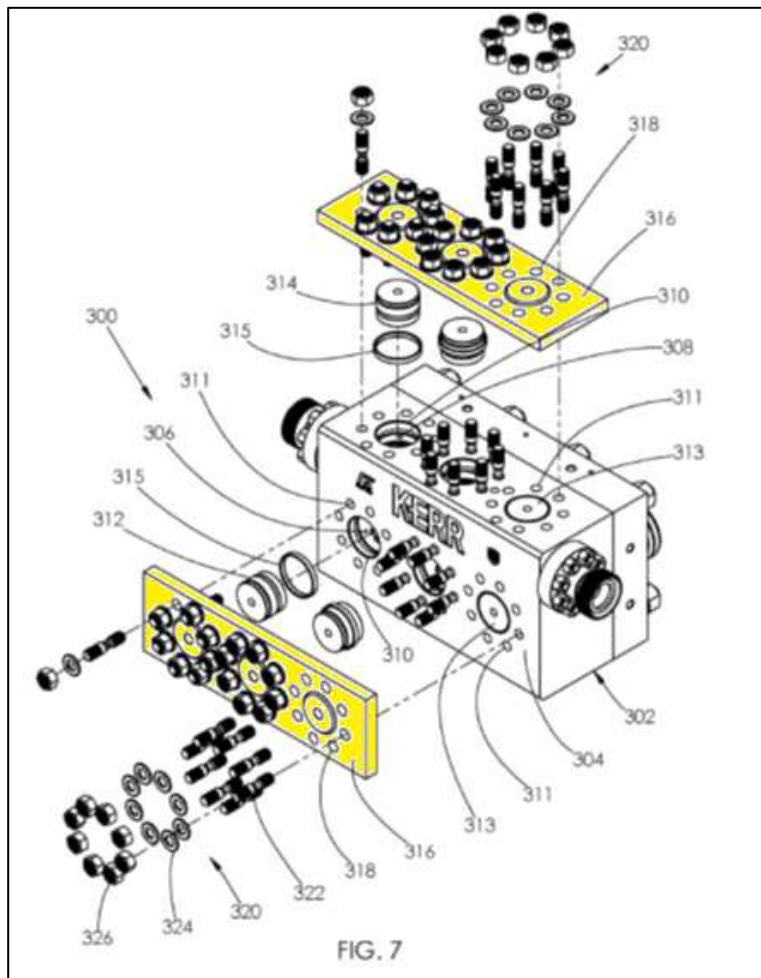
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particular note for the claims of Foster is the following discussion of the retainer elements 316, which replace the threaded retaining nuts and take the form of a plate sized to cover a plurality of adjacent bore openings:

Once installed within the body 302, a top surface 313 of each of the components 312, 314 may sit flush with the external surface 304 of the body 302. Each of the components 312, 314 is secured within each respective bore 306, 308 by a retainer element 316. Each of the retainer elements 316 shown in FIG. 7 is a large rectangular plate having a footprint sized to cover a plurality of adjacent bore openings 310 at one time. A plurality of openings 318 are formed in each retainer element 316 that are alignable with a corresponding one of the openings 311 in a one-to-one relationship.

EX1001, 8:41-51.

46. These rectangular plate retainer elements 316 are illustrated in FIG. 7 from Foster, reproduced below. As illustrated in the discussion above and the figure below, Foster draws no distinction between the cover plate 316 for the vertical bore and the cover plate 316 for the horizontal bore, giving them the same reference numeral and describing them as an identical part.

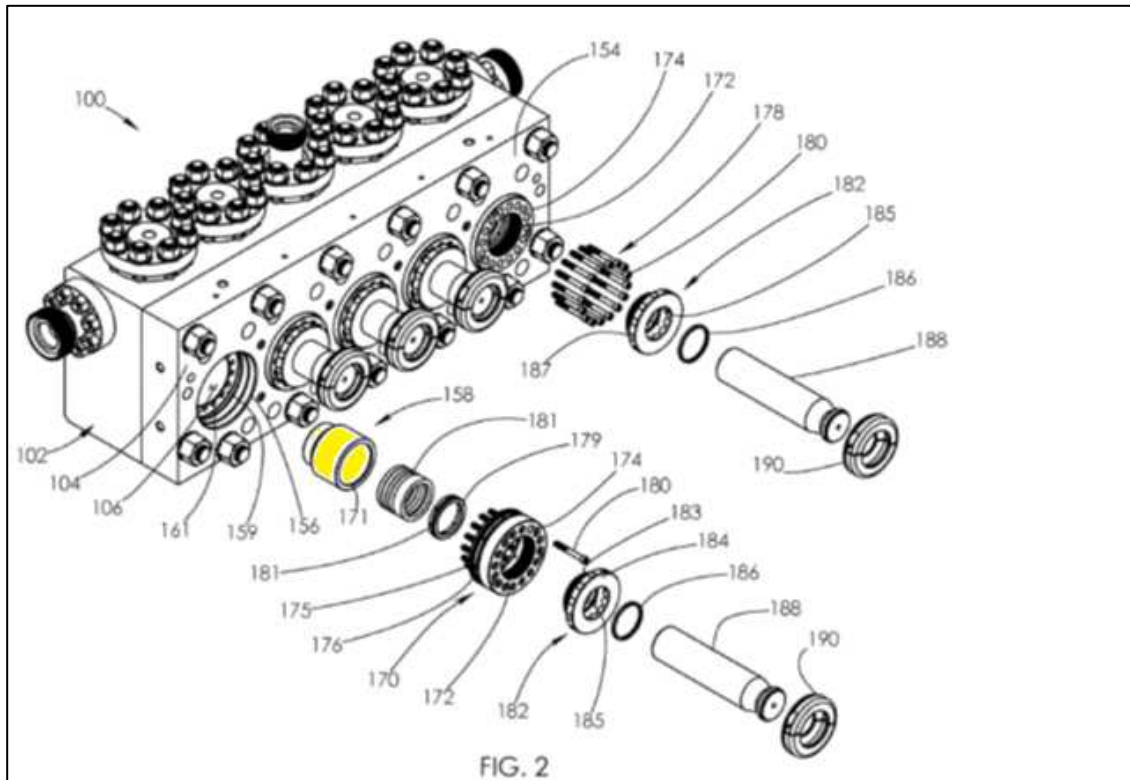


A reproduction of FIG. 7 from Foster (EX1001) (annotated).

47. Also of note in the Foster claims is the “component” installed in the horizontal bore of the fluid end, which is described and illustrated as follows:

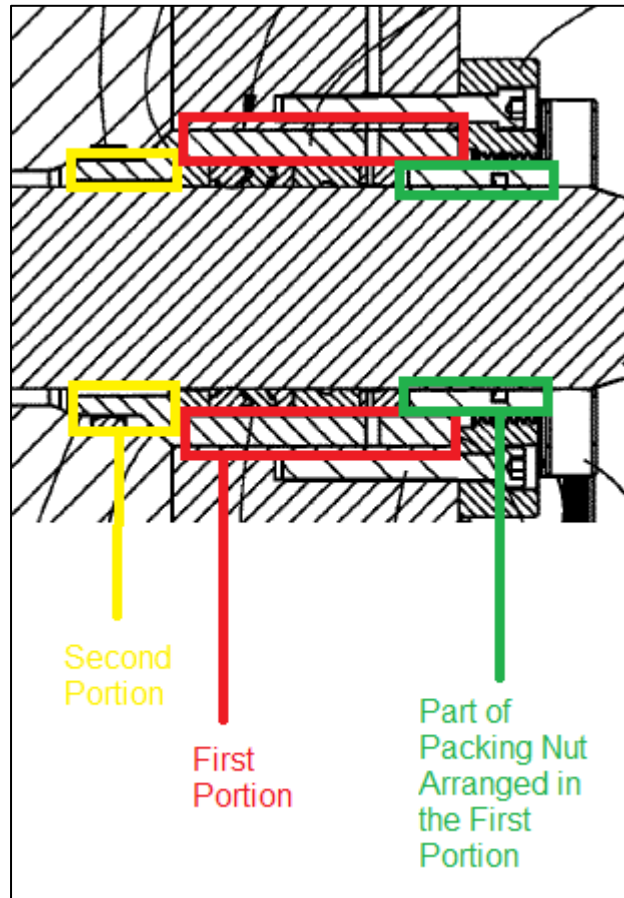
A component 158 is positioned within each first bore 106 through each of the openings 156. Each of the components 158 is tubular and sized to be closely received within each bore 106. In one embodiment, the components 158 are stuffing box sleeves.

EX1001, 4:12-16.



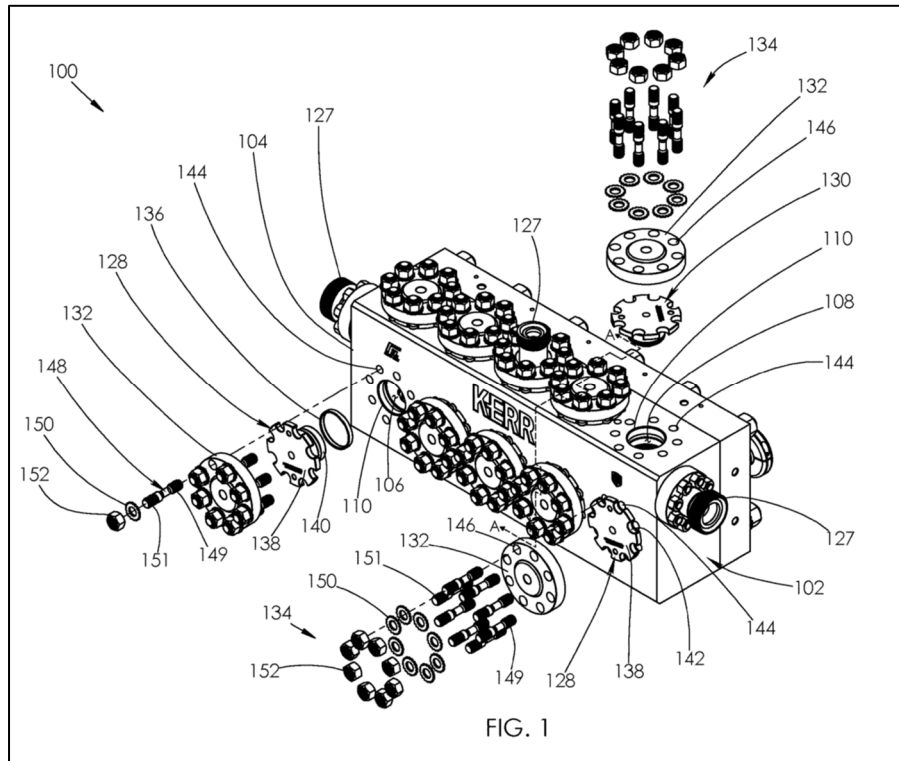
Kerr (EX1001) FIG. 1 (annotated)

48. The sleeve of Foster is described in more detail with reference to FIG. 6 (and illustrated in the detail of FIG. 6 provided below) as having a first section with a larger diameter than a second section, and with the packing nut 266 being at least partially arranged within the sleeve to form a backwall of the sleeve. These specific features, however, are not claimed in the claims of Foster.

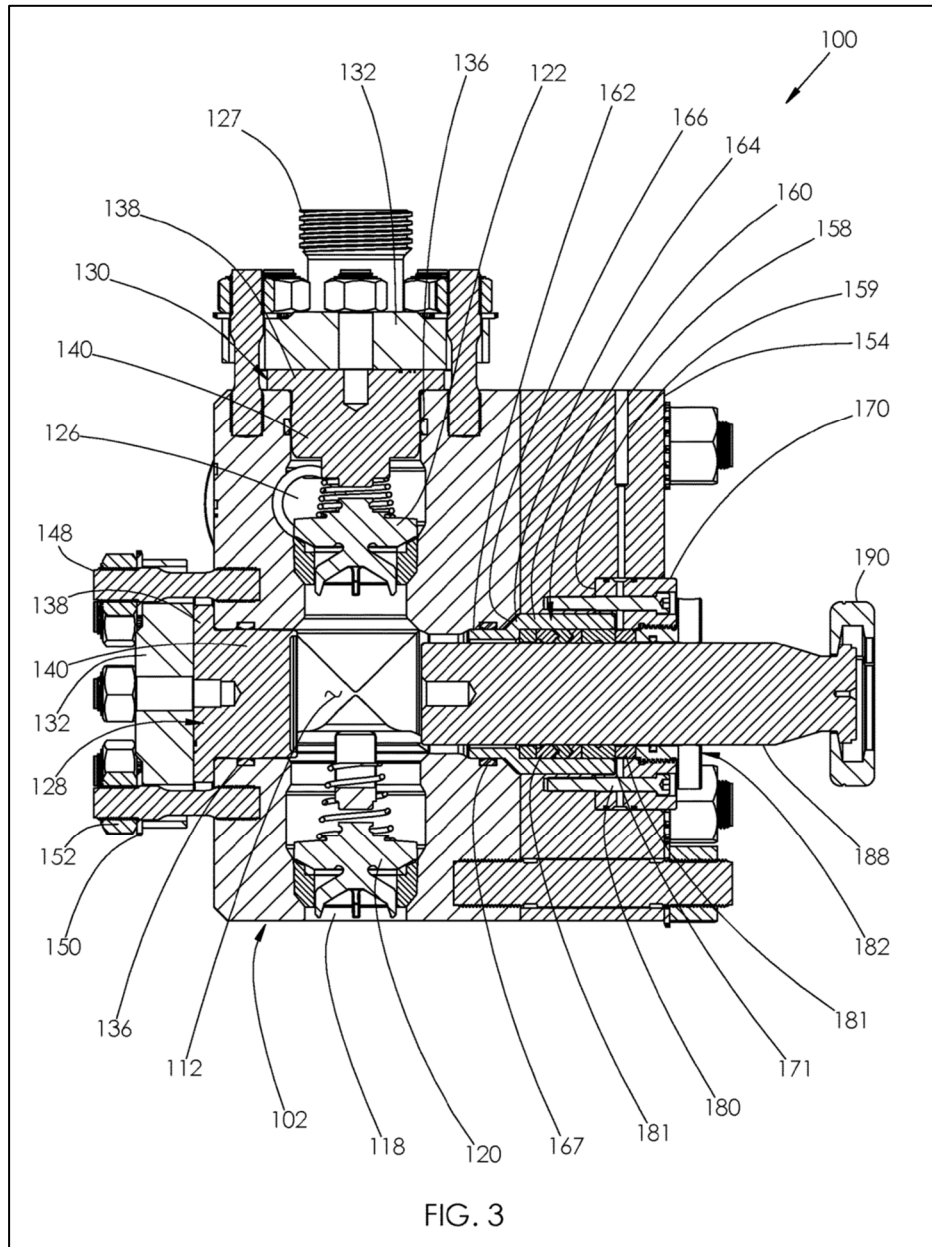


Foster (EX1001), FIG. 3 (annotated).

49. The remainder of Foster relevant to the claims appears to be a fairly conventional multiplex reciprocating pump fluid end. Figures 1 and 3 from the Foster specification are provided below. The component parts shown in these illustrations are typical of other reciprocating pumps I have experience in designing, and/or servicing in the field, as far back as the 1980s when I was Director of Mechanical Engineering at the HQ of Worthington Pump.



A reproduction of Fig. 1 from the Foster (EX1001).



A reproduction of Fig. 3 from Foster (EX1001).

50. The following explanation of the teachings of the Foster specification is transcribed from Foster as issued by the USPTO. The figure numbers in the text represent the original figure numbers as presented in Foster. In this manner, I discuss in order the paragraphs found in column 2 line 31, to column 4 line 3.

With reference to FIGS. 1 and 3, a first embodiment of a fluid end 100 is shown. The fluid end 100 comprises a fluid end body 102 having a flat external surface 104 and a plurality of first and second bores 106, 108 formed adjacent one another therein, as shown in FIG. 1. Preferably, the number of first bores 106 equals the number of second bores 108. More preferably, each first bore 106 intersects its paired second bore 108 within the fluid end body 102 to form an internal chamber 112, as shown in FIG. 3.

EX1001, 2:31-39.

51. The above describes a fairly typical design of a reciprocating pump.

This typical design layout was in use in the 1980's, when I first became involved in reciprocating pump design.

FIG. 1 shows five first and second bores 106, 108. In alternative embodiments, the number of sets of paired first and second bores in the fluid end body may be greater than five, or less than five. Thus, FIG. 4 shows a fluid end body that includes three sets of paired first and second bores. Each bore of each set of paired bores 106 and 108 terminates in a corresponding opening 110 formed in the external surface 104. The bores 106 and 108 and openings 110 exist in one-to-one relationship. A plurality of internally threaded openings 144 are formed in the body 102 and uniformly spaced around each bore opening 110, as shown in FIG. 1.

EX1001, 2:40-50.

52. The quote above describes the typical design of a reciprocating pump, and in particular, a multiplex reciprocating pump. The pairs of bores, and associated plungers typically being three (a “triplex” pump), five (a “quintuplex” pump), or seven (a “septuplex” pump).

With reference to FIG. 3, each second bore 108 may have an intake opening 118 formed, proximate the bottom end of the fluid end body 102. Each intake opening 118 is connected in one-to-one relationship to a corresponding coupler or pipe. These couplers or pipes are fed from a single common piping system (not shown).

EX1001, 2:51-56.

53. The above passage describes a conventional method by which fluid is conveyed to and from a reciprocating power pump.

A pair of valves 120 and 122 are positioned within each second bore 108. The valves 120, 122 route fluid flow within the body 102. The intake valve 120 blocks fluid backflow through the intake opening 118. The discharge valve 122 regulates fluid through one or more discharge openings 126. A plurality of couplers 127 may be attached to each discharge opening 126 for connection to a piping system (not shown), as shown in FIG. 1.

EX1001, 2:57-64.

54. Again, this passage provides a fairly typical valve operation for reciprocating pump.

Continuing with FIGS. 1 and 3, the fluid end 100 further comprises a plurality of sets of components 128 and 130. The number of sets preferably equals the number of sets of paired first and second bores 106 and 108 formed in the body 102. The component 128 is positioned within a first bore 106, and the component 130 is positioned within its paired second bore 108. In one embodiment, the component 128 is a suction plug and the component 130 is a discharge plug. Each of the components 128 and 130 are substantially identical in shape and construction, and each is sized to fully block fluid flow within the respective bore 106, 108. A seal 136 is positioned around the outer surface of each component 128, 130 to block fluid from leaking from the bores 106, 108.

EX1001, 2:65-3:11.

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55. I do not see any difference between the teaching in the above-quoted passage and that shown for a typical reciprocating pump, from Karassik.

Each of the components 128 and 130 comprises a first section 138 joined to a second section 140. The first section 138 has a footprint sized to cover the bore opening 110 and the second section 140 is configured for removable receipt within one of the bores 106, 108. In one embodiment, the first section 138 is an enlarged plate and the second section 140 is a plug sized to be closely received within one of the bores 106, 108. When the component 128 or 130 is installed within one of the bores 106, 108, the first section 138 engages with the external surface 104 of the body 102. This engagement prevents longitudinal movement of the second section 140 within the bore 106 or 108 as shown in FIG. 3.

EX1001, 3:12-23.

56. There is no difference between the above-quoted teaching and that shown for a typical reciprocating pump in Karassik.

With reference to FIG. 1, the first section 138 may be formed as a circular structure having a plurality of notches 142 cut from its outer periphery. When each of the first sections 138 is engaged with the external surface 104 of the body 102, each of the notches 142 partially surrounds one of the openings 144 spaced around each bore opening 110.

EX1001, 3:23-29.

57. The “circular structure” described above is called a bolt circle, typical for flanges such as shown in the figures from Karassik. Such a flange can be attached by bolts to the pump frame (body) through either such notches or through full-circle bolt holes.

Continuing with FIGS. 1 and 3, once each component 128, 130 is installed in the fluid end body 102, each of the components 128, 130 is secured in place by a retainer element 132 in a one-to-one relationship. Each retainer element 132 has a footprint sized to fully cover the first section 138 of the components 128 and 130. The retainer elements 132 shown in FIG. 1 are flat and cylindrical. A plurality of openings 146 are formed about the periphery of each retainer element 132. Each opening 146 is alignable with a corresponding one of the openings 144 in a one-time relationship.

EX1001, 3:30-40.

58. Again, this is called a bolt circle, typical for flanges such as shown in the figures below, from Karassik. Such a flange can be attached by bolts to the pump frame (body) through either such notches or through full-circle bolt holes.

Each of the retainer elements 132 is secured to the fluid end body 102 using a fastening system 134. The fastening system comprises a plurality of studs 148, a plurality of washers 150, and a plurality of nuts 152. Each stud 148 is externally threaded adjacent its first end 149, while each opening 144 has internal threads that mate with those of the stud 148. Each stud 148 may be threaded into place within a corresponding one of the openings 144, in a one-to-one relationship.

EX1001, 3:41-49.

59. Use of studs and nuts, or alternatively using screws, is standard practice for attachment of any pump flange. This has been true for over two centuries.

Once a first stud 148 has been installed in the body 102 at its first end 149, its opposed second end 151 projects from the body's external surface 104. When each component 128 is positioned within its bore 106, each of its notches 142 at least partially surrounds a corresponding one of the studs 148. Likewise, when each component 130 is positioned within its bore 108, each of its notches 142 at least partially surrounds a corresponding one of the studs 148.

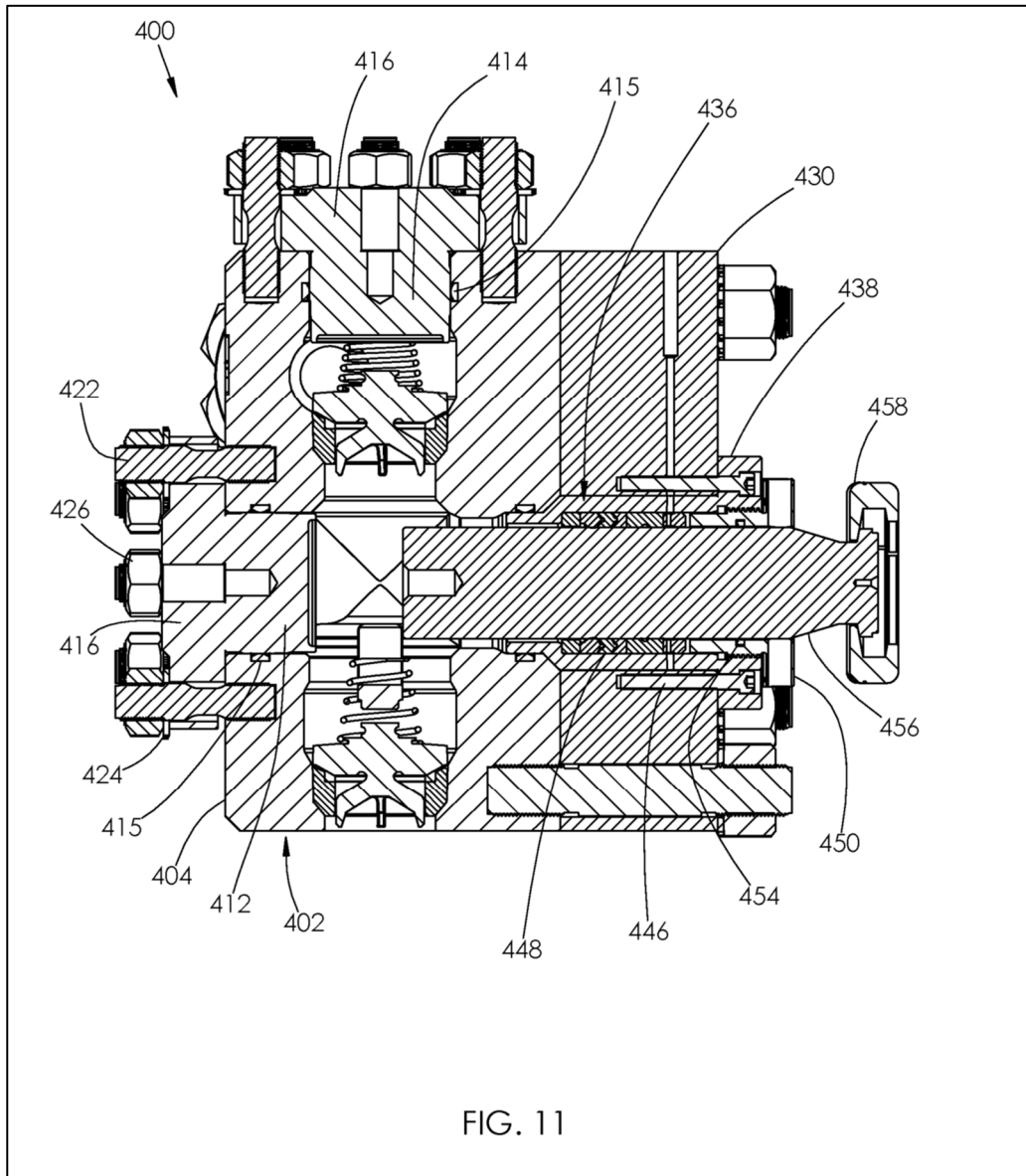
EX1001, 3:50-57.

60. Use of studs and nuts (typically with washers under the nuts), or alternatively using screws with or without washers, in this manner is standard practice for attachment of any pump flange. This has been true for over two centuries.

Each peripheral opening 146 formed in each of the retainer elements 132 is registerable with a corresponding one of the studs 148. The plurality of washers 150 and nuts 152 may be installed and torqued on each one of the studs 148. The plurality of washers 150 and nuts 152 hold the retainer element 132 against the first section 138 of the components 128, 130 and hold the first section 138 against the external surface 104 of the fluid end body 102. Because each of the retainer elements 132 is attached to the fluid end body 102 using the fastening system 134, no external threads are formed on the outer surface of each retainer element 132. Likewise, no internal threads are formed within the walls of each bore 106, 108.

EX1001, 3:58-4:3.

61. This is consistent with the concept shown in Karassik, provided in the figures above. In summary, the representative Fig. 11 from Foster, shown below, is very similar in each of its key components and teachings to the Karassik cross-section that I present in the Background section above.



A reproduction of Fig. 11 from Foster (EX1001). Note the close similarity to the figures from Karassik (EX1010), as shown above.

D. Claim Construction

62. Based on my review of the specification, claims and file history I have determined that the terms in the claims require no special construction and, accordingly, I have utilized the ordinary and customary meaning of those terms.

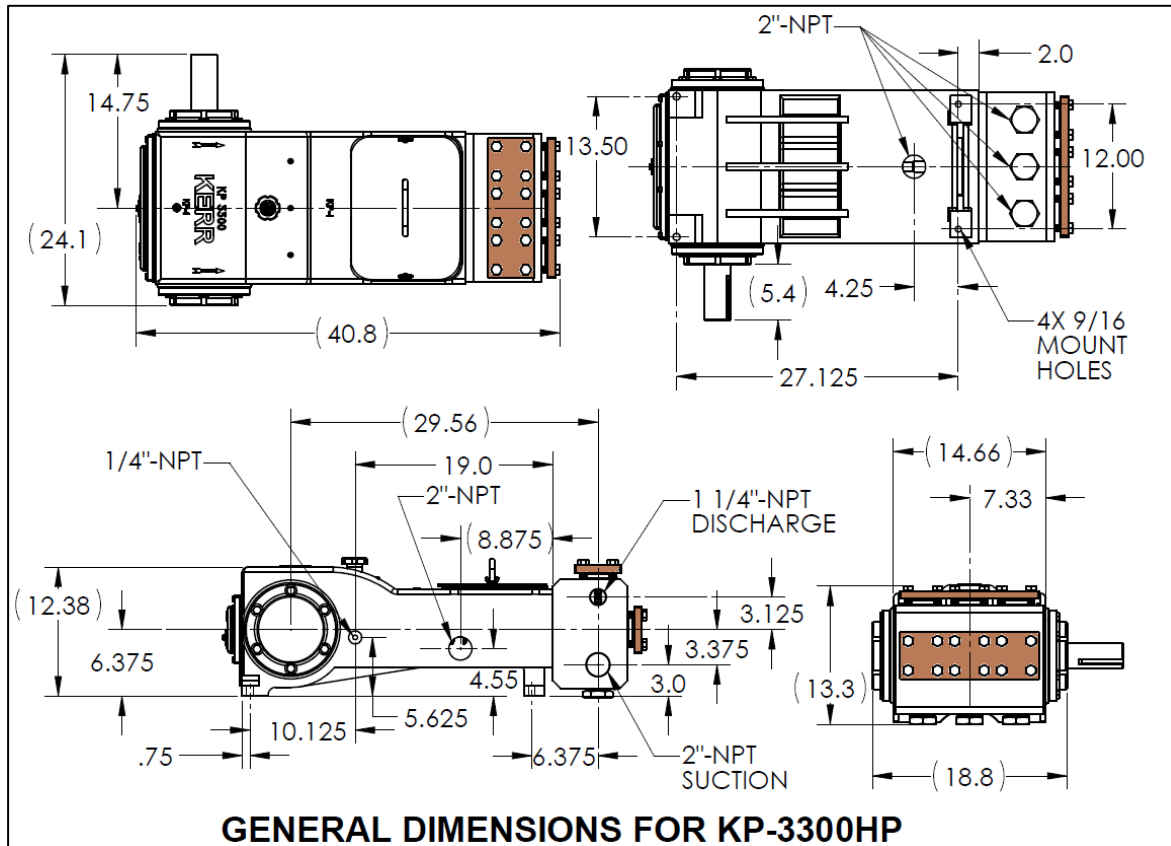
E. Overview of Cited Art**i. Kerr KP-3300HP Pump Manual (Ex. 1004)**

63. The Kerr KP-3300HP Pump Manual (“Kerr”), Ex. 1004 to the Petition, is a service manual describing the Kerr KP-3300HP Pump. I understand that Kerr was publicly available no later than March 17, 2016, based upon confirmation by the Internet Archive. Petition at section IV.g. This is more than a year prior to the filing of the earliest provisional application and, therefore, I understand that Kerr is prior art to Foster.

64. It is my understanding that Kerr was downloaded from the Buckhorn Pump distributor website. A person in industry looking to purchase or otherwise research pumps in the 2017 timeframe, would perform a web search for potential pumps, which would lead them to distributor sites, like Buckhorn Pumps, or the manufacturer site itself. These distributors and manufactures would host documents like the manual relied upon here. These sites would also host specification or “spec” sheets. Accordingly, these documents would be readily known and used by those skilled in the art in the 2017 timeframe. Kerr was created for dissemination to the interested public to provide instructions about how to assemble, use, clean, and maintain the Kerr Pump. Catalogs would also be readily available to the skilled artisan through internet searches and websites, like the Buckhorn Pump and Kerr websites.

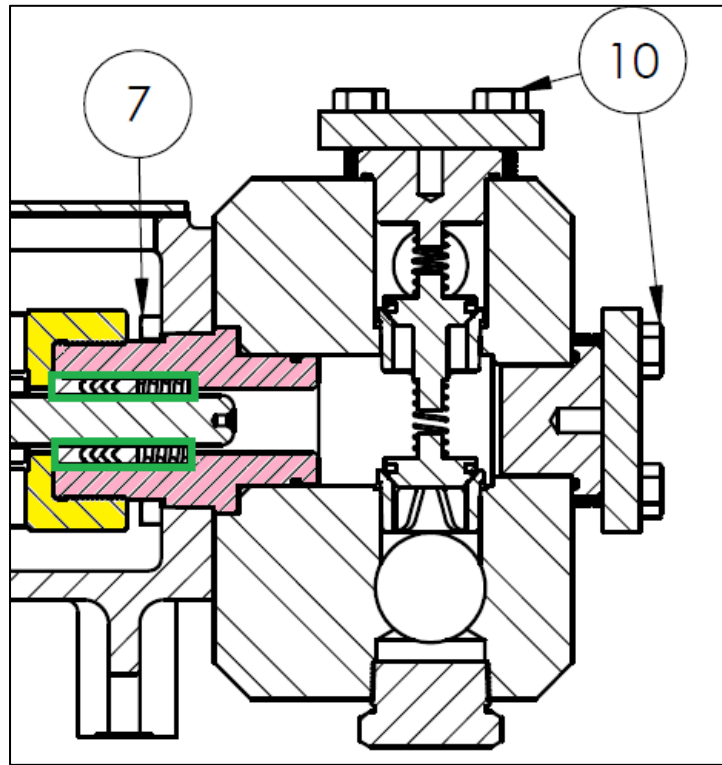
A detailed technical cross-section diagram of a mechanical assembly, likely a pump or motor. The diagram shows a central shaft (hatched) passing through a housing (red hatched). Key components are labeled with numbered circles: 1 (front flange), 2 (housing front cover), 4 (internal bearing), 5 (internal bearing), 6 (internal bearing), 7 (housing rear cover), 8 (internal bearing), 9 (internal bearing), and 10 (rear flange). The assembly is shown in a cutaway view to reveal internal components like bearings and seals.

66. Of particular note for Kerr, the cover plates use a single plate to cover the three horizontal bores of the triplex pump, and a single plate to cover the three vertical bores of the triplex pump, as illustrated in the annotated figures below.



Kerr (EX1004), p. 25 (annotated)

67. Also of note in Kerr, is its packing box that is partially arranged within the fluid end and includes a packing sleeve (annotated below in pink) with packing (green) that is retained within the packing sleeve via packing nut or gland (yellow). As illustrated in this figure, the packing nut serves as a rear wall or barrier for the packing sleeve.



Kerr (EX1004), p. 26 (annotated).

ii. Pentair Apex SC-65 Pump (Ex. 1005)

68. The Pentair Apex SC-65 Pump Manual (“Apex”), Ex. 1004 to the Petition, describes the Pentair Apex SC-65 Pump (“Apex Pump”) and was publicly available no later than May 12, 2016 based upon confirmation by the Internet Archive. Petition at section IV.g. This is more than a year prior to the filing of the earliest provisional application and, therefore, I understand Apex is prior art to Foster.

69. It is my understanding that Apex was downloaded from the Dupagro Pump distributor website. A person in industry looking to purchase or otherwise research pumps in the 2017 timeframe, would perform a web search for potential

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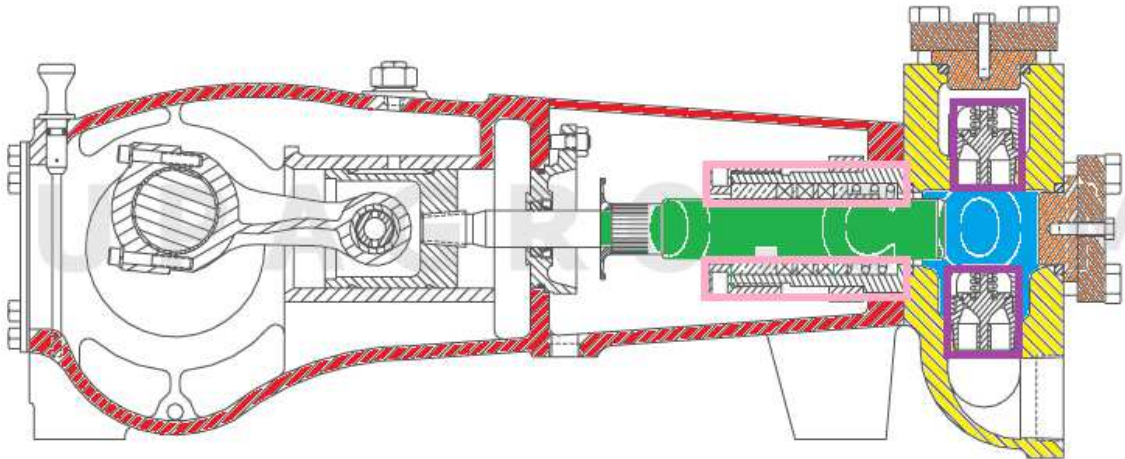
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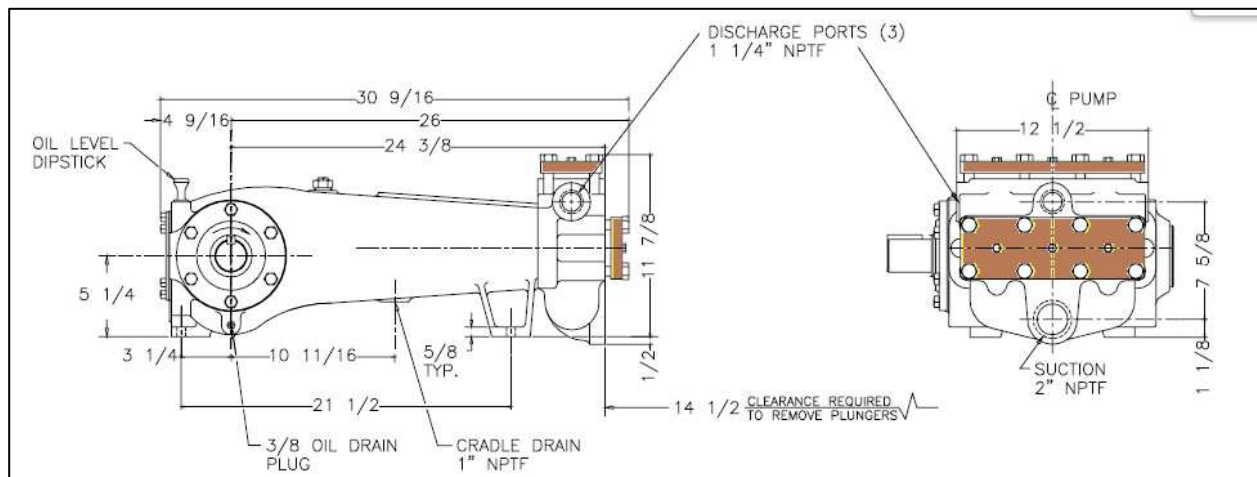
pumps, which would lead them to distributor sites, like Dupagro Pumps or Buckhorn Pumps, or the manufacturer site itself. These distributors and manufactures would host documents like the manual here or spec sheets. Accordingly, these documents would readily be known and used by those skilled in the art in the 2017 timeframe. Apex was created for dissemination to the interested public to provide instructions about how to assemble, use, clean, and maintain the Apex Pump. Catalogs would also be readily available to the skilled artisan through internet searches and websites, like the Dupagro Pumps, Buckhorn Pumps and Pentair Apex websites.

70. Apex, as illustrated in the annotated figure below, describes a fairly conventional triplex pump with a fluid end (yellow), power end (red), plunger (green), packing sleeve (pink), internal chamber (blue), suction and discharge valves (purple), bore plugs (orange) and cover plates (brown) covering both the horizontal and vertical bores. More details of the Apex Pump will be described below when I apply Apex to the claims of Foster.



Apex (EX1005), p. 7 (annotated)

71. Like the Kerr Pump, the Apex Pump uses a single plate to cover the three horizontal bores of the triplex pump, and a single plate to cover the three vertical bores of the triplex pump, as illustrated in the annotated figures below.

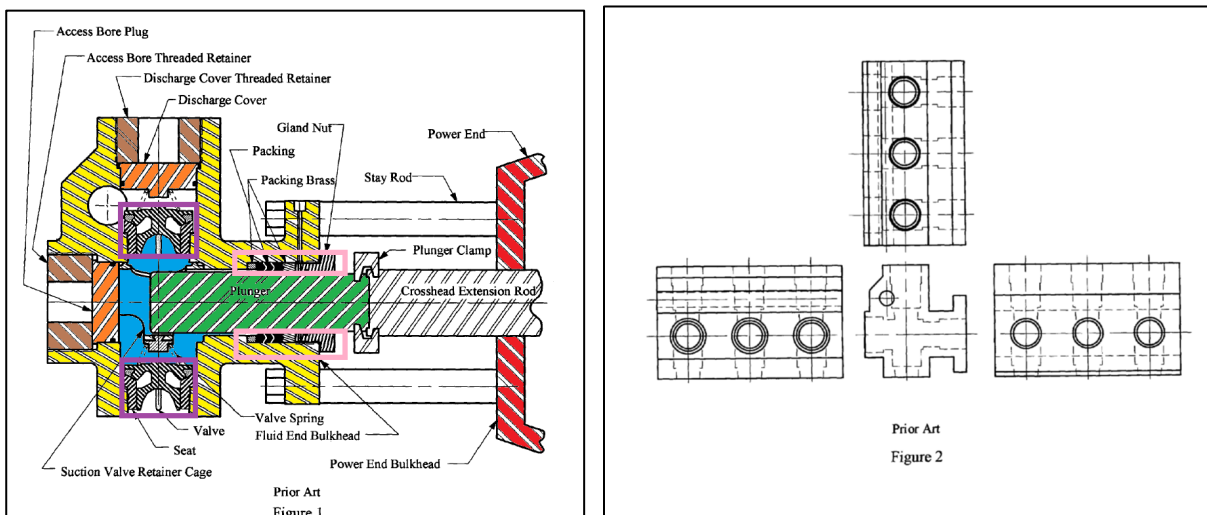


Apex (EX1005), p. 8 (annotated).

iii. U.S. Patent No. 7,186,097 (Ex. 1006)

72. U.S. Patent No. 7,186,097 (“the ‘097 Patent” or “Blume”) issued on March 6, 2007. This is more than a year prior to the filing of the earliest provisional application and, therefore, I understand Blume is prior art to Foster.

73. Blume illustrates a fairly conventional fluid end of a triplex pump (as illustrated in FIG. 2 (reproduced below)) and that includes a fluid end (yellow), power end (red), plunger (green), packing sleeve (pink), internal chamber (blue), suction and discharge valves (purple), bore plugs (orange) and bore covers (brown) covering both the horizontal and vertical bores. As indicated in these figures, these features were “prior art” even at the time of filing of Blume.



Blume (EX1006), FIGs. 1 and 2 (annotated)

iv. U.S. Pre-Grant Publication No. US2005/0200081A1 (Ex. 1007)

74. U.S. Pre-Grant Publication No. US2005/0200081A1 (“the ‘081 Publication” or “Stanton”), Ex. 1007 to the Petition, was published on September

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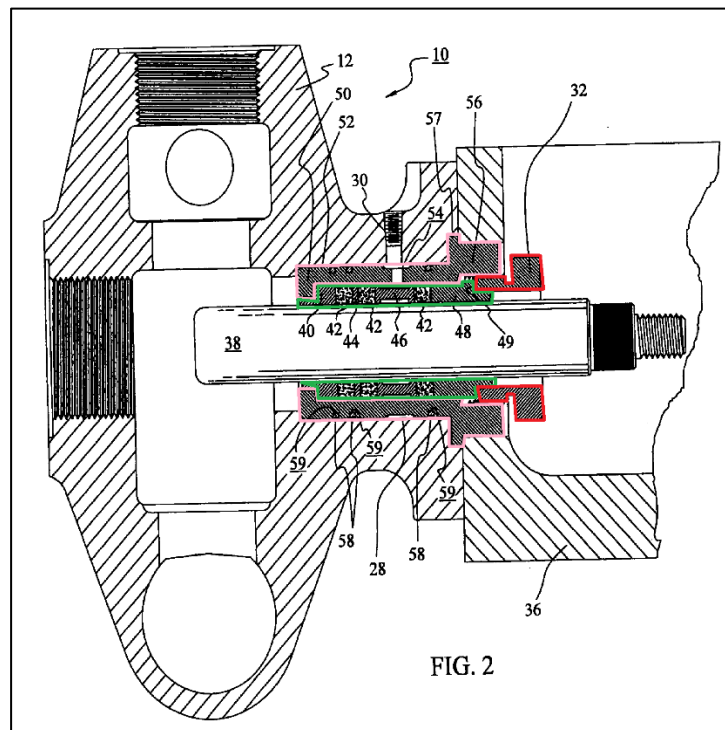
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15, 2005. This is more than a year prior to the filing of the earliest provisional application and, therefore, I understand Stanton is prior art to Foster.

75. Stanton exhibits a wide variety of plunger-sealing stuffing box arrangements, including the stuffing box arrangement of FIG. 2 from the reference, reproduced and annotated below. As illustrated, the packing seal stuffing box is partially arranged within the fluid end and includes a packing sleeve (pink) with packing (green) that is retained within the packing sleeve via packing nut or gland (red). As illustrated in this figure, the packing nut serves as a rear wall or barrier for the packing sleeve.

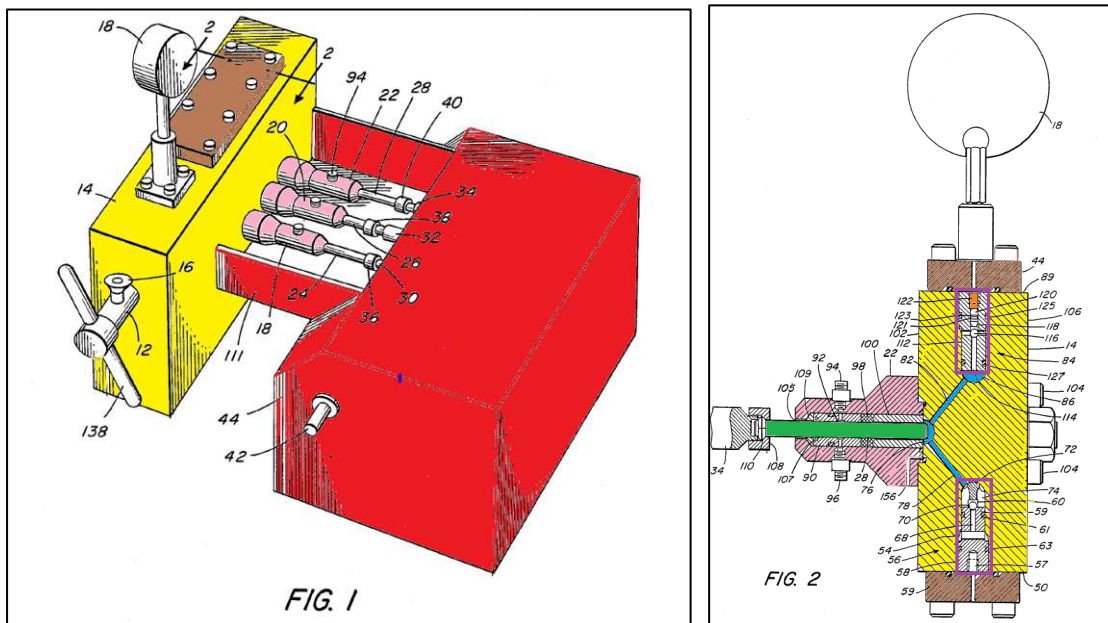


Stanton (EX1007), FIG. 2 (annotated).

v. **U.S. Patent No. 4,773,833 (Ex. 1008)**

76. U.S. Patent No. 4,773,833 (“the ‘833 Patent” or “Wilkinson”), Ex. 1008 to the Petition, issued on September 27, 1988. This is more than a year prior to the filing of the earliest provisional application and, therefore, I understand Wilkinson is prior art to Foster.

77. Wilkinson illustrates a fairly conventional fluid end of a triplex pump (as illustrated in FIGs. 1 and 2 (reproduced below)) including a fluid end (yellow), a power end (red), plunger (green), packing sleeve (pink), internal chamber (blue), suction and discharge valves (purple), a bore plug (orange) and bore cover plates (brown).



Wilkinson (EX1008), FIGs. 1 and 2 (annotated).

78. Of particular note, and as illustrated in FIGs. 1 and 2 provided above, the bore covers of Wilkinson take the form of plates. As explained in column 3 line 25 of Wilkinson: “A set of three suction valves are accessed through the bottom of the block 14, and a set of three discharge valves are accessed through the top of the block by removal of a plate 44.”

V. Claims 1-14 of Foster are Invalid as Obvious

A. Ground 1 – Claims 1-14 are obvious in view of the Kerr KP-3300 HP Pump Manual

79. It is my opinion that every element of claims 1-14 of Foster is taught or would have been rendered obvious by Kerr, and therefore, these claims are invalid over Kerr. Set forth in the following sections is a detailed description of how Kerr applies to the elements of the Foster claims.

i. Claim 1

a. 1.P “a fluid end assembly”

80. The preamble of claim 1 of Foster recites that the claims are directed to a “fluid end assembly.” While I understand that the preamble of a claim does not always recite patentably relevant subject matter, in this case I need not address that issue as Kerr clearly includes a “fluid end assembly.” The chart from Page 26 of Kerr lists ten specific components of the reciprocating power pump, and illustrates the location and interconnection of these components in the drafted figure presented

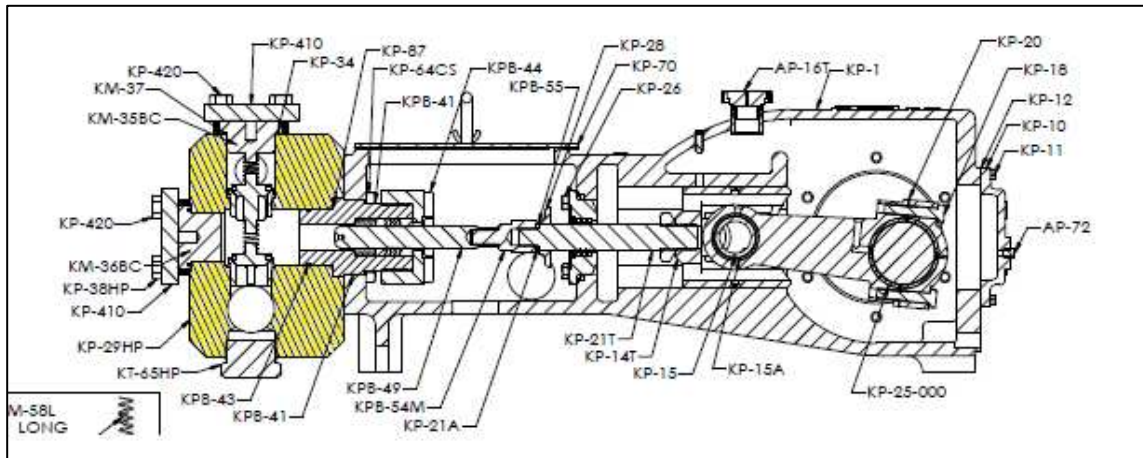
on that page. These components are a partial list of the component parts listed and illustrated in Foster, including a fluid end.

81. On page 12 of the KP-3300 manual, in Section H, it states the following:

Power End/Fluid End Connection: A common misconception is that there is some form of fluid seal between the power end and **the fluid end**. This is false. The fluid end is merely bolted to the power frame. It can be removed by breaking the plunger connection, backing off the packing nut or gland, removing the various fluid end bolts, and sliding the entire fluid end off the power frame. Corrosion may tend to seize the two components together making their separation difficult in some isolated cases. On models KP-3300, KT-3350/KT-3400 and R335/R340 the bolted in stuffing box assemblies must be removed prior to removal **of the entire fluid end**. They are held in place by four studs each. On all other units the stuffing boxes can be left intact. On the remaining pumps (with the exception KD-1250B, KJ- 2250B, KM-3250B, and KCP-6300) the stuffing boxes are held in place **in the fluid end** by a friction or “press” fit. They should be removed with a hydraulic press if possible. These press-in type stuffing boxes carry a gasket and/or an o-ring to insure a good seal. The boxes on the KD-1250B, KJ-2250B, KM-3250B, and KCP-6300 are screw-in type and carry only a copper gasket.”

Kerr (EX1004) at 12.

82. Accordingly, Kerr includes a “fluid end.” This fluid end is also illustrated throughout the figures of Kerr, an example of which I have reproduced below and annotated in yellow.



Kerr (EX1004), p. 27 (annotated).

83. Furthermore, the parts lists from Kerr indicates that the portion of Kerr that I have annotated in yellow is, in fact, a fluid end:

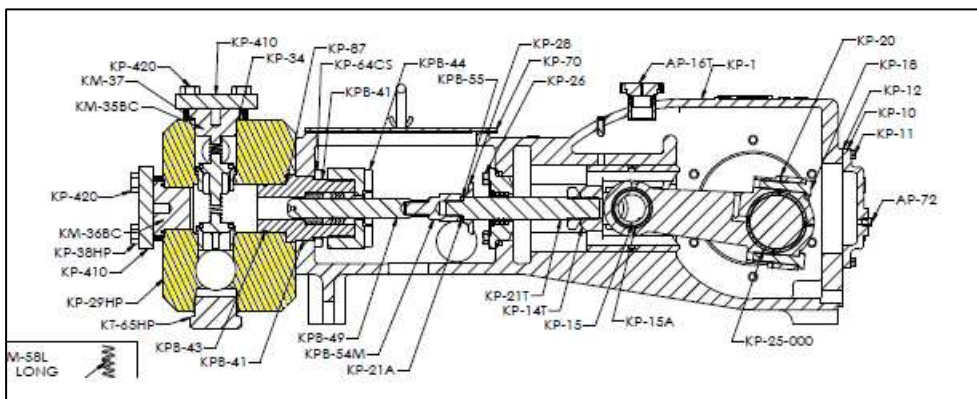
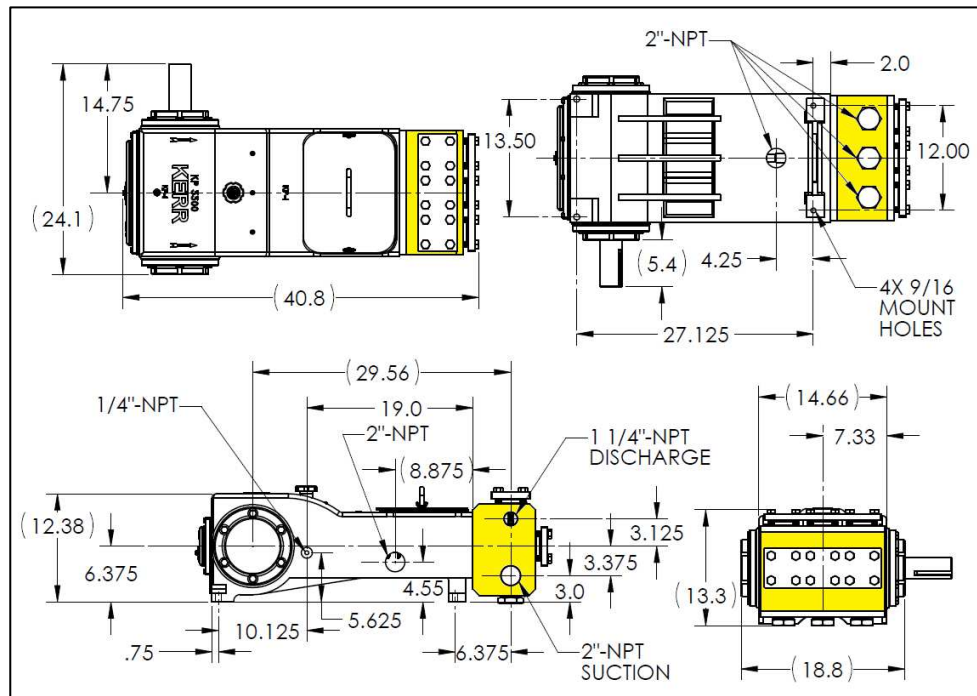
KP-28	Poly Rod Splash Guard
KP-29HP	Fluid End Vessel Only
KP-29HPSS	Fluid End Vessel Only (Stainless Steel)
KA-35	Reel End Gland Component SS

Kerr (EX1004), p. 29.

b. 1.a “a housing made of a single integrally formed piece”

84. The recitation of claim 1 that is being referred to as recitation “1.a” (*see* Petition at Claim Listing Appendix) recites that the fluid end includes “a housing made of a single integrally formed piece.” This is conventionally how fluid end housings are formed – because of the high pressure developed and contained therein; in order to not split the fluid end housing, the housings are machined as an integral piece or “monoblock.” Such an integral monoblock housing is illustrated in Kerr. The figure below is from Kerr. Note that the fluid end of the pump consists of a

single piece, such that no breaks or seams are illustrated. This renders as obvious recitation 1.a of Foster: “A fluid end assembly, comprising a housing made of a single, integrally-formed piece.”



KP-20	Fluid End Vessel Only
KP-29HP	Fluid End Vessel Only (Stainless Steel)
KP-29HPSS	Fluid End Vessel Only (Stainless Steel)
KM-35	Draw End Gland Concentric SS

External views and cross-section of liquid end of Kerr (EX1004), pp. 25, 27, 29 (annotated), illustrating the monoblock design, with no splits in the casing.

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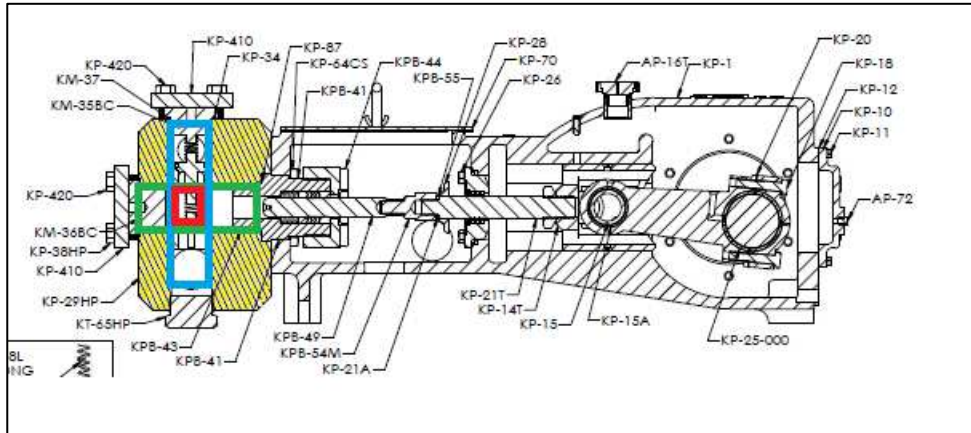
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c. 1.b “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber”

85. Recitation 1.b of claim 1 of Foster recites “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber.” Such an internal chamber is a conventional part of a fluid end, as illustrated in the discussion of the prior art I provide above. Furthermore, the figure from Kerr that I have reproduced below clearly illustrates that Kerr includes such an internal chamber formed by the intersection of a first vertical bore formed in the housing and a first horizontal bore formed in the housing. “First” as used here refers to the bores associated with one of the plunger assemblies of the triplex pump, shown in the annotated figure from Kerr below. The purpose of this internal chamber is to contain the plunger in the horizontal bore and the suction and discharge valves in the intersecting vertical bore. The resulting internal chamber provides a conduit for the suction fluid as the plunger moves backward, and a conduit for the discharge fluid as the fluid is pressurized by the plunger moving toward vertical discharge bore from the internal chamber. This is a conventional design for a reciprocating power pump.

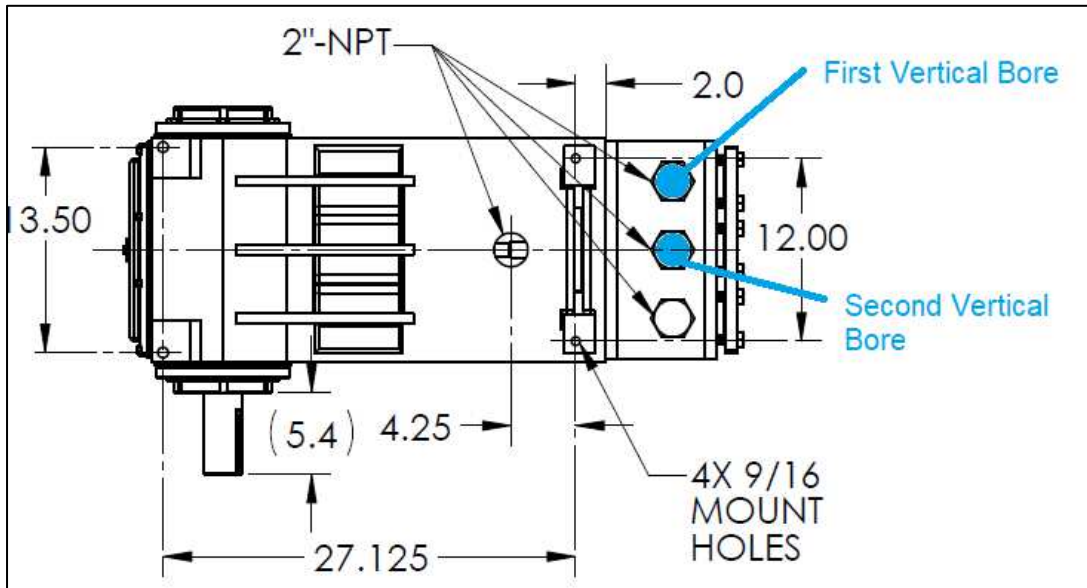


Kerr (EX1004), p. 27 (annotated): Cross-section from pump demonstrating a very typical reciprocating power pump design. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs.

- d. 1.c “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber”

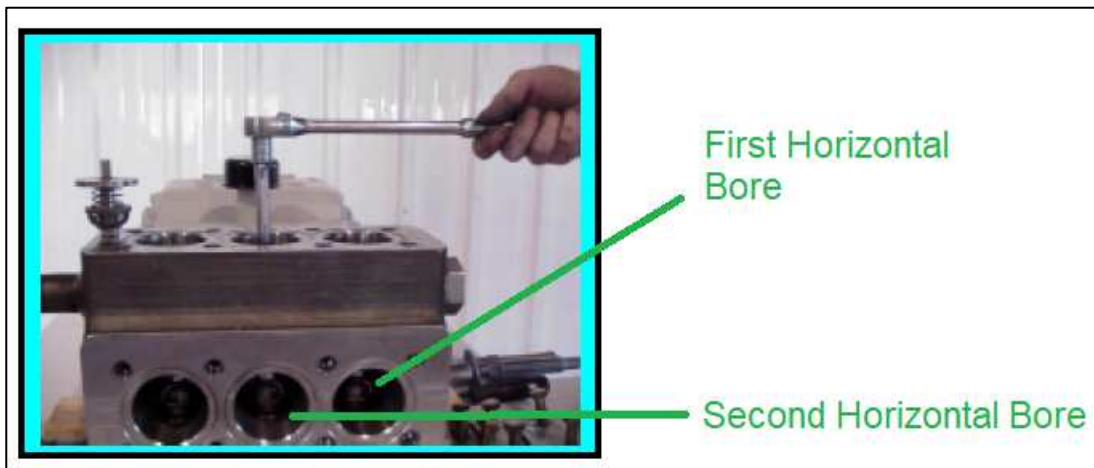
86. Recitation 1.c of claim 1 of Foster recites “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber.” While the “second internal chamber” is not explicitly illustrated, it would have been obvious to the skilled artisan at the time of filing that the Kerr Pump as illustrated in Kerr has these features.

87. The “second vertical bore” is explicitly illustrated in the following figure from Kerr.



Kerr (EX1004), p. 25 (annotated).

88. A “second horizontal bore” is illustrated in the following figure from Kerr.



Kerr (EX1004), p. 20 (annotated).

89. “Second” as used here refers to the bores associated with a second of the plungers of the example triplex pump. *See, e.g.,* EX1001, 8:13-23 (“each set of paired bores...” (emphasis added)). Only one such plunger assembly is illustrated in

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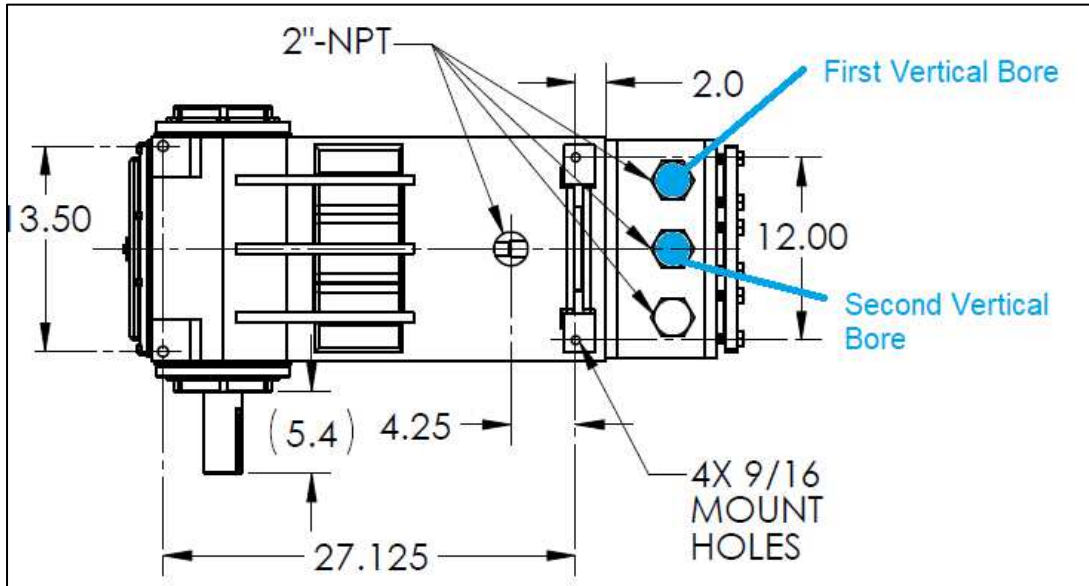
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the drawings (*e.g.* Kerr, pp. 26-27) because the skilled artisan would understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in this case, given the triplex pump being the example), each member of which has the same structure. It would, therefore, have been obvious to the person of ordinary skill in the art that the Kerr Pump has these features, as would be typical of any reciprocating power pump.

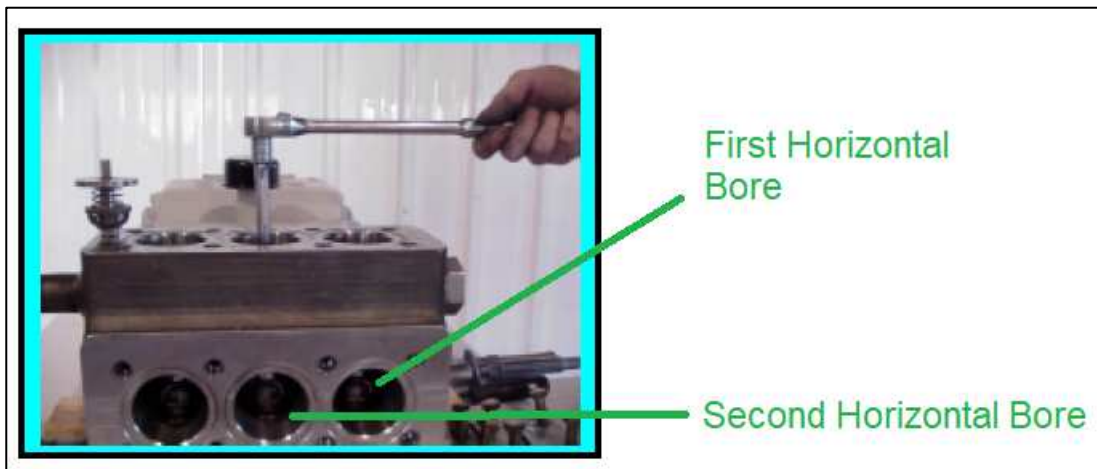
- e. **1.d “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber”**

90. Recitation 1.d of claim 1 of Foster recites that “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.” The POSITA would understand that this feature of claim 1 is present in the Kerr as the Kerr Pump is a triplex pump. Accordingly, three plunger assemblies and their corresponding bores and internal chambers would be arranged in a “side-by-side relationship.” Furthermore, the figures from Kerr below show a side-by-side arrangement of plunger assemblies. Accordingly, it would have been obvious to the skilled artisan that the Kerr Pump has its plunger arrangements, including the respective horizontal bores, vertical bores, and internal chambers, in a

side-by-side relationship. This arrangement is typical of reciprocating power pump design, and has been for many decades.



Kerr (EX1004), p. 25 (annotated).

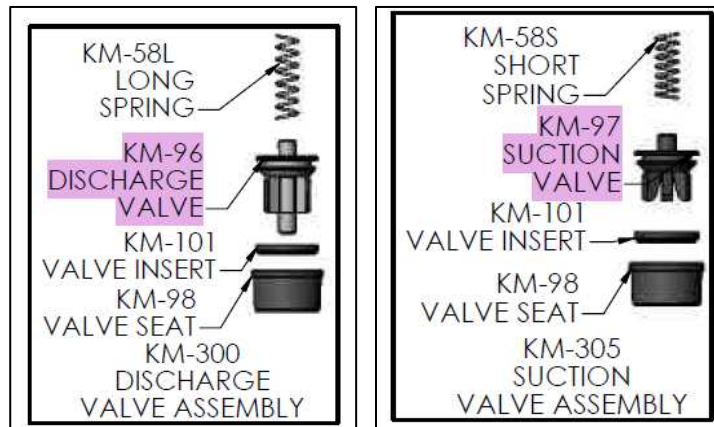
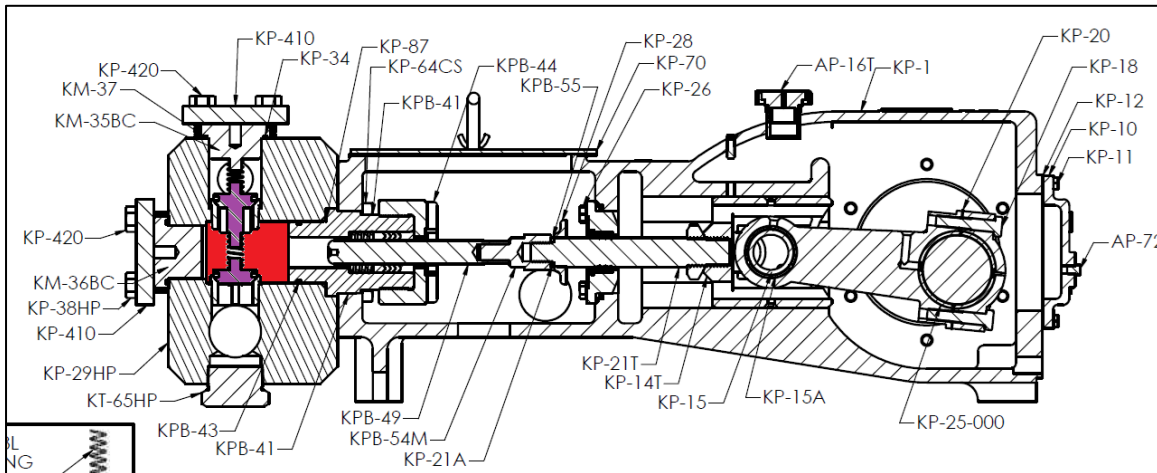


Kerr (EX1004), p. 20 (annotated).

- f. 1.e “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber”**

91. Recitation 1.e of claim 1 of Foster recites “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber.” The skilled artisan would understand that each of the triplex plunger arrangements of the ‘Kerr Pump includes such a pair of valves (*i.e.*, suction and discharge valves) placed as stated in recitation 1.e and as illustrated in the annotated figure from Kerr below.

92. The valves illustrated below are one-way valves, when the plunger retracts (*i.e.*, the intake stroke), the one-way valve in the suction bore, in this case the bottom vertical bore, allows fluid to travel into the internal chamber. When the plunger is actuated toward the internal chamber (*i.e.*, the discharge stroke), the bottom or suction valve prevents fluid from flowing out the suction bore while the top one-way valve (*i.e.*, the discharge valve) allows fluid to be expelled from the internal chamber. As illustrated below, these valves (annotated in purple) are arranged on opposite side of the internal chamber (annotated in red).

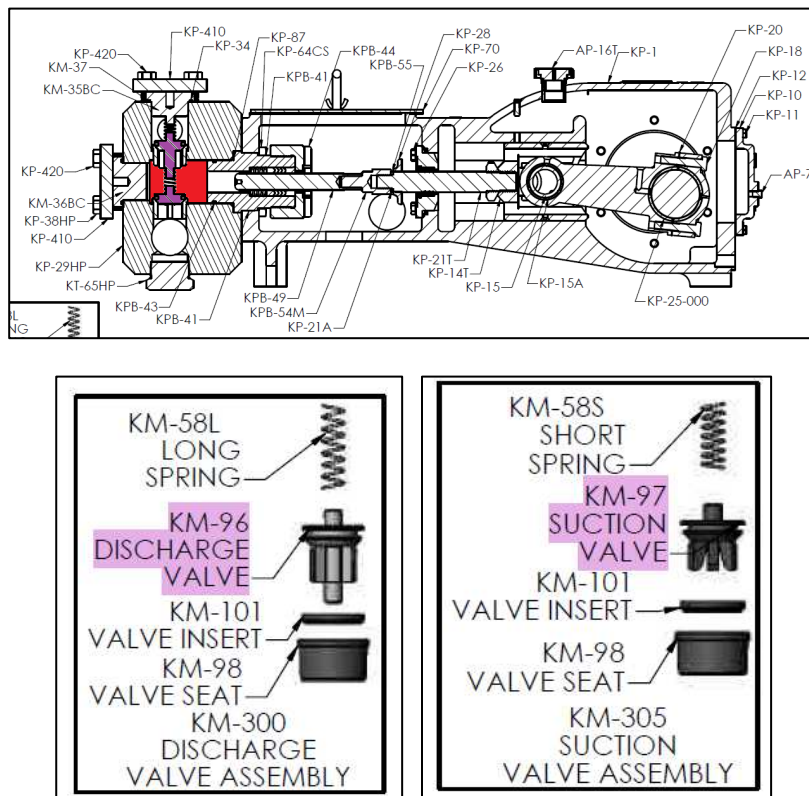


Kerr (EX1004), p. 27 (annotated): Cross-section of the Kerr Pump, demonstrating a very typical reciprocating power pump design, including valve details.

- g. 1.f “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber”

93. Recitation 1.f of claim 1 of Foster recites “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber.” While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the Kerr has these features.

94. “Second” as used here refers to the pair of valves associated with a second of the plungers of the example triplex pump. *See, e.g.*, EX1001, 2:57-64. Only one such plunger assembly is illustrated in the drawings (*e.g.* the annotated figures from Kerr below) because the POSITA would understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in this case, given the triplex pump being the example), each member of which has the same structure. While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the Kerr has these features, as would be typical of any reciprocating power pump.



Kerr (EX1004), p. 27 (annotated): Cross-section of the Kerr Pump, demonstrating a very typical reciprocating power pump design, including valve details.

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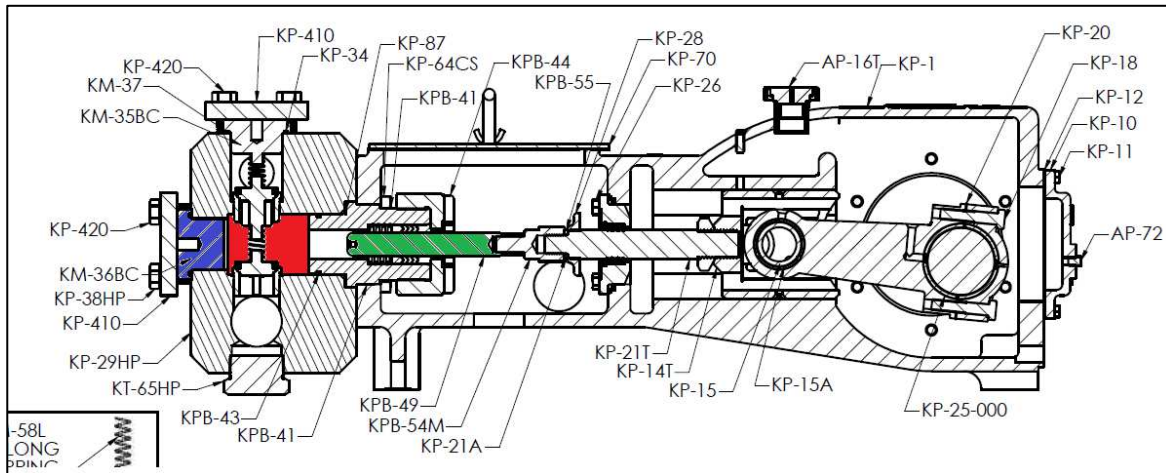
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h. 1.g “a first plug and a first reciprocating plunger installed within the first horizontal bore and positioned on opposite sides of the first internal chamber”

95. Recitation 1.g of claim 1 of Foster recites “a first plug and a first reciprocating plunger installed within the first horizontal bore and positioned on opposite sides of the first internal chamber.” As discussed in section IV.E.i, *supra*, and as illustrated in the annotated figure below, the Kerr Pump includes such an arrangement.

96. The annotated figure below, from Kerr, exhibits a typical fluid end arrangement for a reciprocating power pump. In order to maintain a monoblock (single piece, non-segmented casing) concept, the horizontal bore, within which the plunger moves and pressurizes the fluid during operation, is closed by a plug rather than being retained as a closed end during the fabrication process. This approach allows free access of the boring tool when it is machining the horizontal bore. As also illustrated in this figure, the plunger (green) is positioned on the opposite side of the internal chamber (red) from the plug (blue).



Kerr (EX1004), p. 27 (annotated): Cross-section of the Kerr Pump, demonstrating a very typical reciprocating power pump design, including valve details. The horizontal bore opposite the plunger end is left open for access by the bore machining tool, and is subsequently closed by a plug with some means of firm attachment to the casing.

- i. 1.h “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber”

97. Recitation 1.h of claim 1 of Foster recites “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber.” While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the Kerr Pump has these features.

98. “Second” as used here refers to the plug and plunger associated with a second of the plunger assemblies of the example triplex pump. *See, e.g.*, EX1001, 8:27-33, 9:60-65. Only one such plunger assembly is illustrated in the drawings (*e.g.* the annotated below) because the skilled artisan would understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in

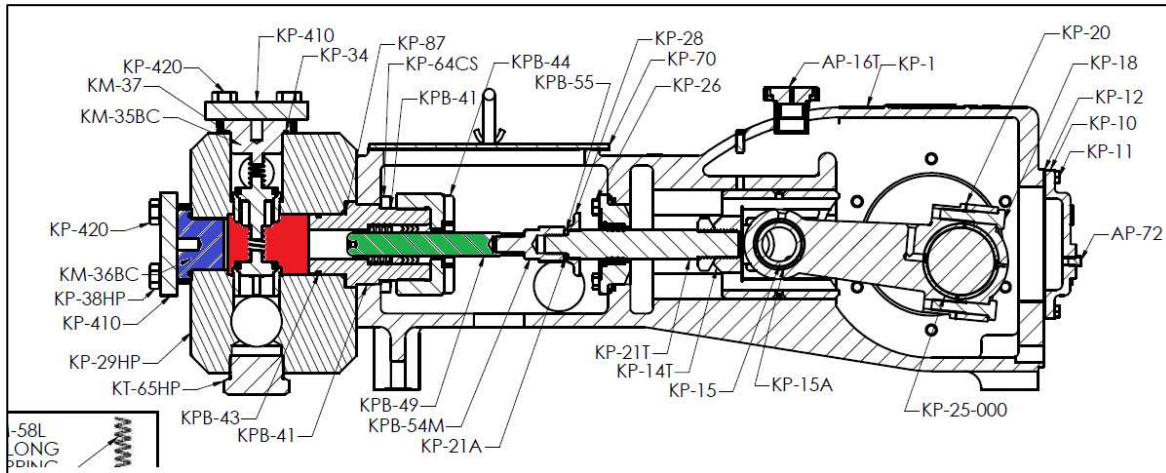
GD ENERGY PRODUCTS LLC

Petitioner

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this case, given the triplex pump being the example), each member of which has the same structure. While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the Kerr Pump has these features, as would be typical of any reciprocating power pump.



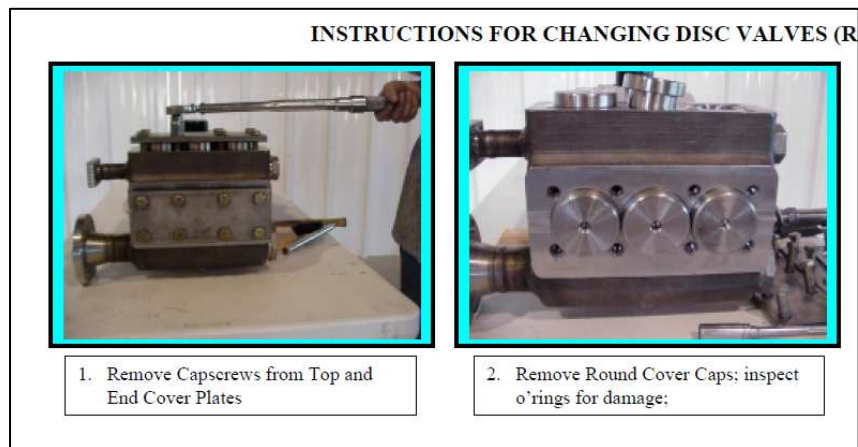
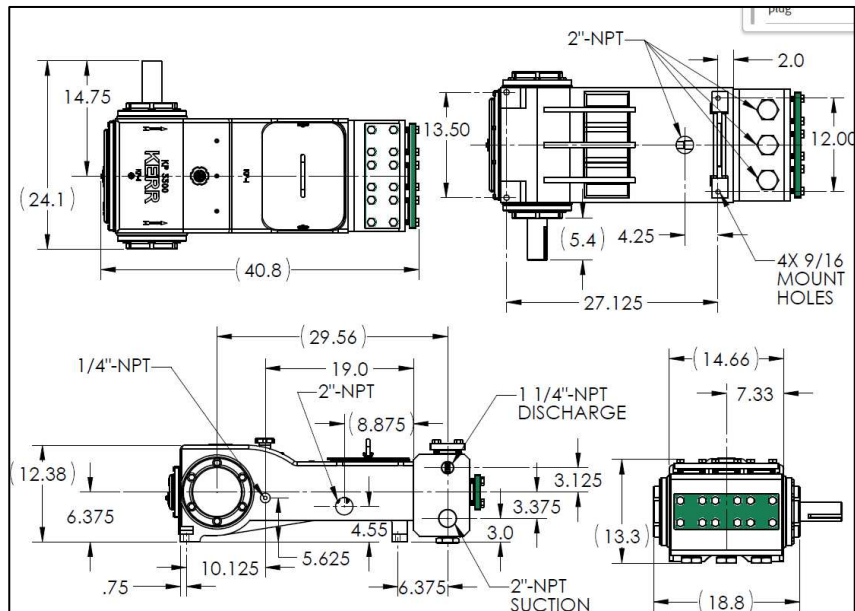
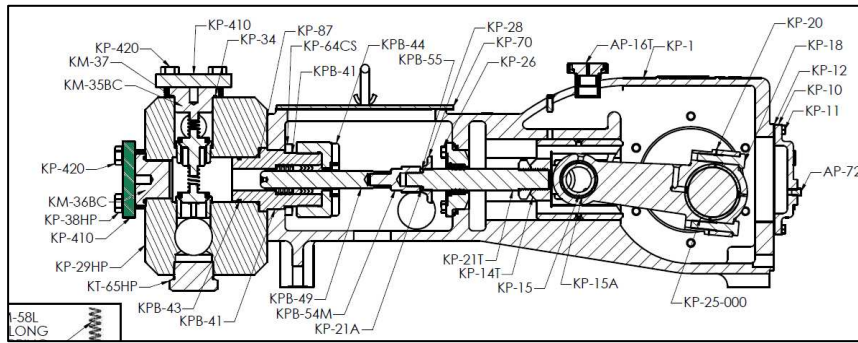
Kerr (EX1004), p. 27 (annotated): Cross-section of the Kerr Pump, demonstrating a very typical reciprocating power pump design, including valve details. The horizontal bore opposite the plunger end is left open for access by the bore machining tool, and is subsequently closed by a plug with some means of firm attachment to the casing.

j. 1.i “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores”

99. Recitation 1.i of claim 1 of Foster recites “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores” is illustrated in the annotated figure below, the Kerr Pump includes such a plate.

100. As annotated in green below, the Kerr Pump includes a plate fastened to the housing of the fluid end along an external surface containing openings to the

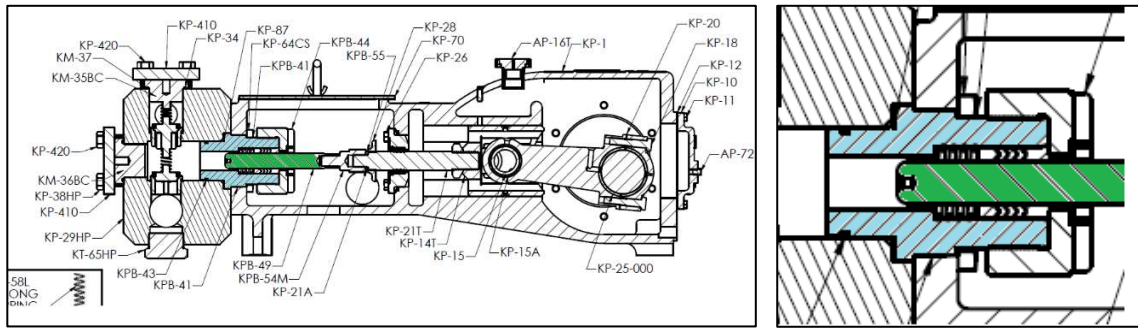
first and second horizontal bores. The structure, function and location of the disclosed plate is conventional, and has been used for many years prior to the priority date for Foster, including by Kerr themselves. For example, as shown in the annotated figures below, the pictures from Kerr indicate using such a bolted-on plate to firmly secure the bore plugs against the casing. *See also* EX1009, 23; EX1008.



Kerr (EX1004), pp. 20, 25, 27 (annotated): Pictures from the KP-3300 Service Manual which indicate using a bolted-on plate to firmly secure the bore plugs against the casing.

- k. 1.j “a first component having a central opening formed therein, at least a portion of the first component installed within the first horizontal bore and at least a portion of the first reciprocating plunger installed within the central opening of the first component”**

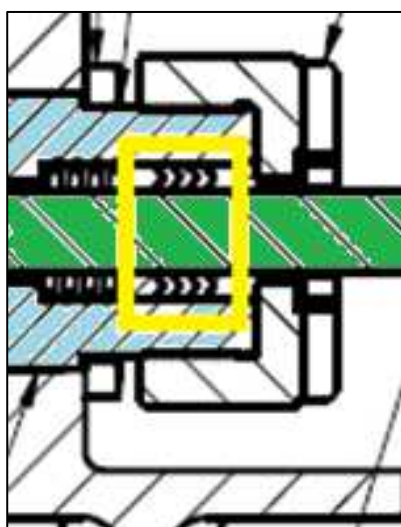
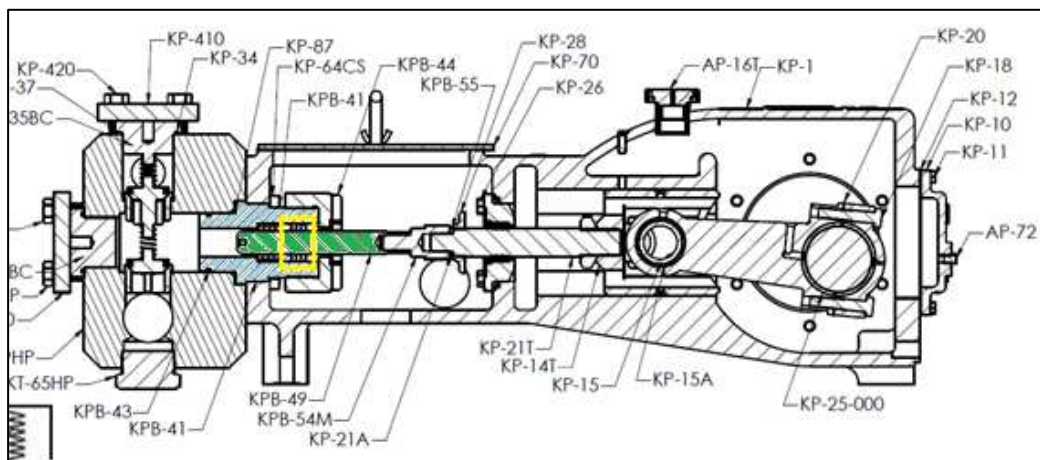
101. Recitation 1.j of claim 1 of Foster recites “a first component having a central opening formed therein, at least a portion of the first component installed within the first horizontal bore and at least a portion of the first reciprocating plunger installed within the central opening of the first component.” This recitation uses broad terms that could correspond, for example, to essentially any component arranged within the bore, such as a packing sleeve or stuffing box. I am therefore relying on a packing sleeve associated with the teachings in the specification of Foster. *See, e.g.*, EX1001, 4:12-16, 6:63-67, 9:14-20, 10:66-11:7. Such a packing sleeve is included in the Kerr Pump, as indicated in the blue annotation in the figures below. As illustrated, the blue component includes a portion that is in the horizontal bore, and the green plunger is partially within the blue component. The blue component is what a skilled artisan would call a “sleeve,” and is a very typical component used to interface cylindrically with a plunger.



Kerr (EX1004), p. 27 (annotated): Pictures from the KP-3300 Service Manual show a packing sleeve associated with the teachings in the specification of Foster, but generically called a “component” by Foster.

l. 1.k “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger”

102. Recitation 1.k of claim 1 of Foster recites “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger.” This is a conventional feature of reciprocating plunger pumps that is included in the Kerr Pump. The annotated figures below illustrate “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger” in the Kerr Pump, annotated in yellow.

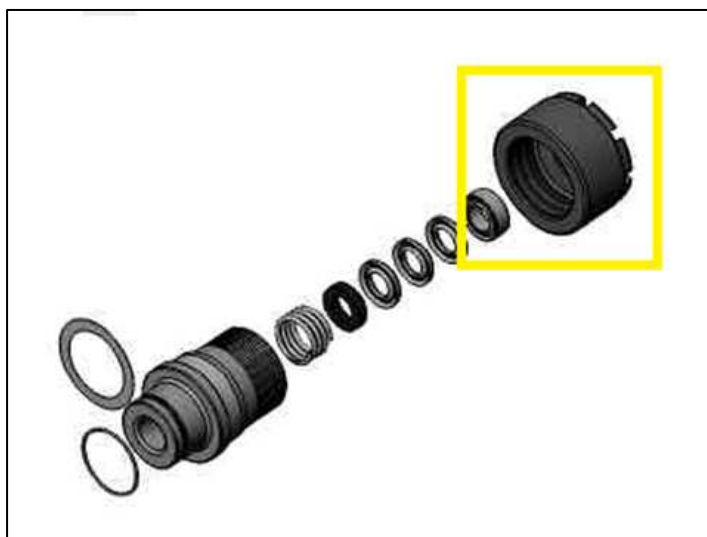
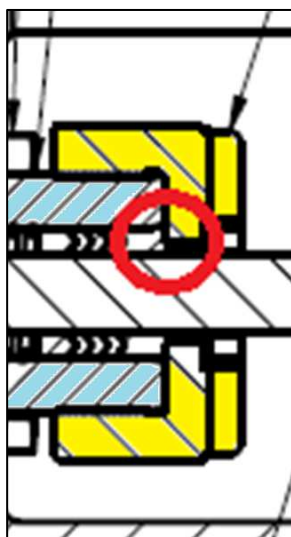
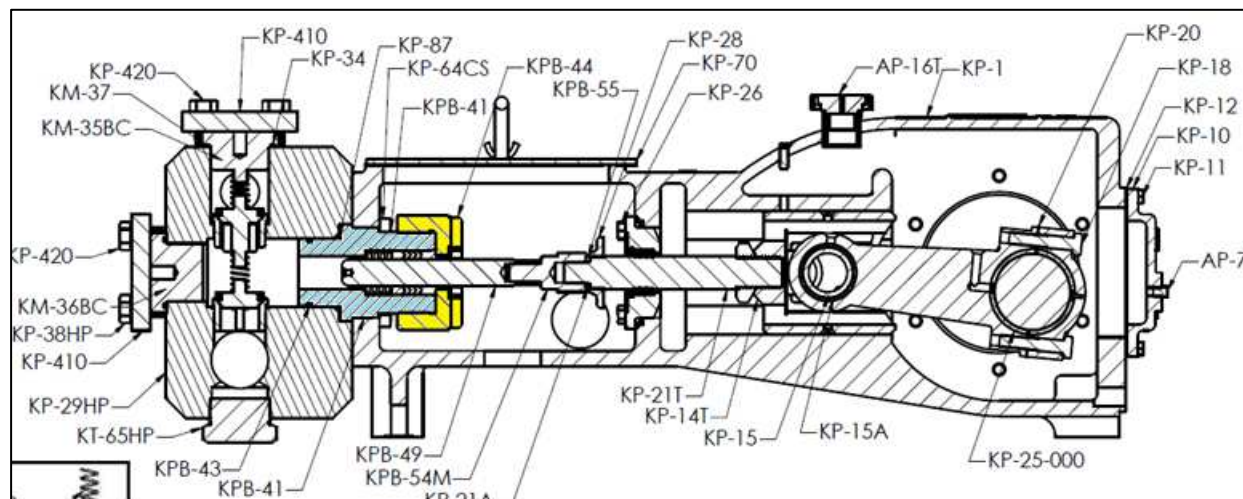


Kerr (EX1004), p. 27 (annotated): The pictures taken from the KP-3300 Service Manual show a packing assembly, including the packing seals, sometimes referred to as packing rings, that I have highlighted in yellow above. As illustrated in the drawings, the seals are arranged within the packing sleeve, where the sleeve corresponds to the first component. The purpose of the seals is to provide a fluid-tight barrier to isolate the pressure in the internal pressure form the external atmospheric pressure. Therefore, the seals engage intimately with the reciprocating plunger.

m. 1.1 “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.”

103. Recitation 1.1 of claim 1 of Foster recites “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.” Such a packing nut is included in the Kerr Pump.

104. In the figures below, the packing nut (annotated in yellow) is attached to the sleeve with threading. This mimics how any packing nut “hold[s] the plurality of packing seals within the first component” (EX1001, claim 1) due to the compression of the packing. If there is no nut, then all the packing loses its fit and function, because the pressure ahead of the plunger would push the packing from the bore, and it could not seal around the plunger. This nut not only compresses the packing rings to squeeze out radial clearance around the plunger through which fluid could leak, but acts to hold the packing rings in the sleeve and as an additional fluid barrier at the rear of the packing box assembly, essentially acting as a detachable rear end of the packing sleeve, as circled in red in the figures below.



Kerr (EX1004), p. 27 (annotated): Packing nut shown along with packing assembly, both as disassembled component parts as well as an installed assembly.

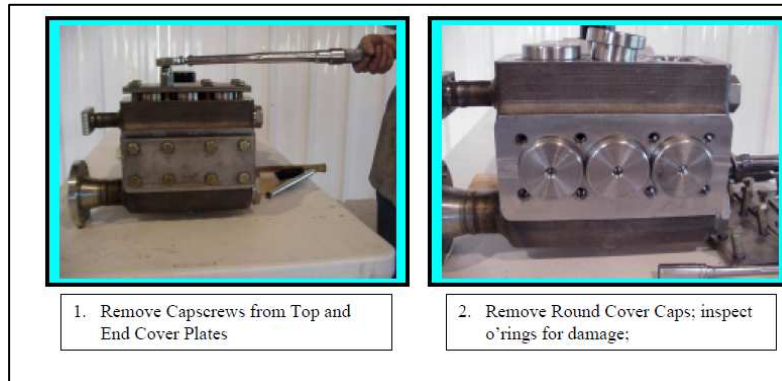
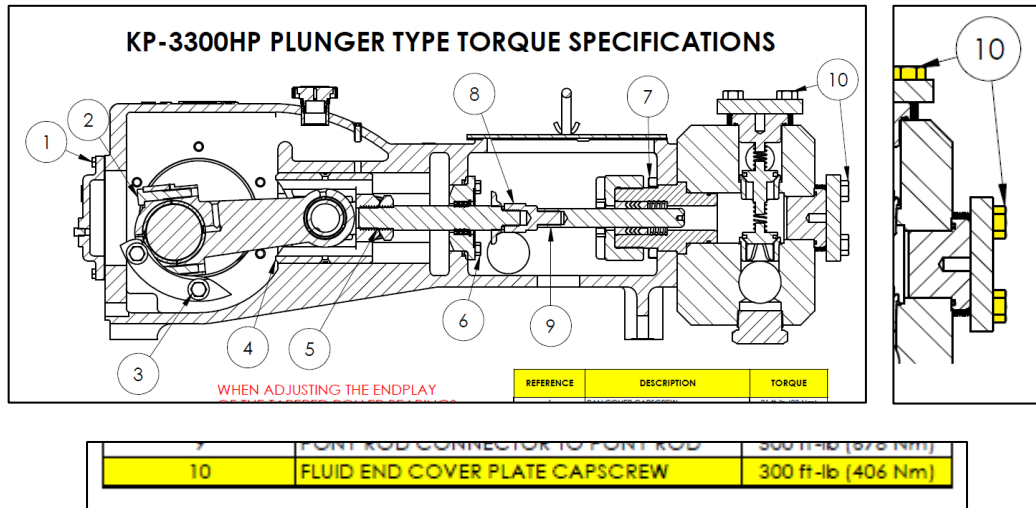
ii. Claim 2

- a. 2.a “the plate comprises a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a one-to-one relationship”

105. Recitation 2.a of claim 2 of Foster recites “a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a

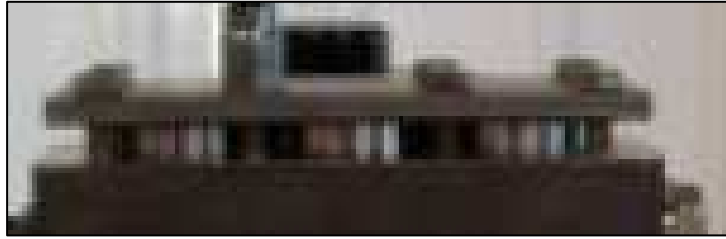
one-to-one relationship.” While the fastener openings are not explicitly illustrated in Kerr, they would have been obvious to the skilled artisan at the time of filing.

106. The annotated figures below are taken from Kerr. These figures illustrate hex-headed capscrew fasteners that secure the cover plates to the fluid end housing and the openings in the fluid end with which the fasteners engage. The skilled artisan would understand that these hex-headed capscrew fasteners pass through fastener openings in the plate and engage with threaded openings formed in the housing in a one-to-one relationship to secure the plates to the fluid end housing. The threaded openings are not shown in sufficient detail to illustrate the actual threads. The presence of threads (in the fastener and its opposing hole or “opening”), however, would have been obvious to the skilled artisan given the fasteners are named “capscrew” fasteners and are illustrated with a hex head. The skilled artisan would understand that a screw, a type of threaded fastener, would need to engage with a threaded opening in order to secure the plate to the housing. Accordingly, it would have been obvious to the skilled artisan that the openings formed in the fluid end housing would be threaded.



Kerr (EX1004), pp. 20, 25: Drawings from the KP-3300 Service Manual, showing multiple threaded connections.

107. In fact, illustrated in the detail from these figures below, the capscrew fasteners can be seen passing through fastener openings in the cover plate and into the fluid end housing, confirming alignment and one-to-one relationship between the fastener openings in the plate and threaded openings in the housing.

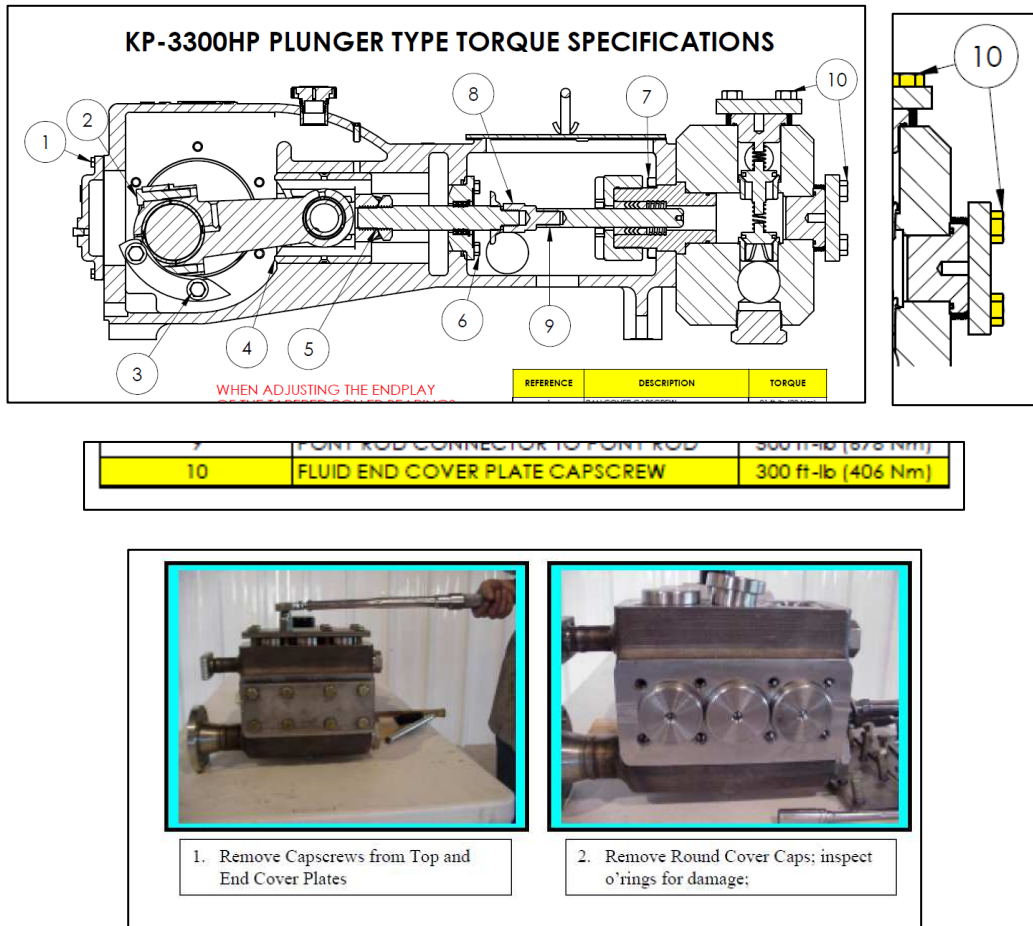


Kerr (EX1004), p. 20.

- b. **2.b “a plurality of fasteners, each of the plurality of fasteners installed within a corresponding one of the aligned fastener openings and threaded openings”**

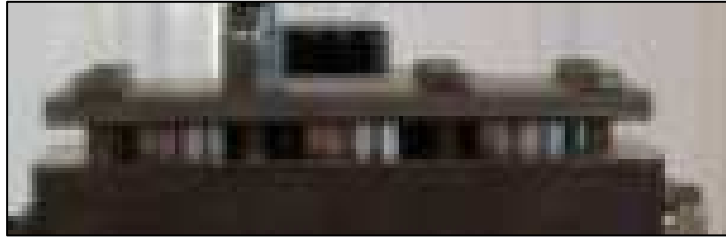
108. Recitation 2.b of claim 2 of Foster recites “a plurality of fasteners, each of the plurality of fasteners installed within a corresponding one of the aligned fastener openings and threaded openings.” Such fasteners are included in the Kerr Pump, the “capscrew” threaded fasteners discussed in section V.A.ii.a, *supra*.

109. The figures below are taken from Kerr. Illustrated in the figures are a “capscrew” with a hex head. The skilled artisan would understand that such a fastener is a threaded fastener that would be installed within the aligned fastener openings in the plate and the threaded openings in the housing.



Kerr (EX1004), pp. 20, 25: Drawings from the KP-3300 Service Manual, showing multiple threaded connections.

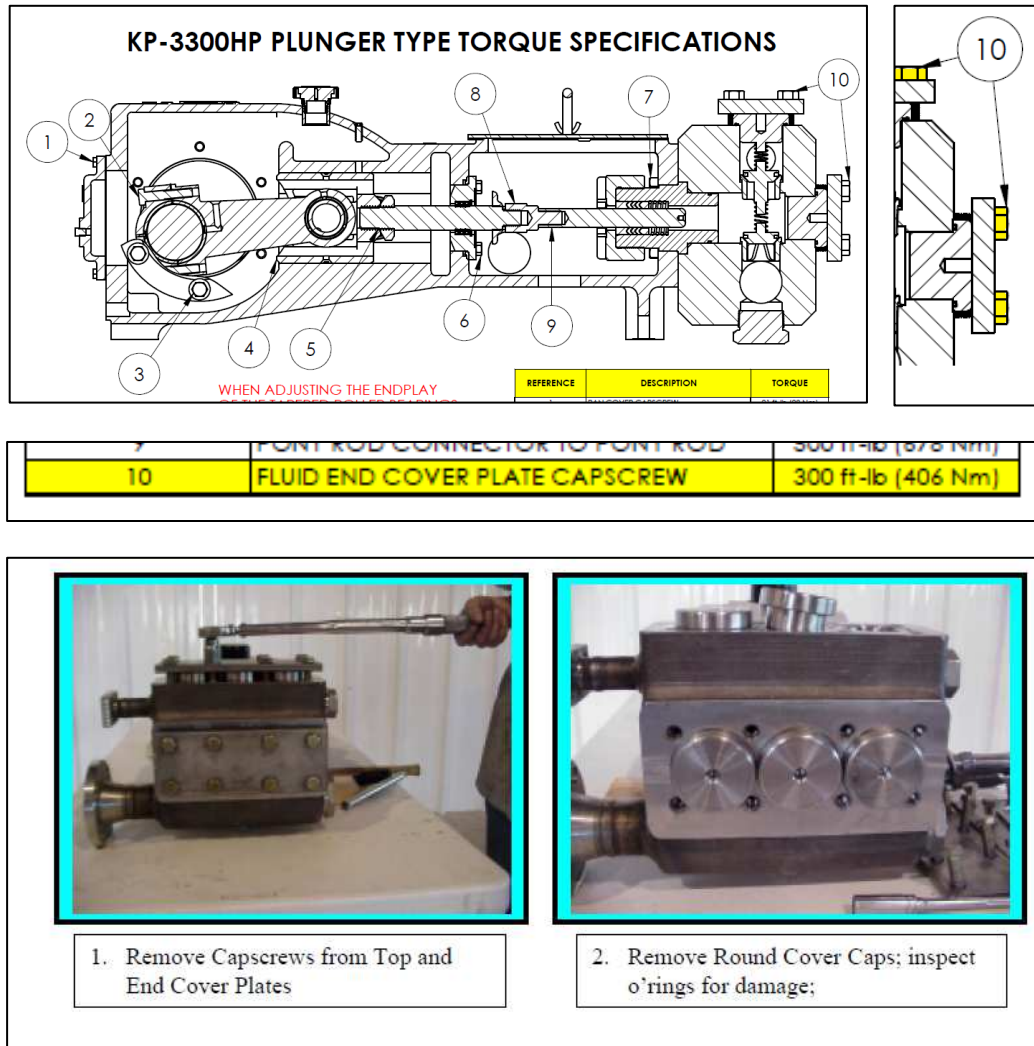
110. In fact, illustrated in the detail from these figures below, the capscrew fasteners can be seen passing through fastener openings in the cover plate and into the fluid end housing, confirming the fasteners are “installed within a corresponding one of the aligned fastener openings and threaded openings.”



Kerr (EX1004), p. 20.

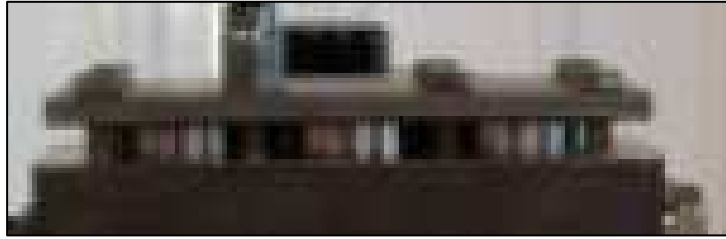
- iii. **Claim 3 “a plurality of fasteners, each of the plurality of fasteners extending through the plate and into the housing to fasten the plate to the housing.”**

111. Claim 3 of Foster recites “a plurality of fasteners, each of the plurality of fasteners extending through the plate and into the housing to fasten the plate to the housing.” The annotated figures below are taken from Kerr and illustrate hex-headed capscrew fasteners that secure the cover plates to the fluid end housing and the openings in the fluid end with which the fasteners engage. The skilled artisan would understand that these hex-headed capscrew fasteners pass through fastener openings in the plate and engage with threaded openings formed in the housing in a one-to-one relationship to fasten the plates to the fluid end housing.



Kerr (EX1004), pp. 20, 25: Drawings from the KP-3300 Service Manual, showing multiple threaded connections.

112. In fact, illustrated in the detail from these figures below, the capscrew fasteners can be seen passing through the cover plate and into the fluid end housing, confirming “each of the plurality of fasteners extend[s] through the plate and into the housing to fasten the plate to the housing.”

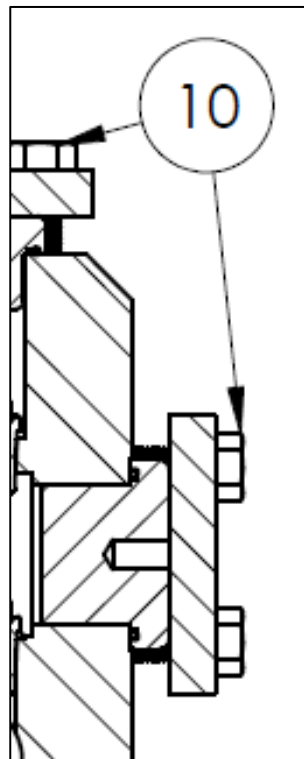
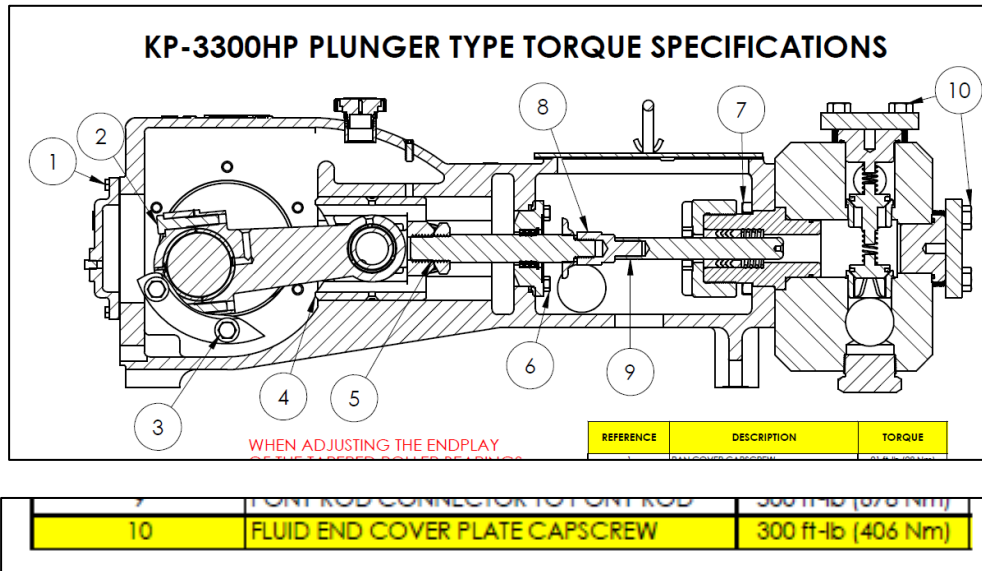


Kerr (EX1004), p. 20.

iv. Claim 4 “each of the plurality of fasteners is a threaded fastener”

113. Claim 4 of Foster recites that “each of the plurality of fasteners is a threaded fastener.”

114. The annotated figures below are taken from Kerr and illustrate the capscrew fasteners of the Kerr Pump. The threaded fasteners are not shown in sufficient detail to clearly illustrate the actual threads, though they are suggested in the images below. The presence of threads (in the fastener and its opposing hole or “opening”), however, would have been obvious to the skilled artisan given they are named “capscrew” fasteners and are illustrated with a hex head. The skilled artisan would understand that a screw, a type of threaded fastener, would need to engage with a threaded opening in order to secure the plate to the housing. Accordingly, it would have been obvious to the skilled artisan that the capscrew fasteners used to fasten the cover plates to the fluid end housing would be threaded.



Kerr (EX1004), p. 25: Drawing from the KP-3300 Service Manual, showing multiple threaded connections.

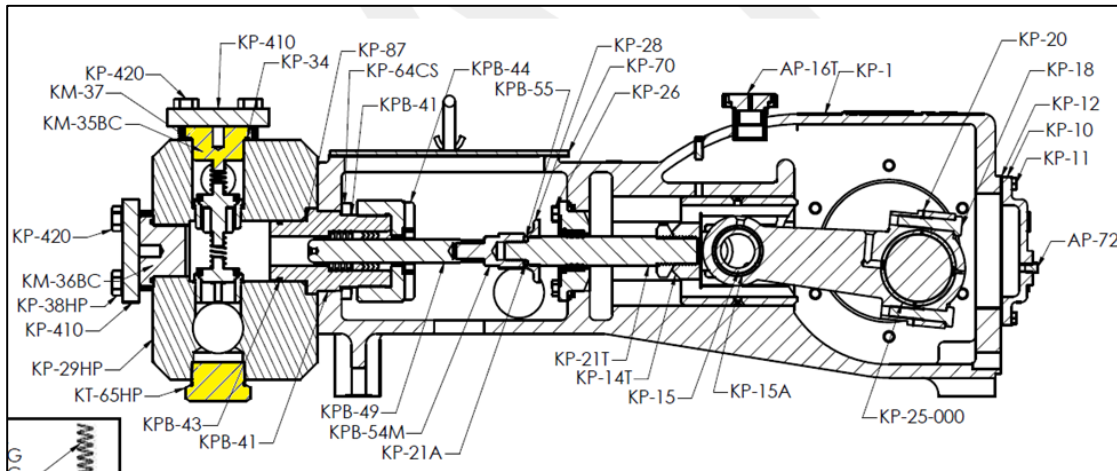
115. Furthermore, the use of a ratchet or torque wrench to fasten and unfasten the capscrews, as illustrated below, would strongly suggest, if not confirm, to the skilled artisan that the capscrews are threaded.



Kerr (EX1004), p. 20.

- v. **Claim 5 “a third plug installed within the first vertical bore and positioned between an external surface of the housing and one of the first pair of valves.”**

116. Claim 5 recites “a third plug installed within the first vertical bore and positioned between an external surface of the housing and one of the first pair of valves.” This claim is broad enough to cover the top vertical bore plug or the bottom vertical bore plug. Both of these are shown in the annotated figures below, from Kerr, and are a conventional part of a plunger pump fluid end. These plugs provide a pressure retention seal, and in some fluid ends, retain the valves in the fluid end.



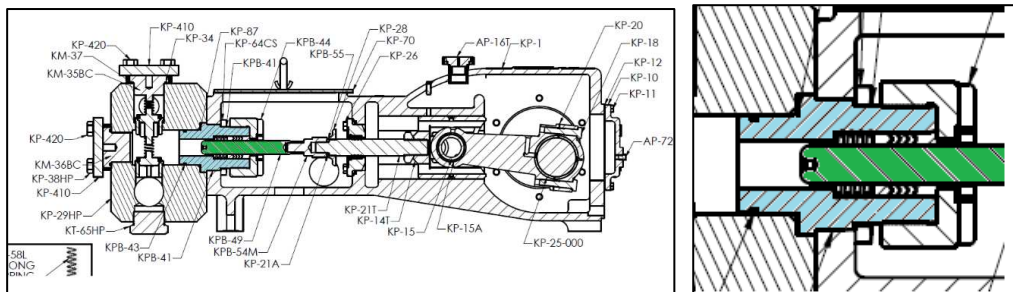
Kerr (EX1004), p. 27 (annotated): Drawing from the KP-3300 Service Manual, showing top and bottom bore plugs (highlighted in yellow).

vi. Claim 6

- a. 6.a “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore and at least a portion of the second reciprocating plunger installed within the central opening of the second component”**

117. Recitation 6.a of claim 6 recites “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore and at least a portion of the second reciprocating plunger installed within the central opening of the second component.” Where recitation 1.j of claim 1 recites the “first component” for a first plunger assembly, this recitation recites the corresponding “component” for a second plunger assembly of a multiplex pump. Accordingly, the Kerr Pump provides a second component for the same reasons as the first component of recitation 1.j.

118. Specifically, this recitation uses broad terms that could correspond, for example, to essentially any component arranged within the bore, such as a packing sleeve or stuffing box. I am therefore relying on a packing sleeve associated with the teachings in the specification of Foster. *See, e.g.*, EX1001, 4:12-16, 6:63-67, 9:14-20, 10:66-11:7. Such a packing sleeve is included in the Kerr Pump, as indicated in the blue annotation in the figures below. As illustrated, the blue component includes a portion that is in the horizontal bore, and the green plunger is partially within the blue component. The blue component is what a skilled artisan would call a “sleeve,” and is a very typical component used to interface cylindrically with a plunger. While Kerr does not explicitly illustrate “first” and “second” components, it would have been obvious to the person of ordinary skill in the art that the Kerr Pump has these features, as would be typical of any reciprocating power pump.

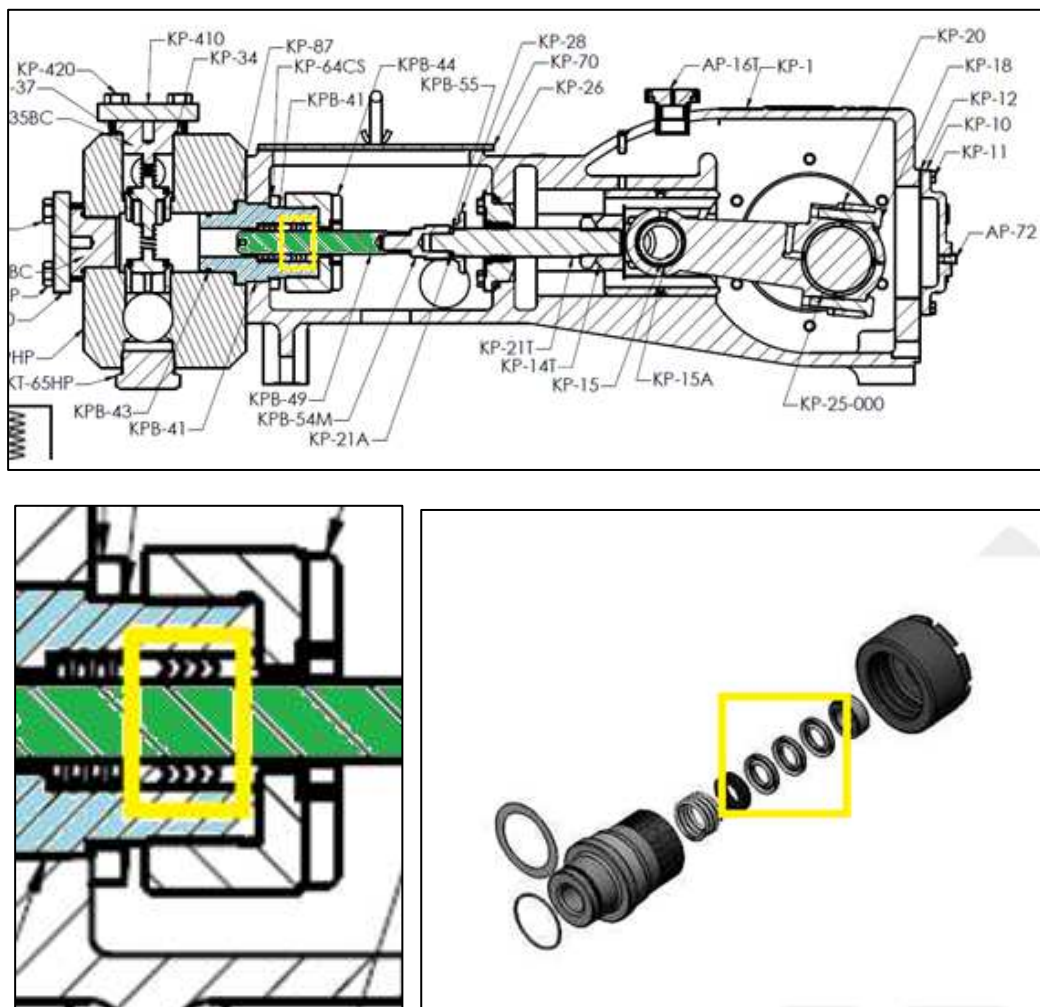


Kerr, page 27 (annotated): The pictures from the KP-3300 Service Manual show a packing sleeve associated with the teachings in the specification of Foster, but generically called a “component” by Foster.

b. 6.b “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger”

119. Recitation 6.b of claim 6 recites “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger.” Where recitation 1.k of claim 1 recites the “first plurality of packing seals” for a first plunger assembly, this recitation recites the corresponding “plurality of packing seals” for a second plunger assembly of a multiplex pump. Accordingly, the Kerr Pump provides a second component for the same reasons as the first component of recitation 1.k.

120. This is a conventional feature of reciprocating plunger pumps and is included in the Kerr Pump. The annotated figures below illustrate “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger” in the Kerr Pump, annotated in yellow.



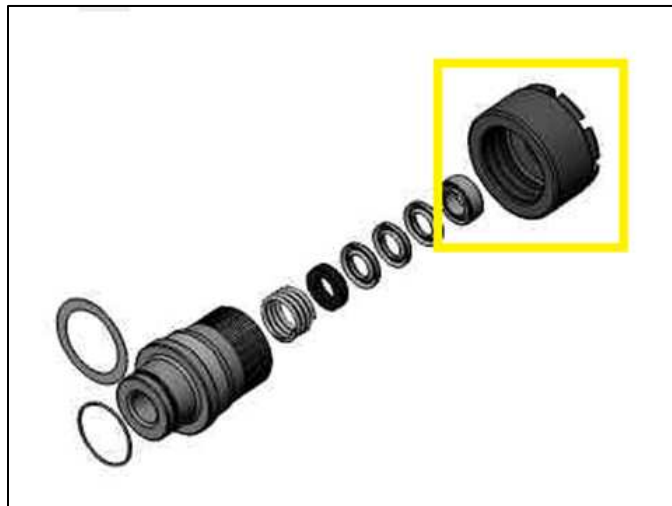
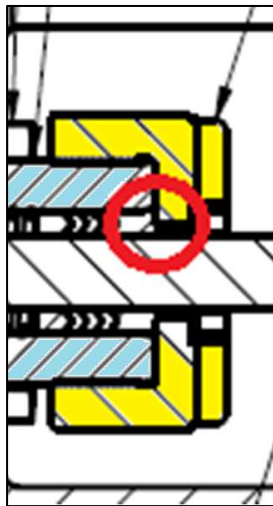
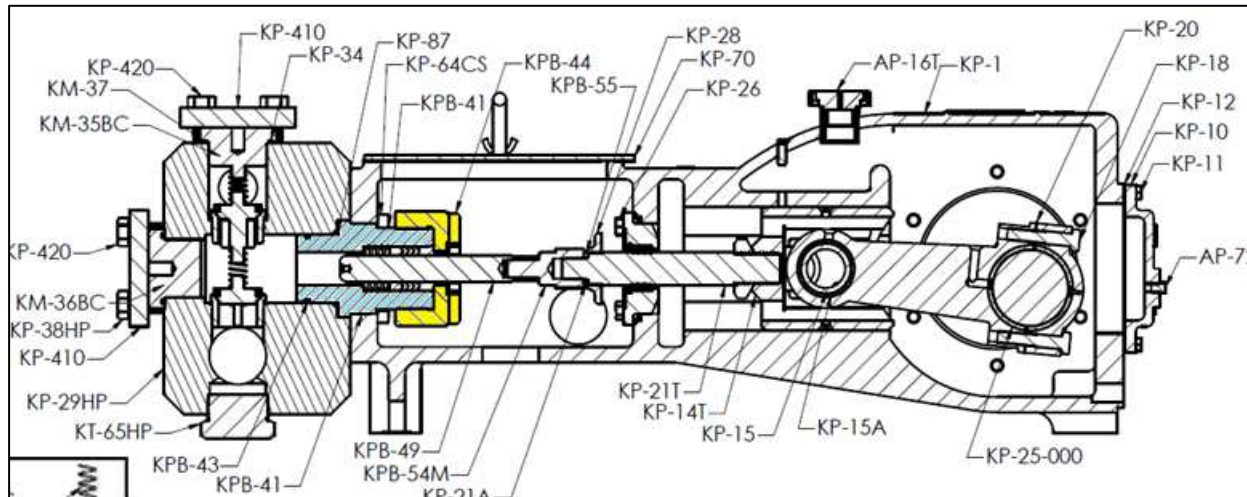
Kerr, page 27 (annotated): The pictures taken from the KP-3300 Service Manual show a packing assembly, including the packing seals, sometimes referred to as packing rings, that I have highlighted in yellow above. As illustrated in the drawings, the seals are arranged within the packing sleeve, where the sleeve corresponds to the first component. The purpose of the seals is to provide a fluid-tight barrier to isolate the pressure in the internal pressure from the external atmospheric pressure. Therefore, the seals engage intimately with the reciprocating plunger.

- c. 6.c “a second packing nut attached to the second component and holding the second plurality of packing seals within the second component.”

121. Recitation 6.c of claim 6 recites “a second packing nut attached to the second component and holding the second plurality of packing seals within the

second component.” Where recitation 1.1 of claim 1 recites the “first packing nut” for a first plunger assembly, this recitation recites the corresponding “packing nut” for a second plunger assembly of a multiplex pump. Accordingly, the Kerr Pump provides a packing nut for the same reasons as the first component of recitation 1.1.

122. In the figures below, the packing nut (annotated in yellow) is attached to the sleeve with threading. This mimics how any packing nut “hold[s] the second plurality of packing seals within the first component” (EX1001, claim 6) due to the compression of the packing. If there is no nut, then all the packing loses its fit and function, because the pressure ahead of the plunger would push the packing from the bore, and it could not seal around the plunger. This nut not only compresses the packing rings to squeeze out radial clearance around the plunger through which fluid could leak, but acts to hold the packing rings in the sleeve and as an additional fluid barrier at the rear of the packing box assembly, essentially acting as a detachable rear end of the packing sleeve, as circled in red in the figures below.



Kerr, page 27 (annotated): Packing nut shown along with packing assembly, both as disassembled component parts as well as an installed assembly.

vii. Claim 7

a. 7.p “a fluid end assembly”

123. The preamble of claim 7 of Foster recites that the claims are directed to a “fluid end assembly.” While I understand that the preamble of a claim does not always recite patentably relevant subject matter, in this case I need not address that issue as the Kerr Pump clearly includes a “fluid end assembly.” The chart from Page

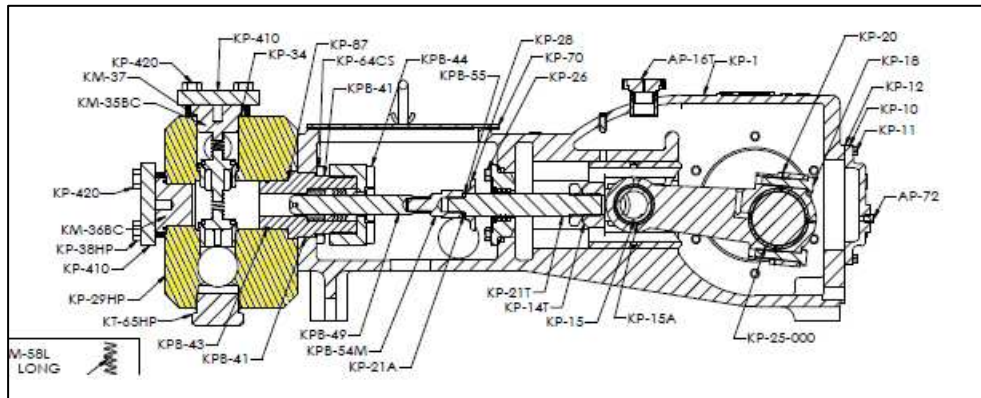
26 of Kerr lists ten specific components of the reciprocating power pump, and illustrates the location and interconnection of these components in the drafted figure presented on that page. These components are a partial list of the component parts listed and illustrated in Foster, including a fluid end.

124. On page 12 of the KP-3300 manual, in Section H, it states the following:

Power End/Fluid End Connection: A common misconception is that there is some form of fluid seal between the power end and **the fluid end**. This is false. The fluid end is merely bolted to the power frame. It can be removed by breaking the plunger connection, backing off the packing nut or gland, removing the various fluid end bolts, and sliding the entire fluid end off the power frame. Corrosion may tend to seize the two components together making their separation difficult in some isolated cases. On models KP-3300, KT-3350/KT-3400 and R335/R340 the bolted in stuffing box assemblies must be removed prior to removal **of the entire fluid end**. They are held in place by four studs each. On all other units the stuffing boxes can be left intact. On the remaining pumps (with the exception KD-1250B, KJ- 2250B, KM-3250B, and KCP-6300) the stuffing boxes are held in place **in the fluid end** by a friction or “press” fit. They should be removed with a hydraulic press if possible. These press-in type stuffing boxes carry a gasket and/or an o-ring to insure a good seal. The boxes on the KD-1250B, KJ-2250B, KM-3250B, and KCP-6300 are screw-in type and carry only a copper gasket.”

EX1004, 12.

125. Accordingly, the Kerr Pump includes a “fluid end.” This fluid end is also illustrated throughout the figures of Kerr, an example of which I have reproduced below and annotated in yellow.



Kerr (EX1004), p. 27 (annotated).

126. Furthermore, the parts lists from Kerr indicates that the portion of the Kerr Pump that I have annotated in yellow is, in fact, a fluid end:

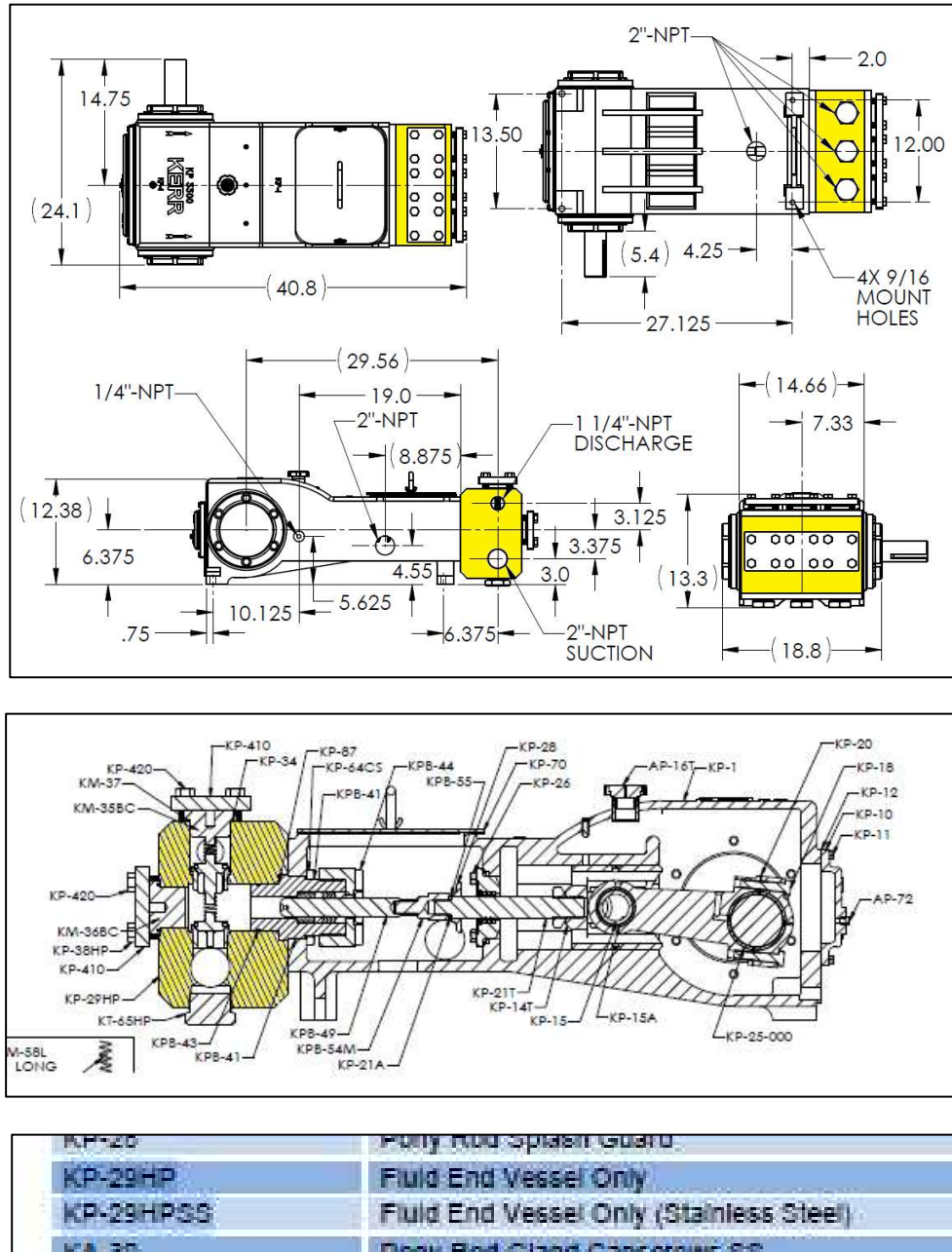
KP-20	Poly Rod Splash Guard
KP-29HP	Fluid End Vessel Only
KP-29HPSS	Fluid End Vessel Only (Stainless Steel)
KA-30	Fluid End Gland Component SS

Kerr (EX1004), p. 29.

b. 7.a “a housing made of a single integrally formed piece”

127. The recitation of claim 7 that is being referred to as recitation “7.a” (*see* Petition at Claim Listing Appendix) recites that the fluid end includes “a housing made of a single integrally formed piece.” This is conventionally how fluid end housings are formed – because of the high pressure developed and contained therein; in order to not split the fluid end housing, the housings are machined as an integral piece or “monoblock.” Such an integral monoblock housing is illustrated in Kerr. The figures below are from Kerr. Note that the fluid end of the pump consists of a single piece, such that no breaks or seams are illustrated. This renders as obvious

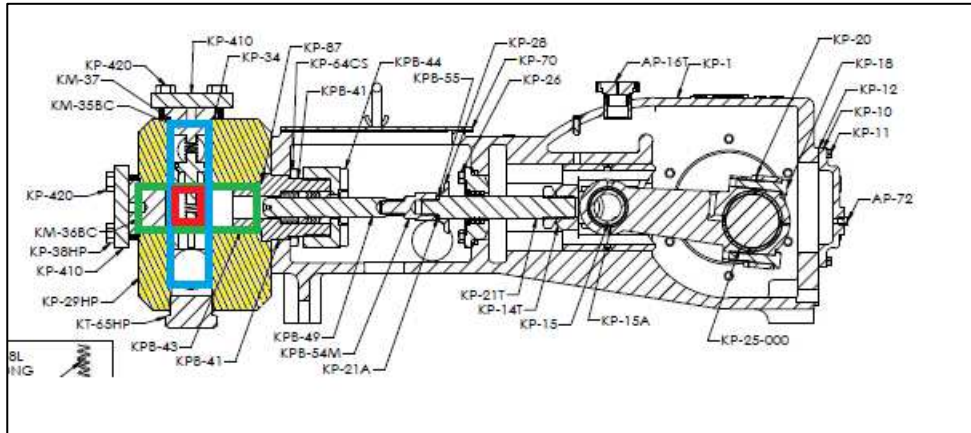
recitation 7.a of Foster: “A fluid end assembly, comprising a housing made of a single, integrally-formed piece.”



External views and cross-section of liquid end of Kerr, pp. 25, 27, 29 (annotated), illustrating the monoblock design, with no splits in the casing.

c. 7.b “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber”

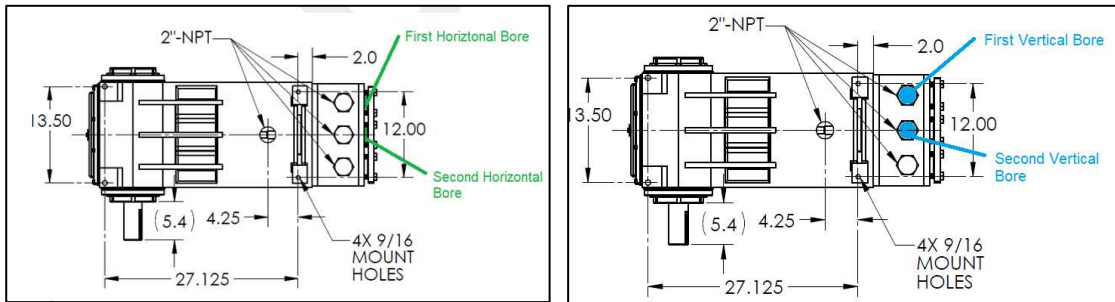
128. Recitation 7.b of claim 7 of Foster recites “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber.” Such an internal chamber is a conventional part of a fluid end, as illustrated in the discussion of the prior art I provide above. Furthermore, the figure from Kerr that I have reproduced below clearly illustrates that the Kerr Pump includes such an internal chamber formed by the intersection of a first vertical bore formed in the housing and a first horizontal bore formed in the housing. “First” as used here refers to the bores associated with one of the plunger assemblies of the triplex pump, shown in the annotated figures below. The purpose of this internal chamber is to contain the plunger in the horizontal bore and the suction and discharge valves in the intersecting vertical bore. The resulting internal chamber provides a conduit for the suction fluid as the plunger moves backward, and a conduit for the discharge fluid as the fluid is pressurized by the plunger moving forward within the bore of the horizontal plunger bore, pumping the fluid through the and vertical discharge bore. This is a conventional design for a reciprocating power pump.



Kerr (EX1004), p. 27 (annotated): Cross-section from pump demonstrating a very typical reciprocating power pump design. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs.

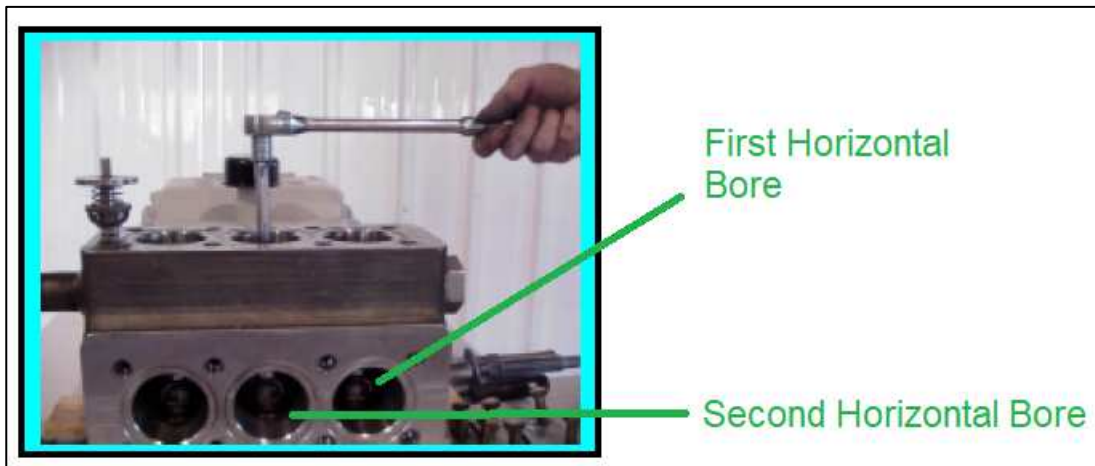
- d. 7.c “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber;”

129. Recitation 7.c of claim 1 of Foster recites “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber.” While the second internal chamber is not explicitly illustrated, it would have been obvious to the POSITA at the time of filing that the Kerr Pump has these features.



Kerr (EX1004), p. 25 (annotated).

130. A “second horizontal bore” is illustrated in the following figure from Kerr.



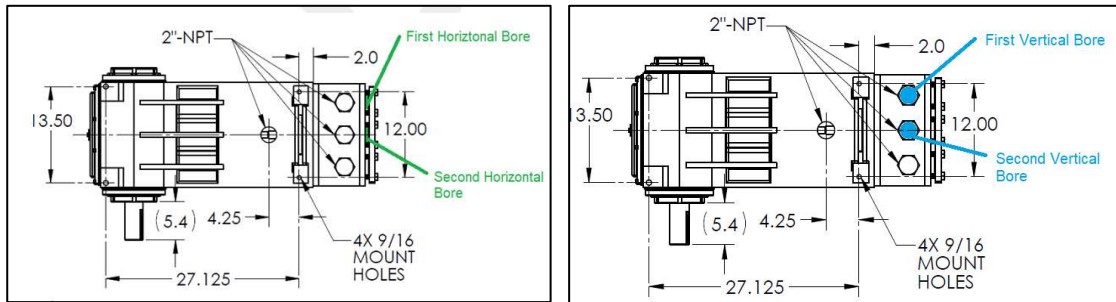
Kerr (EX1004), p. 20 (annotated).

131. “Second” as used here refers to the bores associated with a second of the plunger assemblies of the example triplex pump. *See, e.g.,* EX1001, 9:60-65. Only one such plunger assembly is illustrated in the drawings (*e.g.* the annotated figures above) because the POSITA would understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in this case, given the triplex pump being the example), each member of which has the same

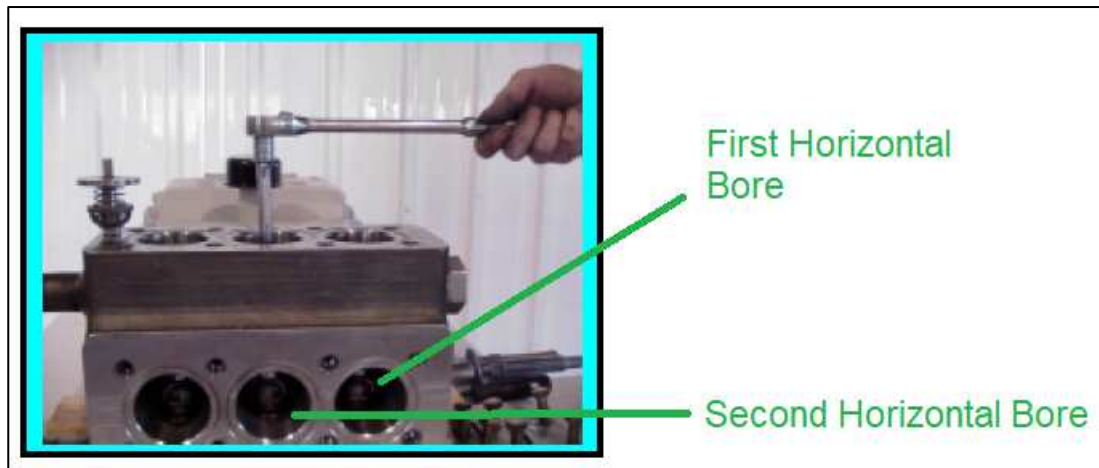
structure. It would, therefore, have been obvious to the person of ordinary skill in the art that the Kerr Pump has these features, as would be typical of any reciprocating power pump.

- e. **7.d “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber;”**

132. Recitation 7.d of claim 1 of Foster recites that the “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.” The skilled artisan would understand that this feature of claim 7 is present in Kerr as the Kerr Pump is a triplex pump. Accordingly, three plunger assemblies and their corresponding bores and internal chambers would be arranged in a “side-by-side relationship.” Furthermore, the annotated figures below from Kerr shows a side-by-side arrangement of plunger assemblies. Accordingly, it would have been obvious to the person of ordinary skill in the art that the Kerr Pump has its plunger arrangements, including the respective horizontal bores, vertical bores, and internal chambers, in a side-by-side relationship. This arrangement is typical of reciprocating power pump design, and has been for many decades.



Kerr (EX1004), p. 25 (annotated).

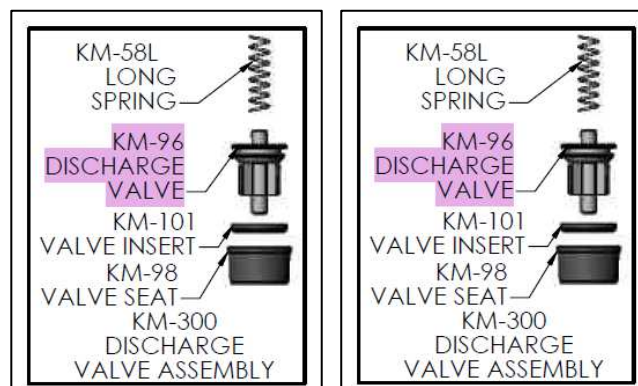
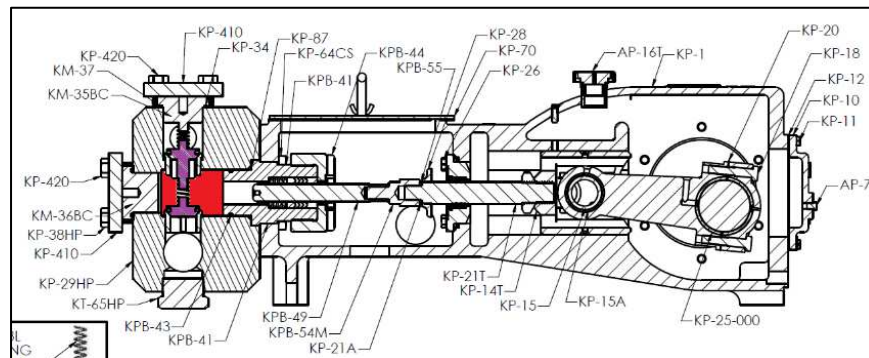


Kerr (EX1004), p. 20 (annotated).

- f. 7.e “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber”

133. Recitation 7.e of claim 7 of Foster recites “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber.” The POSITA would understand that each of the triplex plunger arrangements of the Kerr Pump includes such a pair of valves (*i.e.*, suction and discharge valves) placed as stated in recitation 7.e and as illustrated in the annotated figures below.

134. The valves illustrated below are one-way valves, when the plunger retracts (*i.e.*, the intake stroke), the one-way valve in the suction bore, in this case the bottom vertical bore, allows fluid to travel into the internal chamber. When the plunger is actuated toward the internal chamber (*i.e.*, the discharge stroke), the bottom or suction valve prevents fluid from flowing out the suction bore while the top one-way valve (*i.e.*, the discharge valve) allows fluid to be expelled from the internal chamber.

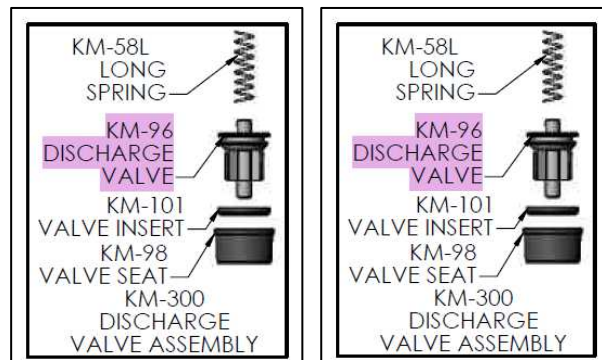
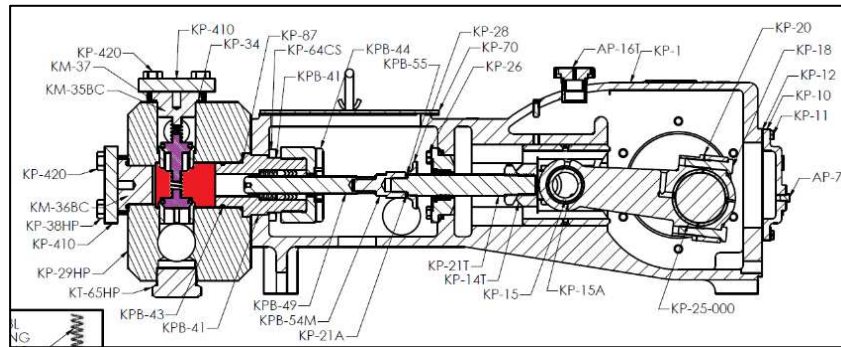


Cross-section from KP-3300 Service Manual, demonstrating a very typical reciprocating power pump design, including valve details. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs.

- g. 7.f “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber”**

135. Recitation 7.f of claim 7 of Foster recites “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber.” While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the Kerr Pump has these features.

136. “Second” as used here refers to the pair of valves associated with a second of the plunger assemblies of the example triplex pump. *See, e.g.*, EX1001, 2:57-64. Only one such plunger assembly is illustrated in the drawings (*e.g.* the annotated figures below) because the POSITA would understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in this case, given the triplex pump being the example), each member of which has the same structure. While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the Kerr Pump has these features, as would be typical of any reciprocating power pump.



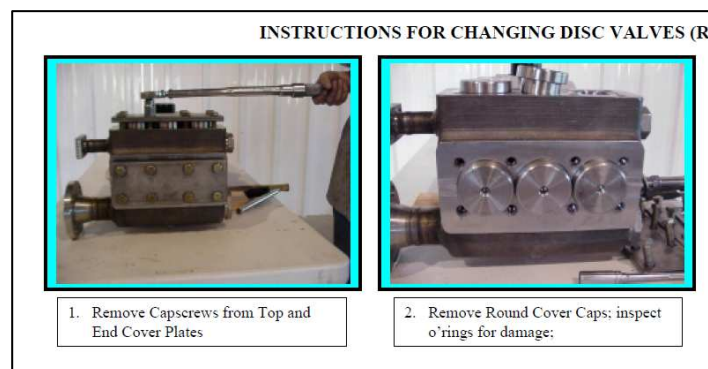
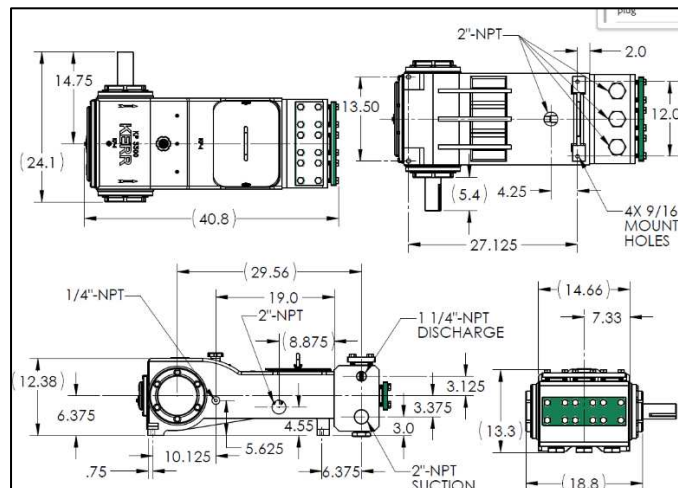
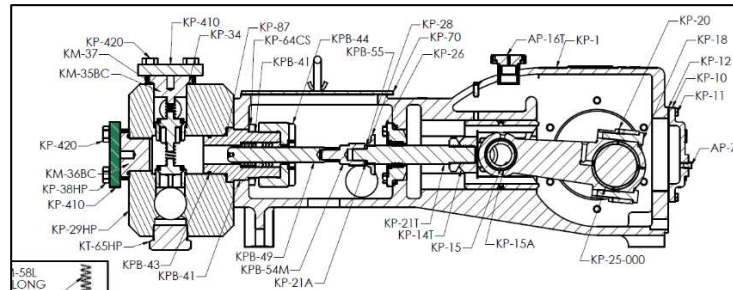
Cross-section from KP-3300 Service Manual, demonstrating a very typical reciprocating power pump design, including valve details. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs.

h. 7.g “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores”

137. Recitation 7.g of claim 7 of Foster recites “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores” is illustrated in the annotated figures below, the Kerr Pump includes such a plate.

138. As annotated in green below, the Kerr Pump includes a plate fastened to the housing of the fluid end along an external surface containing openings to the first and second horizontal bores. The structure, function and location of the

disclosed plate is conventional, and has been used for many years prior to the priority date for the '582 Application, including by Kerr themselves. For example, as shown in the figures below, the pictures from Kerr indicate using such a bolted-on plate to firmly secure the bore plugs against the casing. *See also* EX1009, 23; EX1008.



Kerr (EX1004), pp. 20, 25, 27 (annotated): Pictures from the KP-3300 Service Manual which indicate using a bolted-on plate to firmly secure the bore plugs against the casing.

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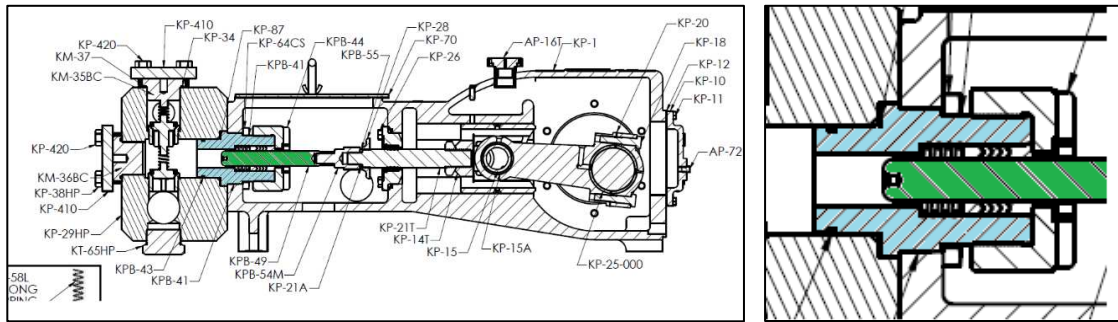
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- i. **7.h “a first component having a central opening formed therein, at least a portion of the first component installed within the first horizontal bore;”**

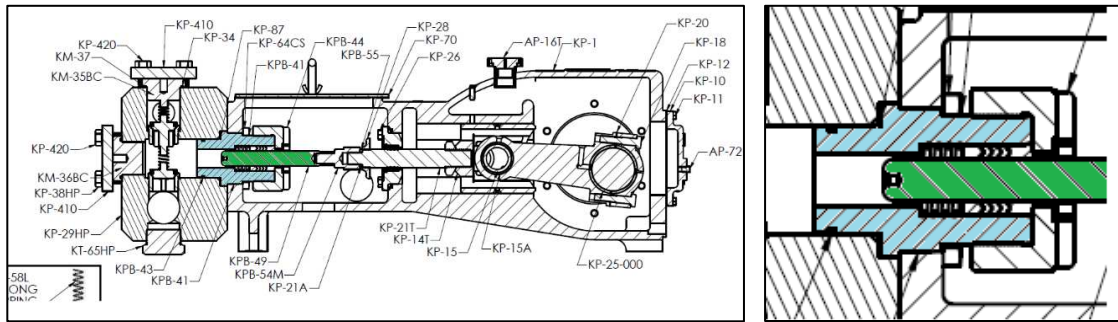
139. Recitation 7.h of claim 7 of Foster recites “a first component having a central opening formed therein, at least a portion of the first component installed within the first horizontal bore.” This recitation uses broad terms that could correspond, for example, to essentially any component arranged within the bore, such as a packing sleeve or stuffing box. I am therefore relying on a packing sleeve associated with the teachings in the specification of Foster. *See, e.g.*, EX1001, 4:12-16, 6:63-67, 9:14-20, 10:66-11:7. Such a packing sleeve is included in the Kerr Pump, as indicated in the blue annotation in the figures 15 below. As illustrated, the blue component includes a portion that is in the horizontal bore, and the green plunger is partially within the blue component. The blue component is what a POSITA engineer would call a “sleeve,” and is a very typical component used to interface cylindrically with a plunger.



Kerr (EX1004), p. 27 (annotated): Pictures from the KP-3300 Service Manual show a packing sleeve associated with the teachings in the specification of Foster, but generically called a “component” by Foster.

j. 7.i “a first reciprocating plunger, at least a portion of the first reciprocating plunger installed within the central opening of the first component”

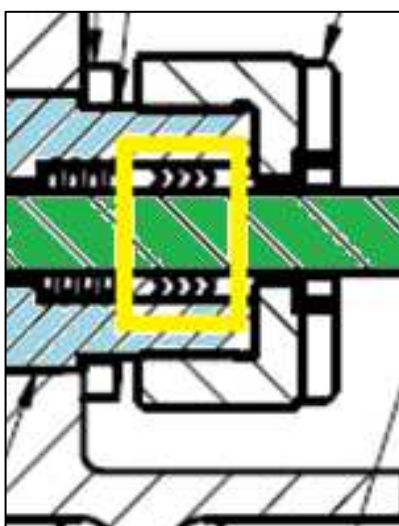
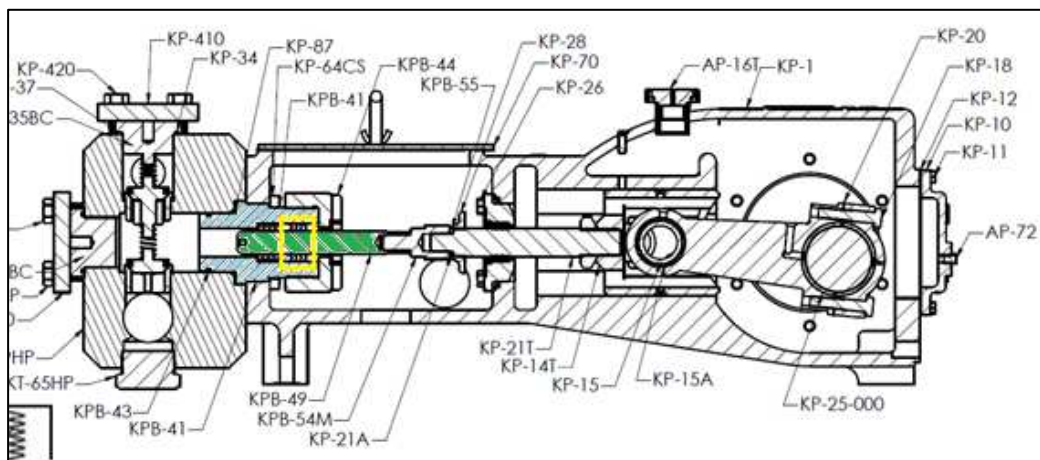
140. Recitation 7.i of Foster recites “a first reciprocating plunger, at least a portion of the first reciprocating plunger installed within the central opening of the first component.” The annotated figures below, from Kerr, exhibit a typical fluid end arrangement for a reciprocating power pump. Note the green plunger partially within the blue sleeve, showing that such a configuration is not novel in Foster. Accordingly, Kerr provides “a first reciprocating plunger, at least a portion of the first reciprocating plunger installed within the central opening of the first component.”



Kerr (EX1004), p. 27 (annotated): Pictures from the KP-3300 Service Manual show a packing sleeve associated with the teachings in the specification of Foster, but generically called a “component” by Foster.

k. 7.j “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger”

141. Recitation 7.j of claim 7 of Foster recites “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger.” This is a conventional feature of reciprocating plunger pumps that is included in the Kerr Pump. The annotated figures below illustrate “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger” in the Kerr Pump, annotated in yellow.

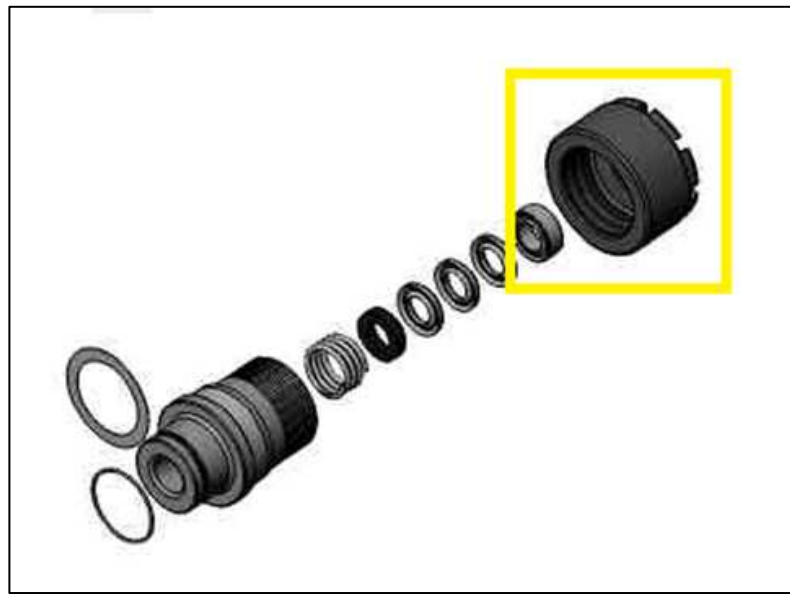
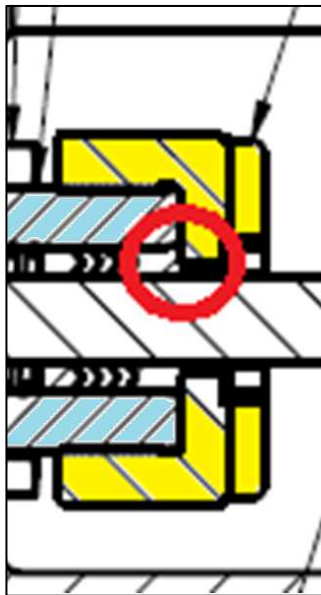
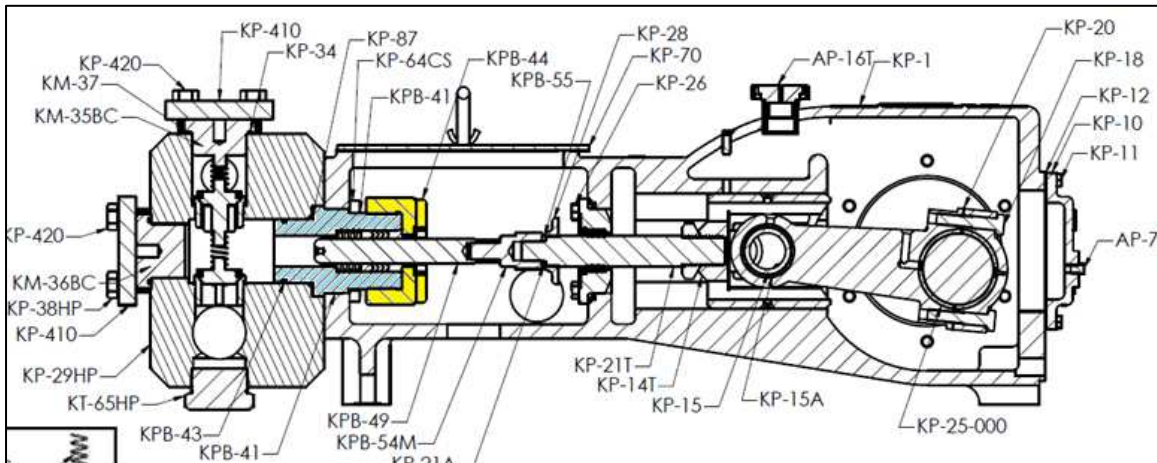


Kerr (EX1004), p. 27 (annotated): The pictures taken from the KP-3300 Service Manual show a packing assembly, including the packing seals, sometimes referred to as packing rings, that I have highlighted in yellow above. As illustrated in the drawings, the seals are arranged within the packing sleeve, where the sleeve corresponds to the first component. The purpose of the seals is to provide a fluid-tight barrier to isolate the pressure in the internal pressure form the external atmospheric pressure. Therefore, the seals engage intimately with the reciprocating plunger.

l. 7.k “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.”

142. Recitation 7.k of claim 7 of Foster recites “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.” Such a packing nut is included in Kerr.

143. In the figure below, the packing nut (annotated in yellow) is attached to the sleeve with threading. This mimics how any packing nut “hold[s] the plurality of first packing seals within the first component” (EX1001, claim 7) due to the compression of the packing. If there is no nut, then all the packing loses its fit and function, because the pressure ahead of the plunger would push the packing from the bore, and it could not seal around the plunger. This nut not only compresses the packing rings to squeeze out radial clearance around the plunger through which fluid could leak, but acts to hold the packing rings in the sleeve and as an additional fluid barrier at the rear of the packing box assembly, essentially acting as a detachable rear end of the packing sleeve, as circled in red in the figure below.



Kerr (EX1004), p. 27 (annotated): Packing nut shown along with packing assembly, both as disassembled component parts as well as an installed assembly.

viii. Claim 8

- a. 8.a “a first plug and the first reciprocating plunger installed within the first horizontal bore and positioned on opposite sides of the first internal chamber”**

144. Recitation 8.a of claim 8 of Foster recites “a first plug and a first reciprocating plunger installed within the first horizontal bore and positioned on opposite sides of the first internal chamber.” As discussed in section IV.E.i, *supra*,

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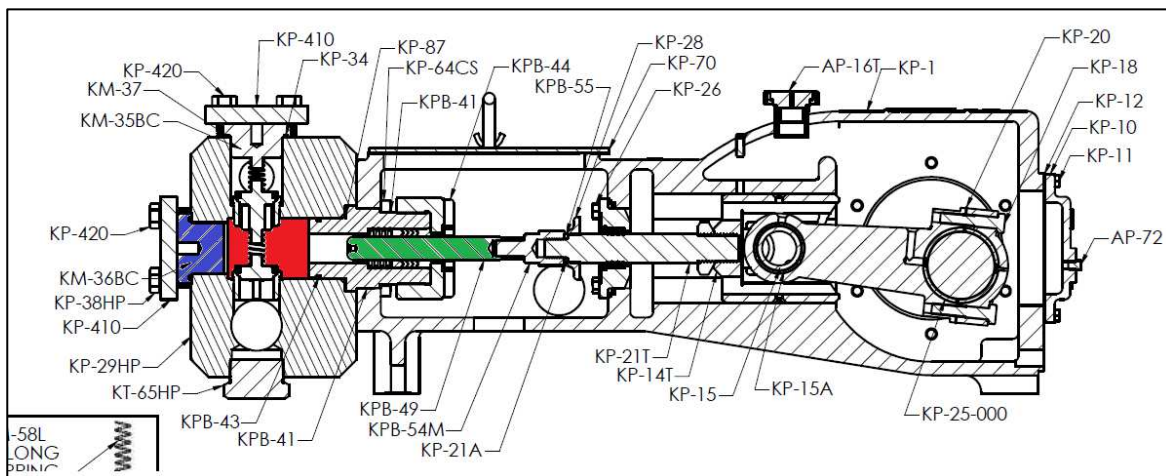
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and as illustrated in the annotated figure below, the Kerr Pump includes such an arrangement.

145. The annotated figure below, from Kerr, exhibits a typical fluid end arrangement for a reciprocating power pump. In order to maintain a monoblock (single piece, non-segmented casing) concept, the horizontal bore, within which the plunger moves and pressurizes the fluid during operation, is closed by a plug rather than being retained as a closed end during the fabrication process. This approach allows free access of the boring tool when it is machining the horizontal bore. As also illustrated in this figure, the plunger (green) is positioned on the opposite side of the internal chamber (red) from the plug (blue).

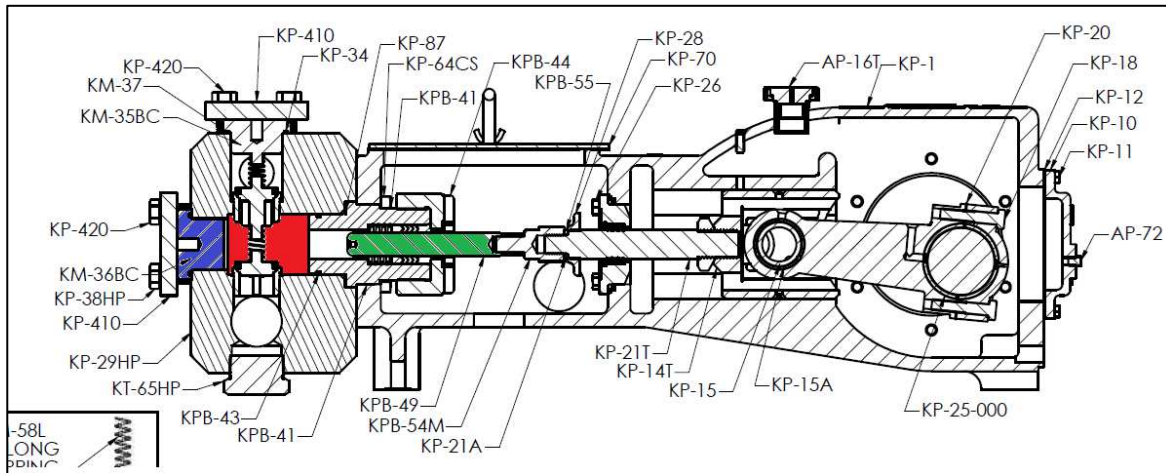


Kerr (EX1004), p. 27 (annotated): Cross-section of the Kerr Pump, demonstrating a very typical reciprocating power pump design, including valve details. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs. The horizontal bore opposite the plunger end is left open for access by the bore machining tool, and is subsequently closed by a plug with some means of firm attachment to the casing.

b. 8.b “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber”

146. Recitation 8.b of claim 8 of Foster recites “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber.” While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the Kerr Pump has these features.

147. “Second” as used here refers to the plug and plunger associated with a second of the plunger assemblies of the example triplex pump. *See, e.g.*, EX1001, 8:25-33, 9:60-65. Only one such plunger assembly is illustrated in the drawings (*e.g.* the annotated below) because the POSITA would understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in this case, given the triplex pump being the example), each member of which has the same structure. While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the Kerr Pump has these features, as would be typical of any reciprocating power pump.

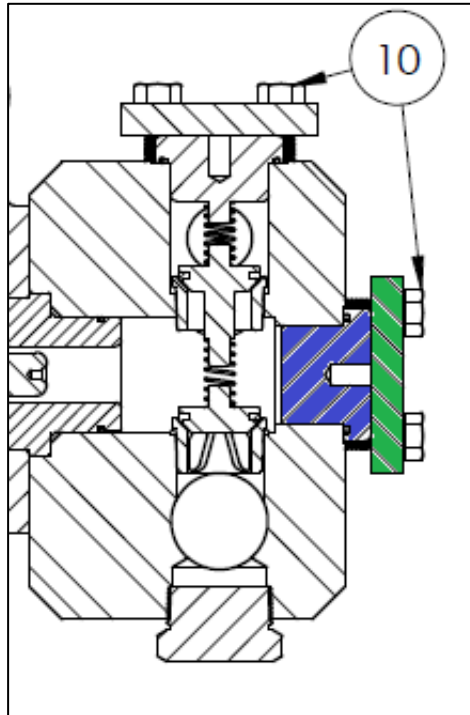


Kerr (EX1004), p. 27 (annotated): Cross-section of the Kerr Pump, demonstrating a very typical reciprocating power pump design, including valve details. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs.

c. 8.c “in which the first plug is positioned adjacent the plate”

148. Recitation 8.c of claim 8 of Foster recites “in which the first plug is positioned adjacent the plate.”

149. The “first plug” of Kerr is “positioned adjacent the plate,” as illustrated in the annotated figure provided below. Specifically, the first plug (blue) is adjacent to the plate (green), and also abuts the plate.



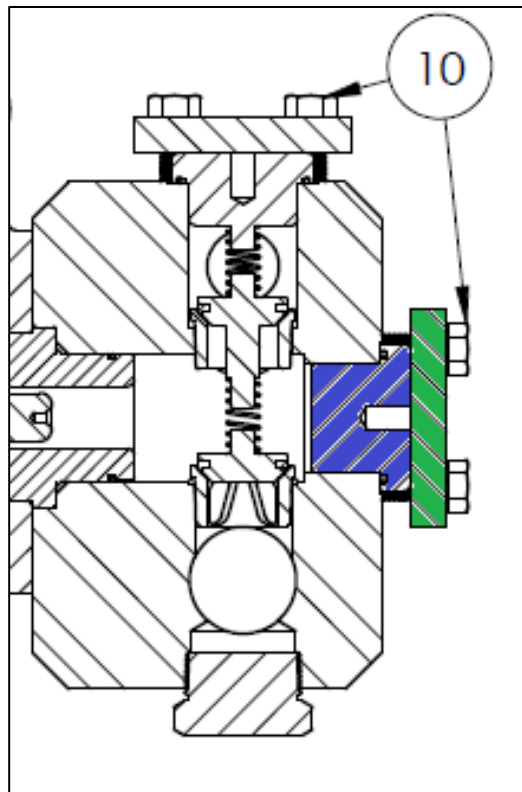
Kerr (EX1004), p. 26 (annotated).

d. 8.d “in which the second plug is positioned adjacent the plate”

150. Recitation 8.d of claim 8 of Foster recites “in which the second plug is positioned adjacent the plate.” “Second” as used here refers to the plug associated with a second of the plunger assemblies of the example triplex pump. *See, e.g.*, EX1001, 8:24-33. Only one such plunger assembly is illustrated in the drawings (*e.g.* the annotated below) because the POSITA would understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in this case, given the triplex pump being the example), each member of which has the same structure. While not explicitly illustrated, it would have been obvious to the

person of ordinary skill in the art that the Kerr Pump has these features, as would be typical of any reciprocating power pump.

151. Accordingly, the skilled artisan would understand that the “second plug” of Kerr is “positioned adjacent the plate,” as illustrated in the annotated figure provided below. Specifically, the second plug (blue) is adjacent to the plate (green), and also abuts the plate.

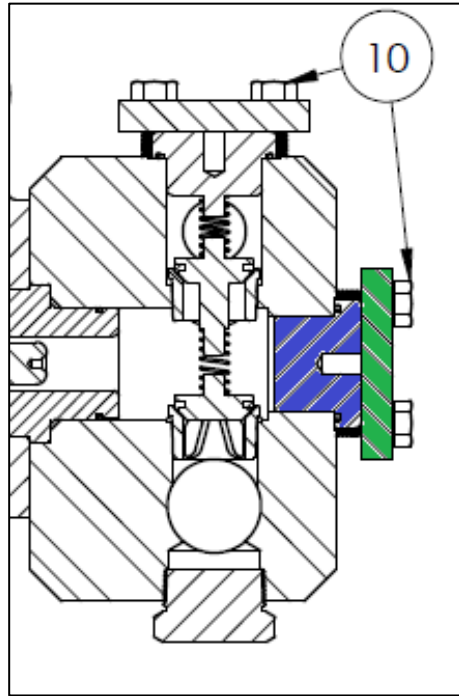


Kerr (EX1004), p. 26 (annotated).

- ix. **Claim 9 “in which the plate abuts the first plug; and in which the plate abuts the second plug.”**

152. Claim 9 recites “in which the plate abuts the first plug; and in which the plate abuts the second plug.” As explained above, and as illustrated in the figures

below, the “first plug” and the “second plug” of the Kerr Pump are arranged adjacent to and abut the “plate.”

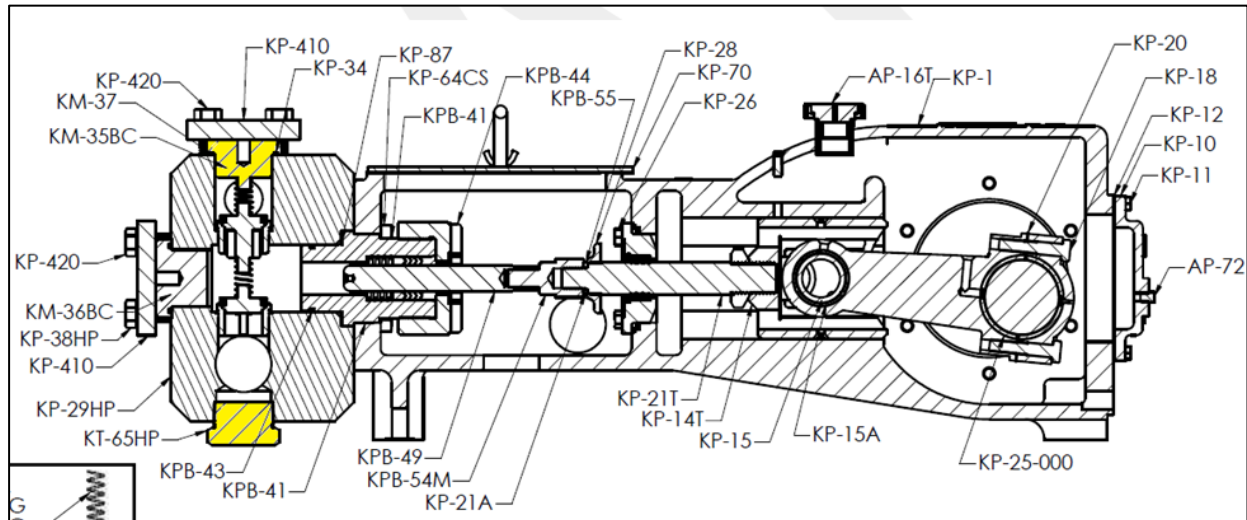


Kerr (EX1004), p. 26 (annotated).

- x. **Claim 10 “a third plug installed within the first vertical bore and positioned between an external surface of the housing and one of the first pair of valves.”**

153. Claim 10 recites “a third plug installed within the first vertical bore and positioned between an external surface of the housing and one of the first pair of valves.” This claim is broad enough to cover the top vertical bore plug or the bottom vertical bore plug of the Kerr Pump. Both of these are shown in the annotated figures below, from Kerr, and are a conventional part of a plunger pump fluid end. These

plugs provide a pressure retention seal, and in some fluid ends, retain the valves in the fluid end.



Drawing from the KP-3300 Service Manual, showing top and bottom bore plugs (highlighted in yellow).

xi. Claim 11

- a. 11.a “which the plate comprises a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a one-to-one relationship, the fluid end assembly”**

154. Recitation 11.a of claim 11 of Foster recites that “the plate comprises a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a one-to-one relationship.” While the fastener openings are not explicitly illustrated in Kerr, they would have been obvious to the skilled artisan at the time of filing.

155. The annotated figures below are taken from Kerr. The figures illustrate hex-headed capscrew fasteners that secure the cover plates to the fluid end housing

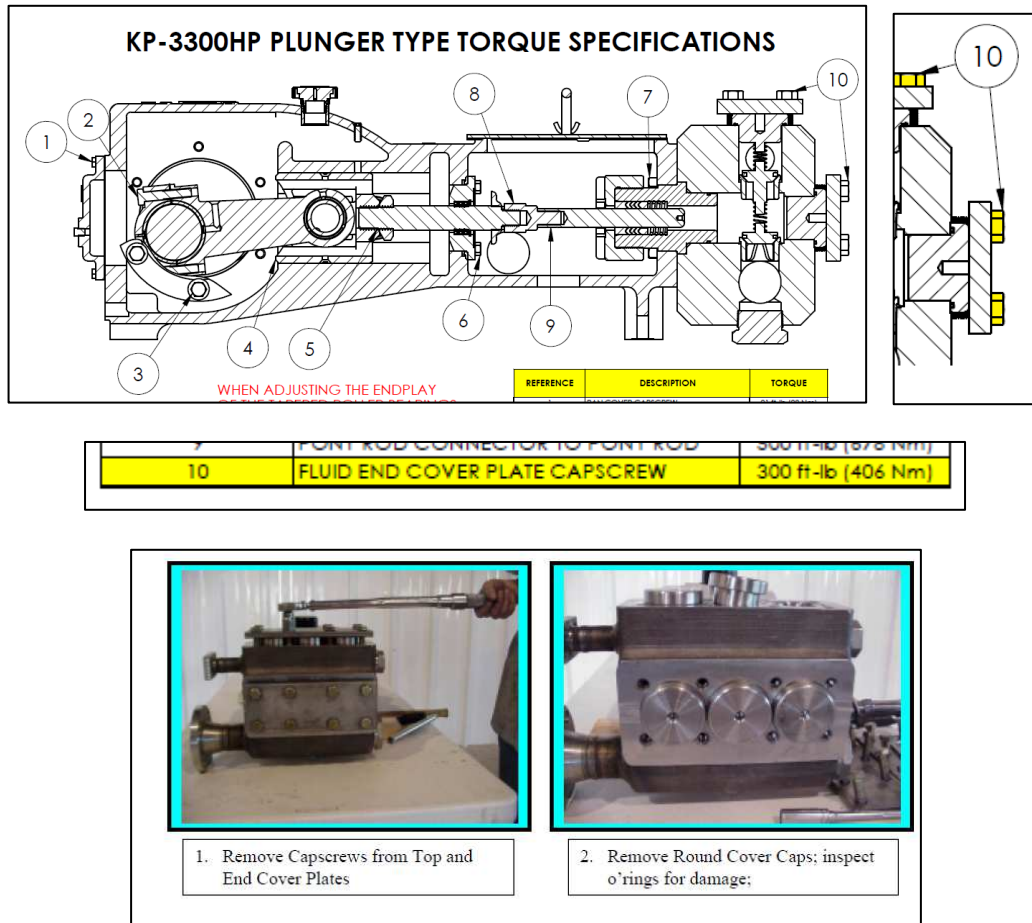
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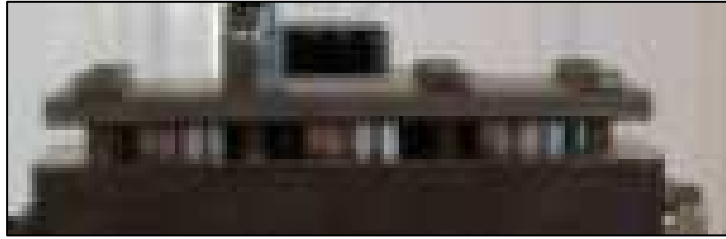
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and the openings in the fluid end with which the fasteners engage. The skilled artisan would understand that these hex-headed capscrew fasteners pass through fastener openings in the plate and engage with threaded openings formed in the housing in a one-to-one relationship to secure the plates to the fluid end housing. The threaded openings are not shown in sufficient detail to illustrate the actual threads. The presence of threads (in the fastener and its opposing hole or “opening”), however, would have been obvious to the skilled artisan given the fasteners are named “capscrew” fasteners and are illustrated with a hex head. The skilled artisan would understand that a screw, a type of threaded fastener, would need to engage with a threaded opening in order to secure the plate to the housing. Accordingly, it would have been obvious to the skilled artisan that the openings formed in the fluid end housing would be threaded.



Kerr, pp. 20, 25: Drawings from the KP-3300 Service Manual, showing multiple threaded connections.

156. In fact, illustrated in the detail from these figures below, the capscrew fasteners can be seen passing through fastener openings in the cover plate and into the fluid end housing, confirming alignment and one-to-one relationship between the fastener openings in the plate and threaded openings in the housing.

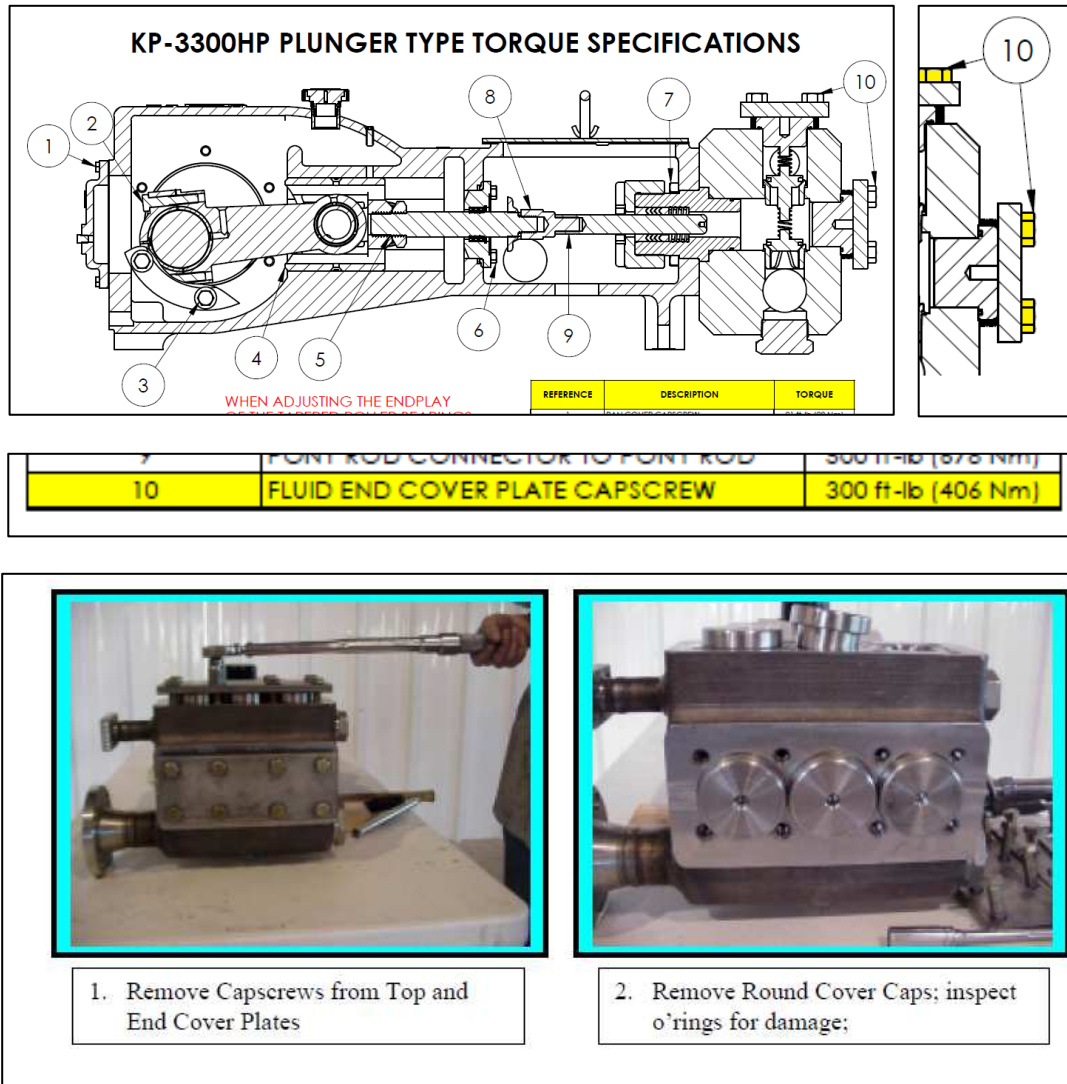


Kerr (EX1004), p. 20.

- b. **11.b “a plurality of fasteners, each of the plurality of fasteners installed within a corresponding one of the aligned fastener openings and threaded openings”**

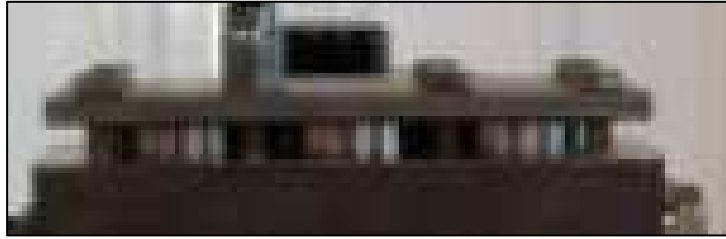
157. Recitation 11.b of claim 11 of Foster recites “a plurality of fasteners, each of the plurality of fasteners installed within a corresponding one of the aligned fastener openings and threaded openings.” Such fasteners are included in the Kerr Pump, the “capscrew” threaded fasteners discussed in section V.A.ii, *supra*.

158. The annotated figures below are taken from Kerr. Illustrated in the figures are a “capscrew” with a hex head. The skilled artisan would understand that such a fastener is a threaded fastener that would be installed within the aligned fastener openings in the plate and the threaded openings in the housing.



Kerr, pp. 20, 25: Drawings from the KP-3300 Service Manual, showing multiple threaded connections.

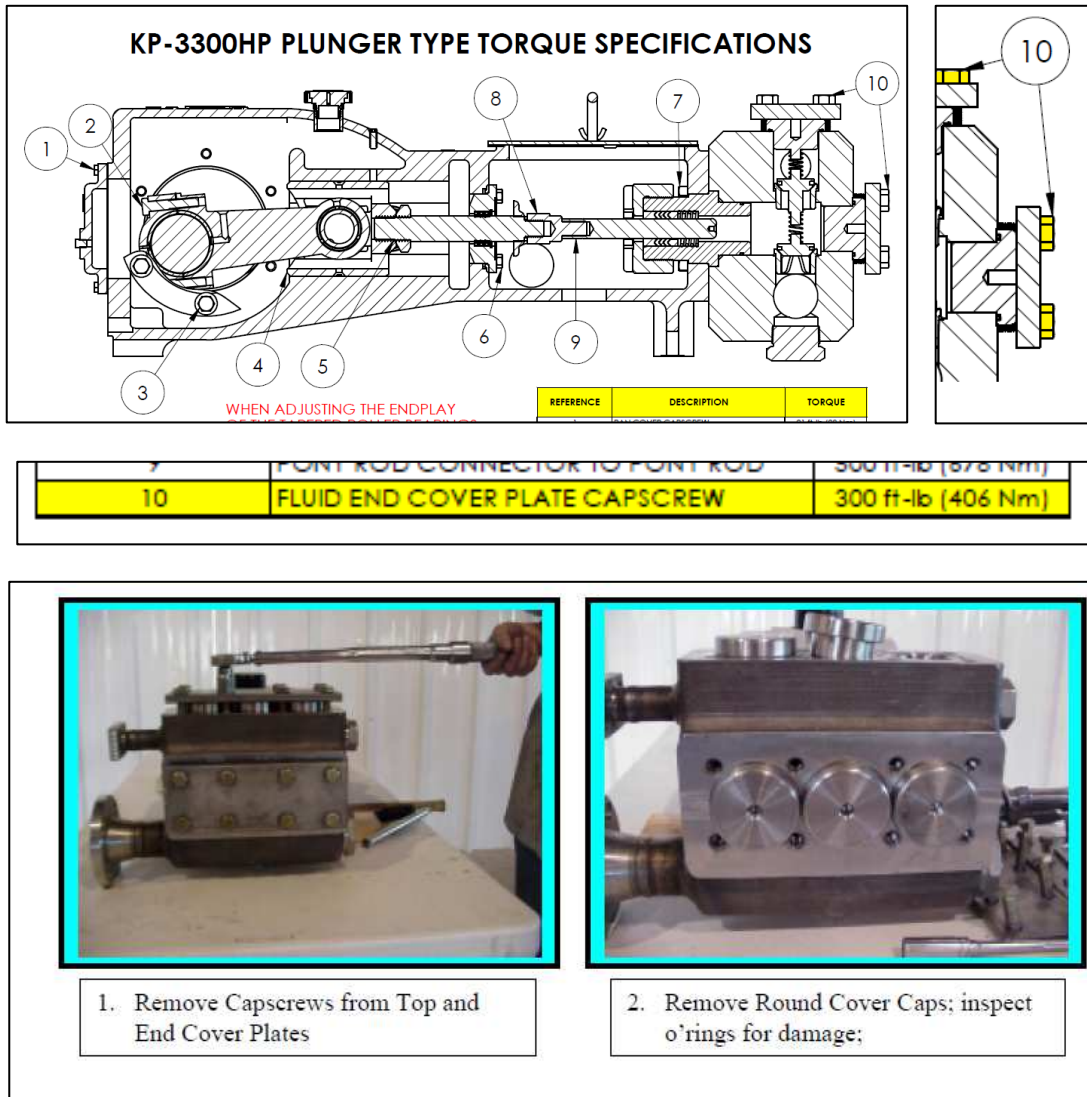
159. In fact, illustrated in the detail from these figures below, the capscrew fasteners can be seen passing through fastener openings in the cover plate and into the fluid end housing, confirming the fasteners are “installed within a corresponding one of the aligned fastener openings and threaded openings.”



Kerr (EX1004), p. 20.

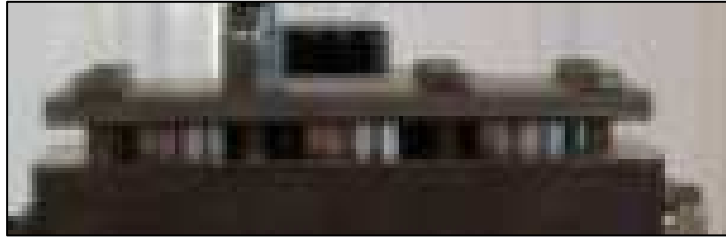
- xii. **Claim 12 “a plurality of fasteners, each of the plurality of fasteners extending through the plate and into the housing to fasten the plate to the housing.”**

160. Claim 12 of Foster recites “a plurality of fasteners, each of the plurality of fasteners extending through the plate and into the housing to fasten the plate to the housing.” The annotated figures below are taken from Kerr and illustrates hex-headed capscrew fasteners that secure the cover plates to the fluid end housing and the openings in the fluid end with which the fasteners engage. The skilled artisan would understand that these hex-headed capscrew fasteners pass through fastener openings in the plate and engage with threaded openings formed in the housing in a one-to-one relationship to fasten the plates to the fluid end housing.



Kerr, pp. 20, 25: Drawings from the KP-3300 Service Manual, showing multiple threaded connections.

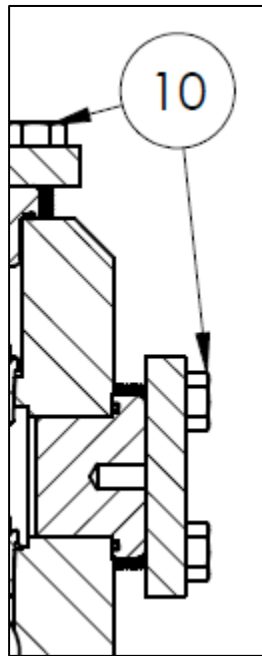
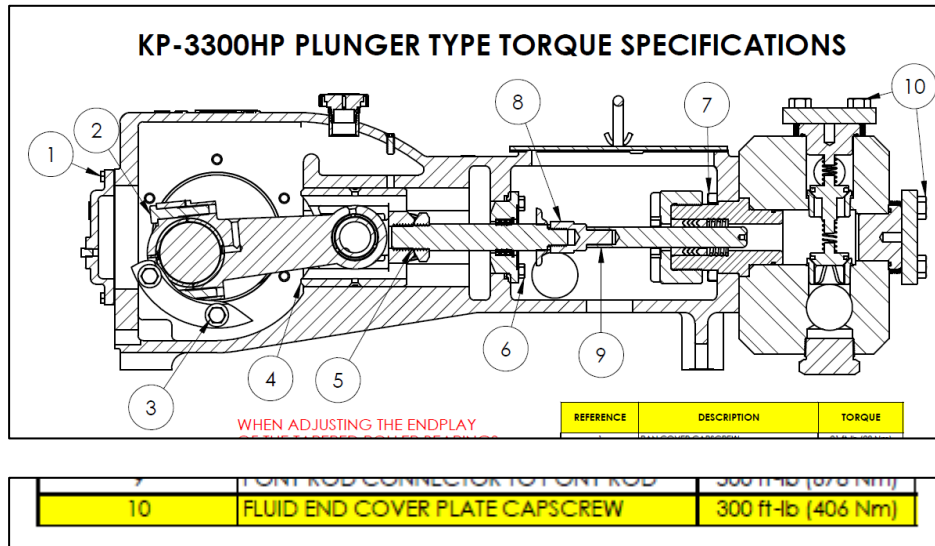
161. In fact, illustrated in the detail from these figures below, the capscrew fasteners can be seen passing through the cover plate and into the fluid end housing, confirming “each of the plurality of fasteners extend[s] through the plate and into the housing to fasten the plate to the housing.”



Kerr (EX1004), p. 20.

xiii. Claim 13 “each of the plurality of fasteners is a threaded fastener.”

162. Claim 13 of Foster recites that “each of the plurality of fasteners is a threaded fastener.” The annotated figures below are taken from Kerr and illustrates the capscrew fasteners of the Kerr Pump. The threaded fasteners are not shown in sufficient detail to clearly illustrate the actual threads, though they are suggested in the images below. The presence of threads (in the fastener and its opposing hole or “opening”), however, would have been obvious to the skilled artisan given they are named “capscrew” fasteners and are illustrated with a hex head. The skilled artisan would understand that a screw, a type of threaded fastener, would need to engage with a threaded opening in order to secure the plate to the housing. Accordingly, it would have been obvious to the skilled artisan that the capscrew fasteners used to fasten the cover plates to the fluid end housing would be threaded.



Kerr (EX1004), p. 25: Drawing from the KP-3300 Service Manual, showing multiple threaded connections.

163. Furthermore, the use of a ratchet or torque wrench to fasten and unfasten the cap screws, as illustrated below, would strongly suggest, if not confirm, to the skilled artisan that the cap screws are threaded.

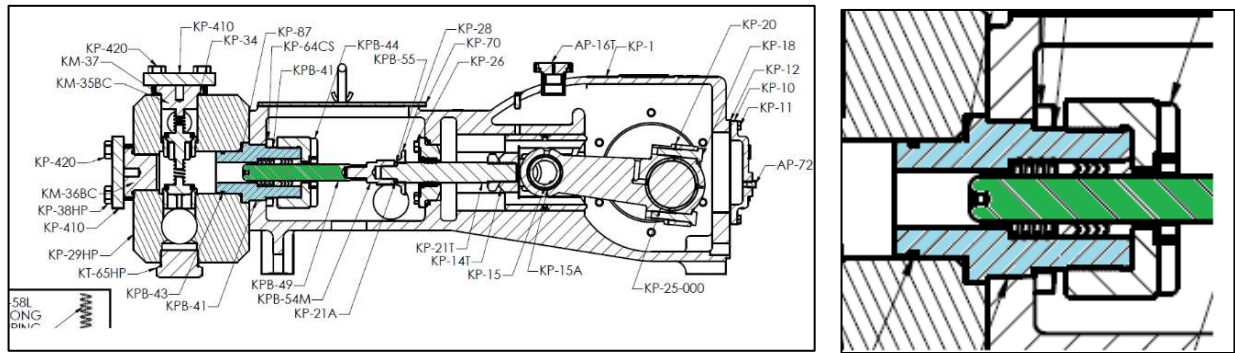


Kerr (EX1004), p. 20.

xiv. **Claim 14**

- a. **14.a “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore”**

164. Recitation 14.a of claim 14 recites “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore.” Where recitation 7.h of claim 7 recites the “first component” that is “installed within the first horizontal bore,” this recitation recites the corresponding “component” for a second horizontal bore of a multiplex pump. Accordingly, the Kerr Pump provides a second component for the same reasons as the first component of recitation 7.h. Specifically, note the green plunger partially within the blue sleeve, showing that such a configuration is not novel in Foster.

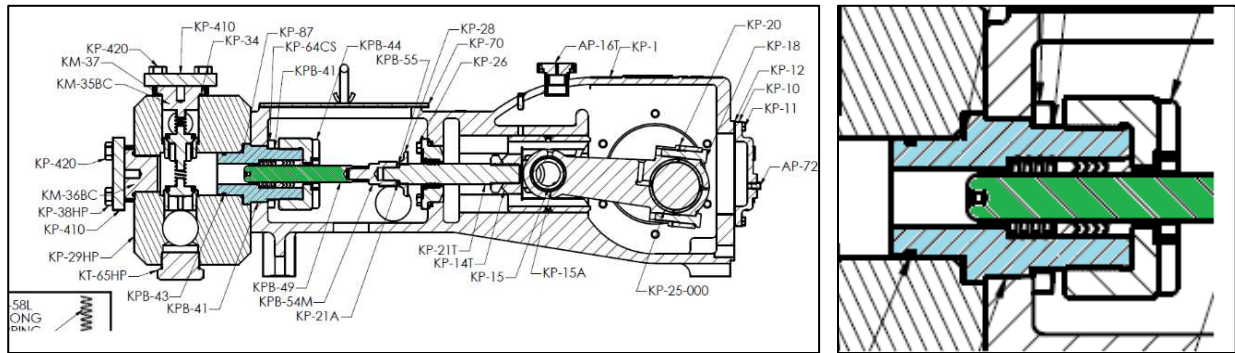


Kerr, page 27 (annotated): The pictures from the KP-3300 Service Manual show a packing sleeve associated with the teachings in the specification of Foster, but generically called a “component” by Foster.

- b. **14.b “a second reciprocating plunger, at least a portion of the second reciprocating plunger installed within the central opening of the second component;”**

165. Recitation 14.b of claim 14 recites “a second reciprocating plunger, at least a portion of the second reciprocating plunger installed within the central opening of the second component.” Where recitation 7.i of claim 7 recites the “first reciprocating plunger,” wherein “at least a portion of first reciprocating plunger installed within the central opening of the first component,” this recitation recites the corresponding “second reciprocating plunger” for a second plunger assembly of a multiplex pump. Accordingly, the Kerr Pump provides a second component for the same reasons as the first component of recitation 7.I.

166. The annotated figures below, from the KP-3300 Service Manual, exhibit a typical fluid end arrangement for a reciprocating power pump. Note the green plunger partially within the blue sleeve, showing that such a configuration is not novel in Foster.

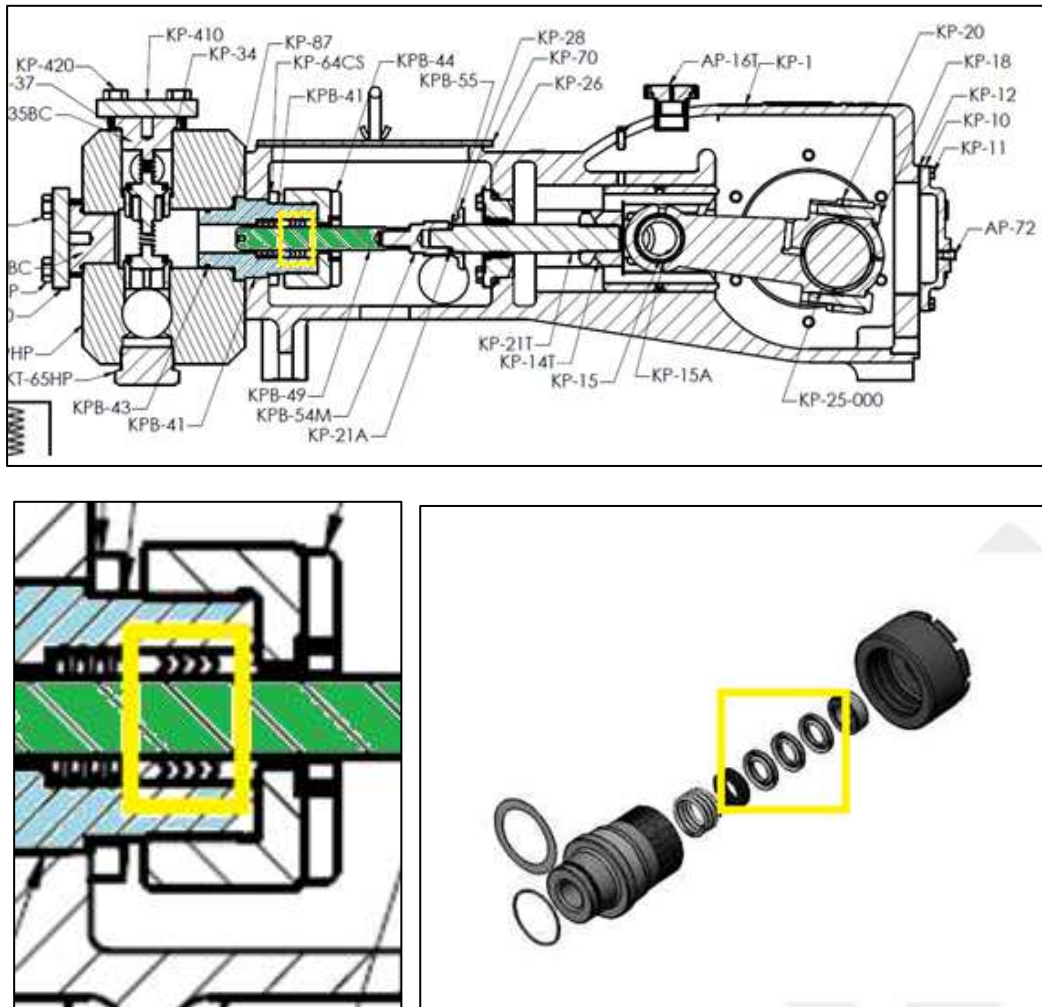


Kerr, page 27 (annotated): The pictures from the KP-3300 Service Manual show a packing sleeve associated with the teachings in the specification of Foster, but generically called a “component” by Foster.

c. 14.c “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger;”

167. Recitation 14.c of claim 14 recites “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger.” Where recitation 7,j of claim 7 recites the “first plurality of packing seals” for a first plunger assembly, this recitation recites the corresponding “plurality of packing seals” for a second plunger assembly of a multiplex pump. Accordingly, the Kerr Pump provides a second component for the same reasons as the first component of recitation 7.j.

168. This is a conventional feature of reciprocating plunger pumps and is included in the Kerr Pump. The annotated figures below illustrate “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger” in the Kerr Pump, annotated in yellow.



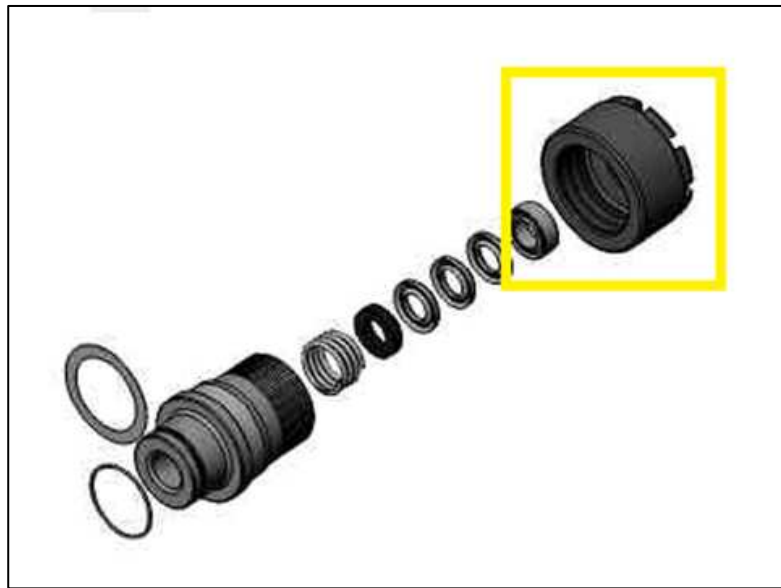
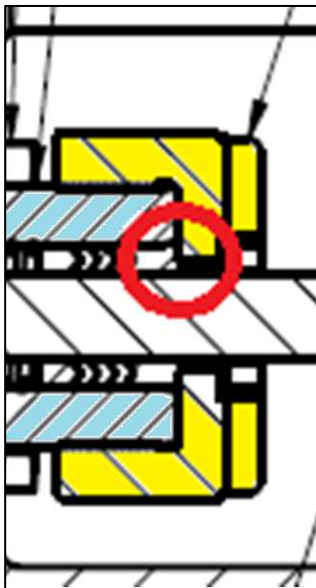
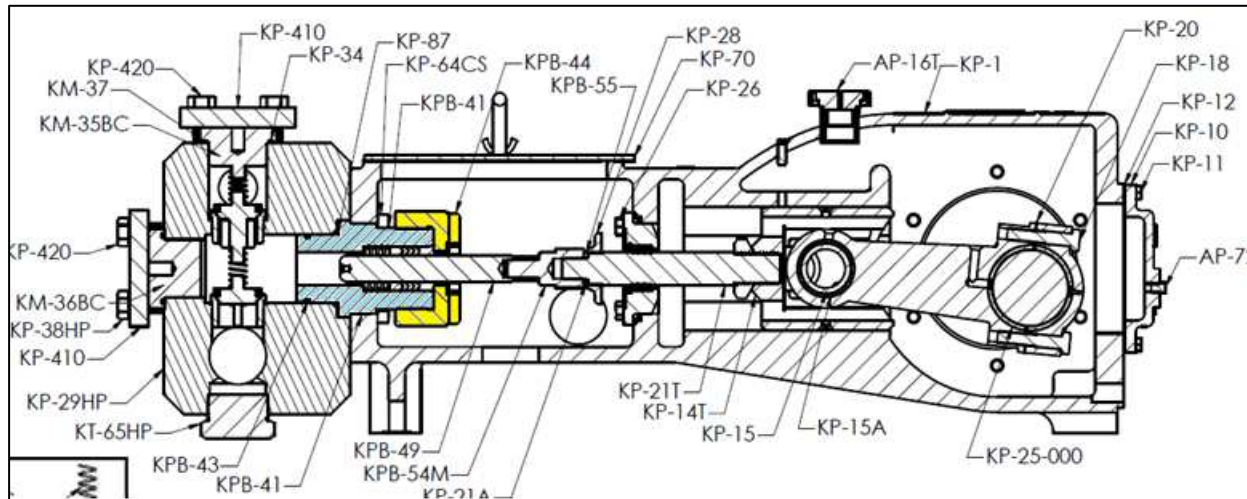
Kerr, page 27 (annotated): The pictures taken from the KP-3300 Service Manual show a packing assembly, including the packing seals, sometimes referred to as packing rings, that I have highlighted in yellow above. As illustrated in the drawings, the seals are arranged within the packing sleeve, where the sleeve corresponds to the first component. The purpose of the seals is to provide a fluid-tight barrier to isolate the pressure in the internal pressure from the external atmospheric pressure. Therefore, the seals engage intimately with the reciprocating plunger.

d. 14.d “a second packing nut holding the second plurality of packing seals within the second component”

169. Recitation 14.d of claim 4 recites “a second packing nut attached to the second component and holding the second plurality of packing seals within the

second component.” Where recitation 7K of claim 7 recites the “first packing nut” for a first plunger assembly, this recitation recites the corresponding “packing nut” for a second plunger assembly of a multiplex pump. Accordingly, the Kerr Pump provides a packing nut for the same reasons as the first component of recitation 7K.

170. In the figure below, the packing nut (annotated in yellow) is attached to the sleeve with threading. This mimics how any packing nut “hold[s] the second plurality of packing seals within the first component” (EX1001, claim 14) due to the compression of the packing. If there is no nut, then all the packing loses its fit and function, because the pressure ahead of the plunger would push the packing from the bore, and it could not seal around the plunger. This nut not only compresses the packing rings to squeeze out radial clearance around the plunger through which fluid could leak, but acts to hold the packing rings in the sleeve and as an additional fluid barrier at the rear of the packing box assembly, essentially acting as a detachable rear end of the packing sleeve, as circled in red in the figure below.



Kerr, page 27 (annotated): Packing nut shown along with packing assembly, both as disassembled component parts as well as an installed assembly.

xv. Conclusion With Respect to the First Ground

171. As illustrated through the discussion above, it is my opinion that every recitation of claims 1-14 of Foster would have been obvious at the time of filing.

B. Ground 2 – Claims 1-14 are Obvious under 35 U.S.C. § 103 over the Pentair Apex SC-65, and in Further View of Stanton.

i. Claim 1

172. As a second ground for rejection, it is my opinion that every element of claims 1-14 of Foster is taught or would have been rendered obvious by the Apex SC-65 Triplex Pump (“Apex Pump”) modified to use power end connection and stuffing box of Stanton. Set forth in the following sections is a detailed description of how the Apex Pump and Stanton applies to the elements of the Foster claims.

Recitations Disclosed in the Apex Pump

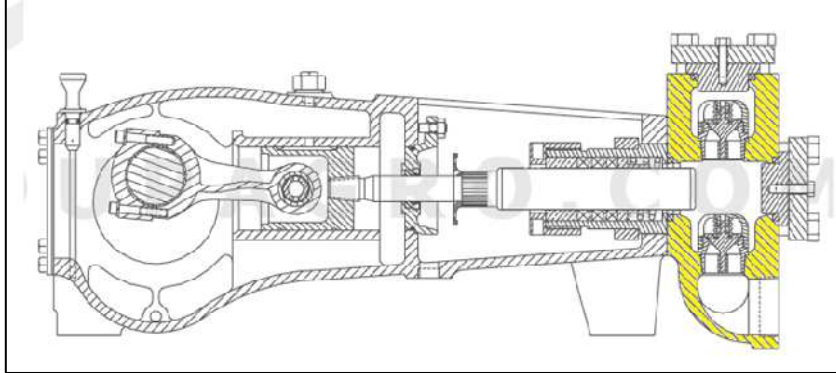
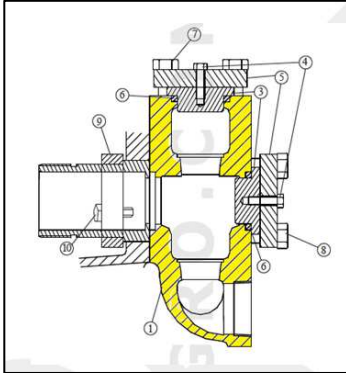
a. 1.P “A fluid end assembly”

173. The preamble of claim 1 of Foster recites that the claims are directed to a “fluid end assembly.” While I understand that the preamble of a claim does not always recite patentably relevant subject matter, in this case I need not address that issue as the Apex Pump clearly includes a “fluid end assembly.”

174. Reproduced below are drawings from Apex, which illustrate the “fluid end assembly of the pump.

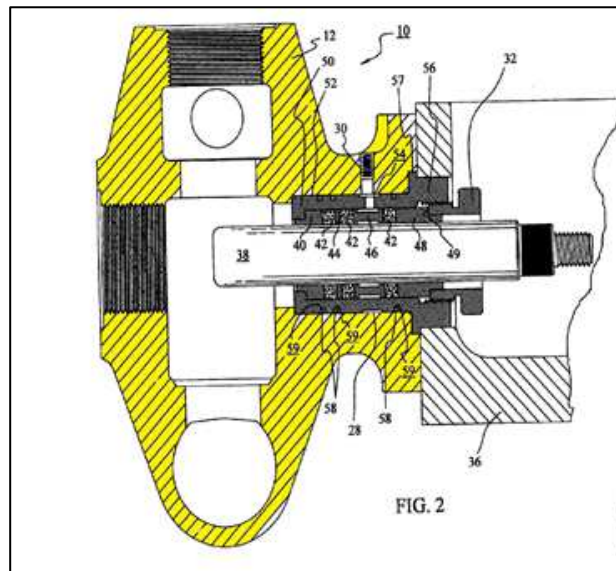
FLUID END ASSEMBLY
DUCTILE IRON

38



Aplex (EX1005), pp. 3, 7, 38 (annotated), illustrating the disclosure of the fluid end assembly.

175. For completeness, I also note that Stanton also includes a fluid end assembly.

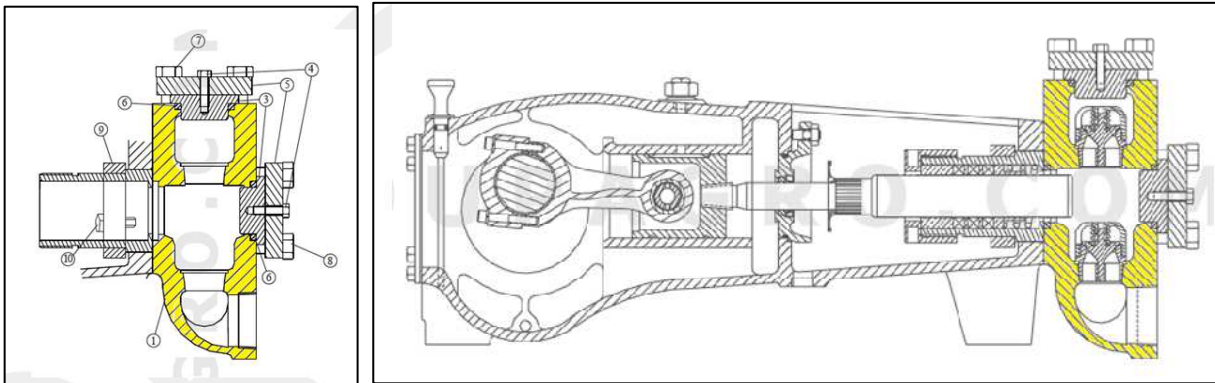


Stanton (EX1007), FIG. 2: Cross-section of fluid end from Stanton.

b. 1.a “a housing made of a single integrally formed piece”

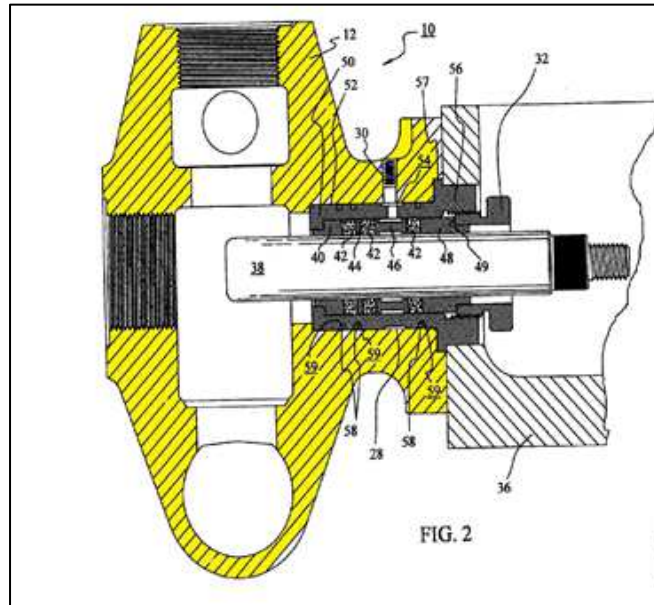
176. The recitation 1.a of claim 1 recites that the fluid end includes “a housing made of a single integrally formed piece.” This is conventionally how fluid end housings are formed – because of the high pressure developed and contained therein, in order to not split the fluid end housing, the housings are machined as an integral piece or “monoblock.” Such an integral monoblock housing is illustrated in Apex.

177. The figure below is from Apex. Note that the fluid end of the pump consists of a single piece, such that no breaks or seams are illustrated. This renders as obvious, and not novel, recitation 1.A of Foster: “A fluid end assembly, comprising a housing made of a single, integrally-formed piece.” As also illustrated below, Stanton also includes a monoblock fluid end.



Apex (EX1005), pp. 7, 38 (annotated): External views and cross-section of liquid end of the KP-3300, from its Service Manual, illustrating the Monoblock design, with no splits in the casing.

178. For completeness, I note that the fluid end of Stanton is also illustrated with a monoblock construction.



Stanton (EX1007), FIG. 2: External views and cross-section of liquid end of Stanton.

- c. **1.b “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber”**

179. Recitation 1.a of claim 1 of Foster recites “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber.” Such an internal chamber is a conventional part of a fluid end, as illustrated in the discussion of the prior art I provide above. Furthermore, the figure from Apex that I have reproduced below clearly illustrates that the Apex Pump includes such an internal chamber formed by the intersection of a first vertical bore formed in the housing and a first horizontal bore formed in the housing.

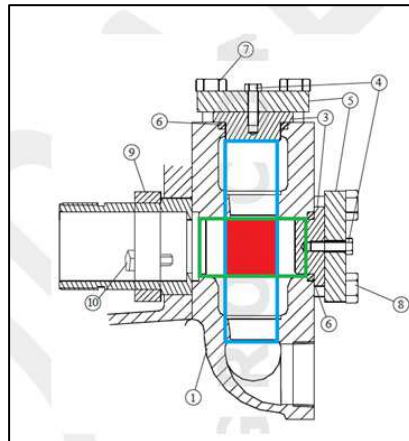
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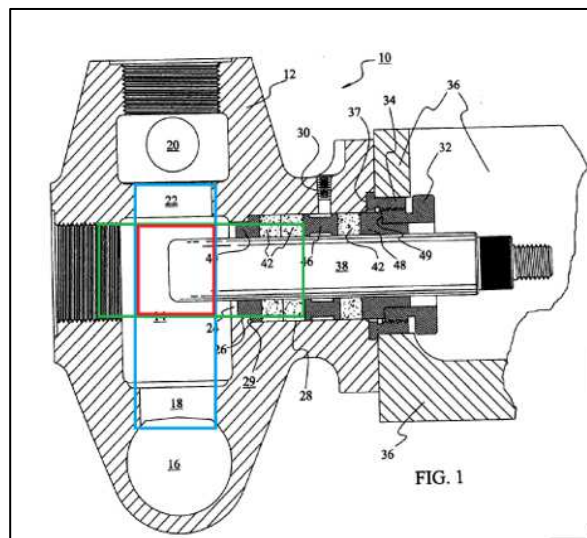
180. “First” as used here refers to the bores associated with one of the plunger assemblies of the triplex pump provided as an exemplar in Foster, shown in the figures below. The purpose of this internal chamber is to contain the plunger in the horizontal bore and the suction and discharge valves in the intersecting vertical bore. The resulting internal chamber provides a conduit for the suction fluid as the plunger moves backward, and a conduit for the discharge fluid as it is pressurized by the plunger and moves forward within the bore of the horizontal plunger bore and vertical discharge bore of the internal chamber. This is a conventional design for a reciprocating power pump. As such, the POSITA would understand that the Apex Pump includes “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber.” This is illustrated in the figure below:



Apex (EX1005), p. 38 (annotated): Cross-section from the Pentair Apex, demonstrating a very typical reciprocating power pump design. As shown in the above-side views in the lower 2/3 of the figure, power pumps typically are constructed with three, five, or seven cylinders

and associated plungers, stuffing box assemblies, and valve pairs. The plungers and their associated components are grouped, with each group side-by-side with adjacent groups.

181. For completeness, I note that the fluid end of Stanton also includes “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber,” as illustrated below.

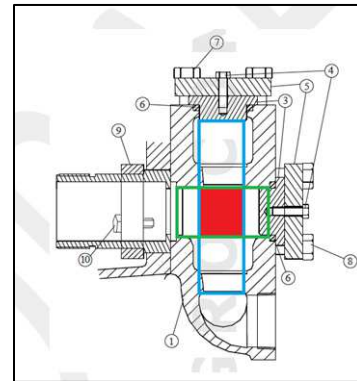
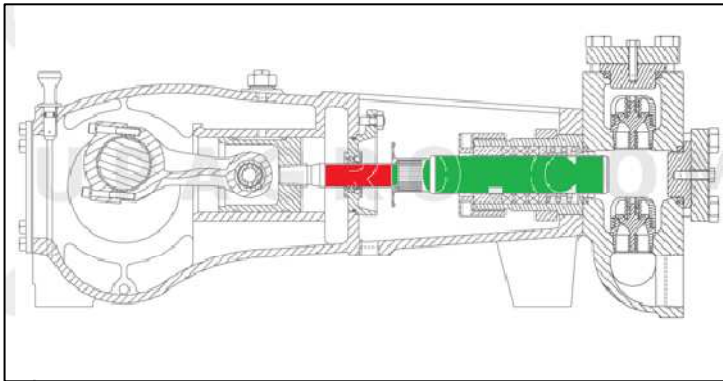
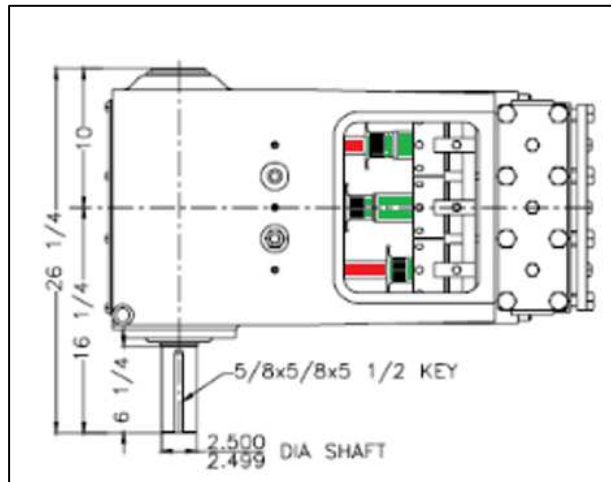


Stanton (EX1007), FIG.1: Cross-section from Stanton, demonstrating a very typical reciprocating power pump design.

- d. 1.c “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber”

182. Recitation 1.c of claim 1 of Foster recites “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber.” “Second” as used here refers to the bores associated with a second of the plungers

of the example triplex pump. *See, e.g.,* EX1001, 8:13-23 (“each set of paired bores...” (emphasis added)). Only one such plunger assembly is illustrated in the drawings (*e.g.* the figure above) because the POSITA would understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in this case, given the triplex pump being the example), each member of which has the same structure. While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the Apex Pump has these features, as would be typical of any reciprocating power pump. For example, as illustrated in the figures below from Apex, the Apex Pump includes three plunger assemblies. Specifically, the three connecting rods (annotated in red) of the power end connect to three plungers (annotated in green). The skilled artisan would understand that the internal structure of the fluid end for each of these three plunger assemblies would be the same, and each would include a horizontal bore, a vertical bore and an internal chamber.



Aplex (EX1005), pp. 7, 8, 38 (annotated): Showing intersecting of the vertical and horizontal bores.

- e. **1.d “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber”**

183. Recitation 1.d of claim 1 of Foster recites that the “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.” The skilled artisan would understand that this feature of claim 1 is present in the Aplex Pump as the Aplex Pump is a triplex pump.

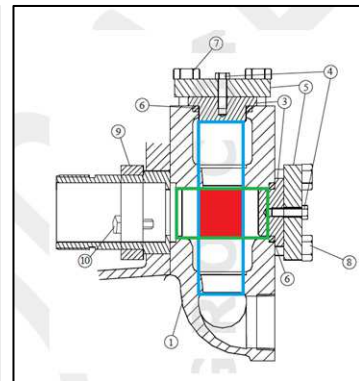
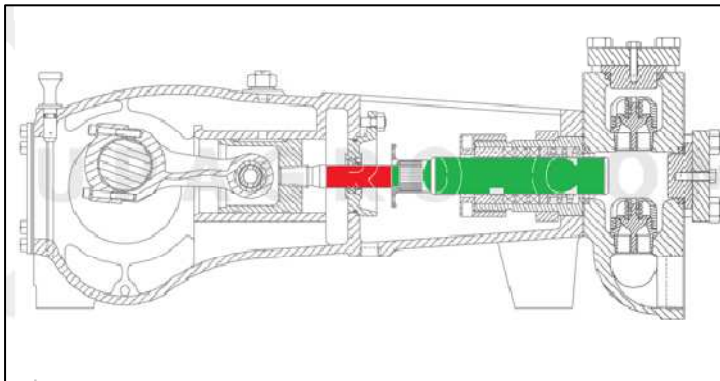
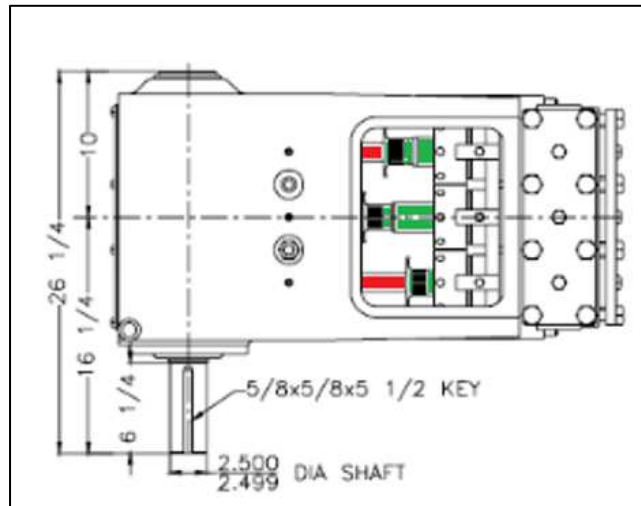
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Furthermore, the drawing in the figure below shows side-by-side arrangement of plunger assemblies. It would have been obvious to the person of ordinary skill in the art that the Apex Pump has its plunger arrangements in side-by-side relationship, which is typical of reciprocating power pump design, and has been for many decades. While the three vertical bores, three horizontal bores and the three internal chambers of the fluid end are not explicitly illustrated in Apex, the three plunger assemblies are illustrated. In the annotated figures from Apex, the three connecting rods (annotated in red) of the power end connect to three plungers (annotated in green). Each of the three plungers is configured to reciprocate within the horizontal bore, pumping fluid in through the intake or suction valve of the vertical bore to the internal chamber, and out the discharge valve of the vertical bore. Accordingly, the Apex Pump includes “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber” as recited in claim 1.

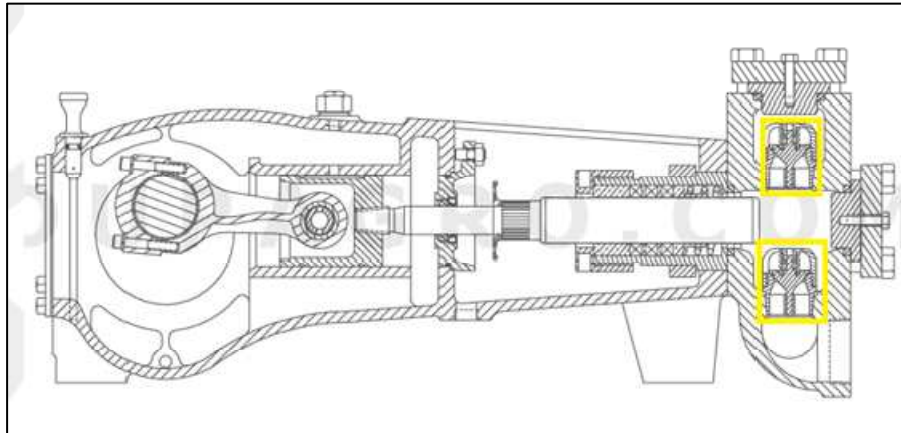


Aplex (EX1005), pp. 7, 8, 38 (annotated): Cross-section from Pentair Aplex demonstrating a very typical reciprocating power pump design. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers and plunger bores, stuffing box assemblies, and valve pairs, in a side-by-side arrangement.

- f. 1.e “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber”

184. Recitation 1.e of claim 1 recites “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber.” As illustrated below, the Aplex Pump includes a pair of valves (a

suction valve and a discharge valve) arranged in the vertical bore and positioned on opposites side of the internal chamber, as illustrated in the annotated figures below.

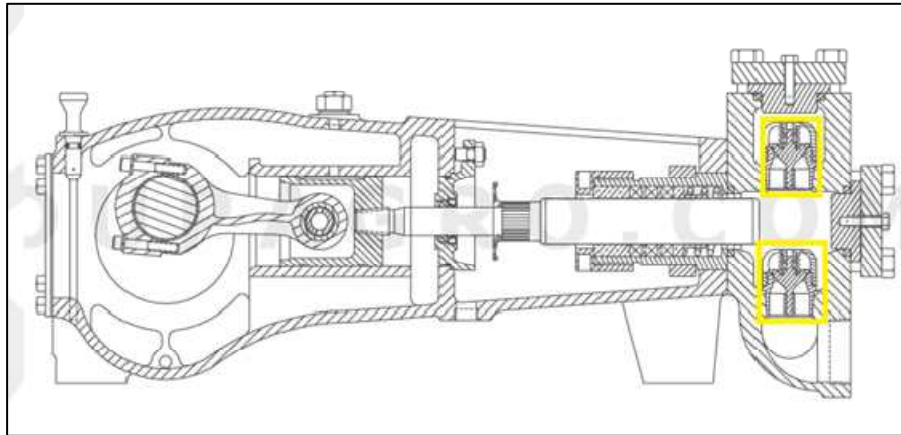


Aplex (EX1005), p. 7 (annotated): Cross-section from the SC-65 Service Manual (left) demonstrating a very typical reciprocating power pump design, including valve details. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs.

- g. **1.f “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber”**

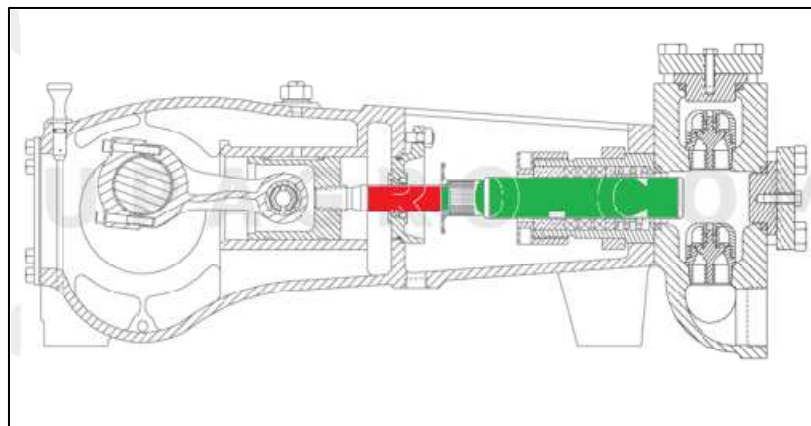
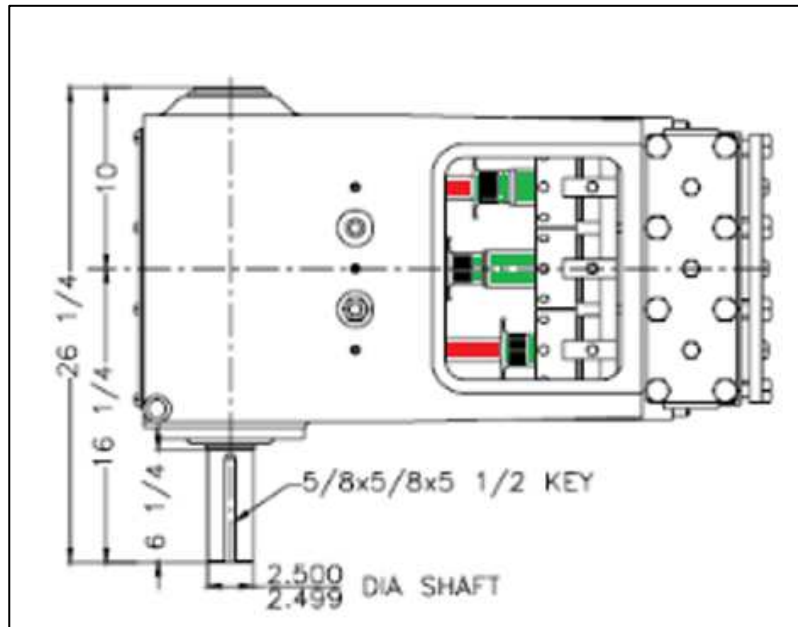
185. Recitation 1.f of the claim 1 recites “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber.”

186. The POSITA would understand that each of the triplex plunger arrangements of the Aplex Pump would include the valves (suction and discharge) placed as illustrated in the figure below.



Aplex (EX1005), p. 7 (annotated): Cross-section from SC-65 Service Manual (left) demonstrating a very typical reciprocating power pump design, including valve details. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs.

187. While a second set of valves in the fluid end is not explicitly illustrated in Aplex, the three plunger assemblies are illustrated. In the annotated figures from Aplex, the three connecting rods (annotated in red) of the power end connect to three plungers (annotated in green). Each of the three plungers is configured to reciprocate within the horizontal bore, pumping fluid in through the intake or suction valve of the vertical bore to the internal chamber, and out the discharge valve of the vertical bore. Accordingly, the Aplex Pump includes “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber” as recited in claim 1.



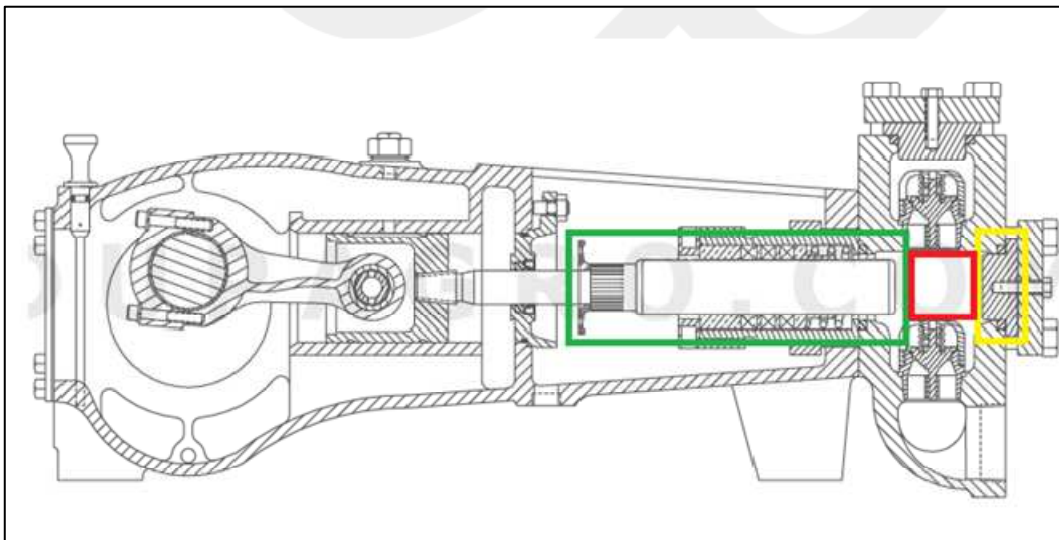
Aplex (EX1005), pp. 7, 8 (annotated): Cross-section from Pentair Aplex demonstrating a very typical reciprocating power pump design. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers and plunger bores, stuffing box assemblies, and valve pairs, in a side-by-side arrangement.

- h. 1.g “a first plug and a first reciprocating plunger installed within the first horizontal bore and positioned on opposite sides of the first internal chamber”

188. Recitation 1.g of claim 1 of Foster recites “a first plug and a first reciprocating plunger installed within the first horizontal bore and positioned on

opposite sides of the first internal chamber.” As discussed in section IV.E.ii, *supra*, and as illustrated in the figures below, Apex includes such an arrangement.

189. The annotated figures below, from Apex, exhibits a typical liquid end arrangement for a reciprocating power pump. In order to maintain a monoblock (single piece, non-segmented casing) concept, the horizontal bore, within which the plunger moves and pressurizes the fluid during operation, is closed by a plug rather than being retained as a closed end during the fabrication process. This approach allows free access of the boring tool when it is machining the horizontal bore. As also illustrated in this figure, the plunger (green) is positioned on the opposite side of the internal chamber (red) from the plug (yellow).



Apex (EX1005), p. 7 (annotated): Cross-section from SC-65 Service Manual (left) demonstrating a very typical reciprocating power pump design, including valve details. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs. The horizontal bore opposite the plunger end is left open for access by the bore machining tool, and is subsequently closed by a plug with some means of firm attachment to the casing.

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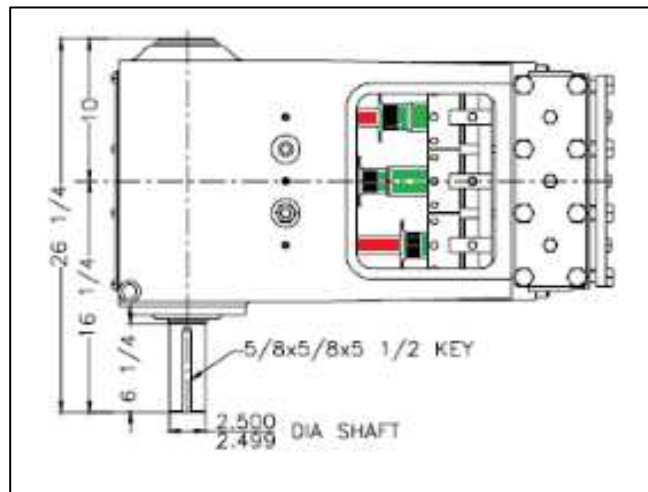
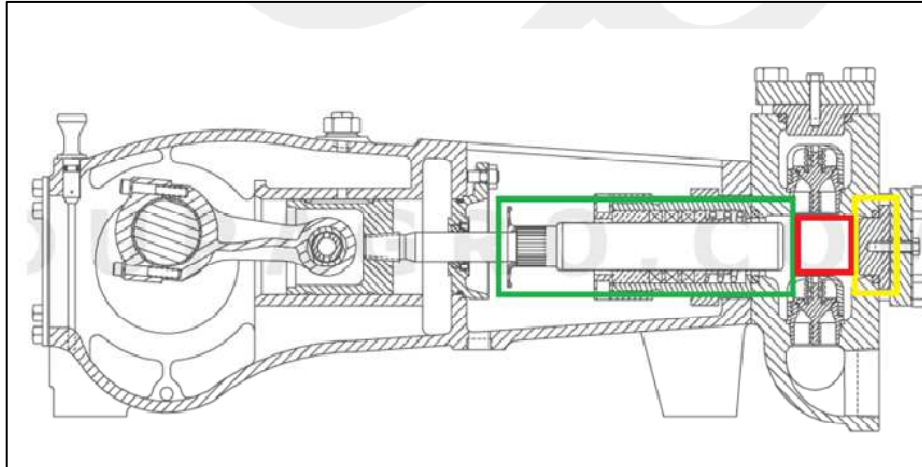
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i. 1.h “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber”

190. Recitation 1.h of claim 1 of Foster recites “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber.” As discussed in section IV.E.ii, *supra*, and as illustrated in the annotated figures below, the Apex Pump includes such an arrangement.

191. The annotated figures below, from Apex, exhibits a typical liquid end arrangement for a reciprocating power pump. In order to maintain a monoblock (single piece, non-segmented casing) concept, the horizontal bore, within which the plunger moves and pressurizes the fluid during operation, is closed by a plug rather than being retained as a closed end during the fabrication process. This approach allows free access of the boring tool when it is machining the horizontal bore. As also illustrated in this figure, the plunger (green) is positioned on the opposite side of the internal chamber (red) from the plug (yellow). While the three plugs are not explicitly illustrated in Apex, the three plunger assemblies are illustrated. In the annotated figures from Apex, the three connecting rods (annotated in red) of the power end connect to three plungers (annotated in green). Each of the three plungers is configured to reciprocate within the horizontal bore opposite a plug. Accordingly, the Apex Pump includes “a second plug and a second reciprocating plunger installed

within the second horizontal bore and positioned on opposite sides of the second internal chamber” as recited in claim 1.

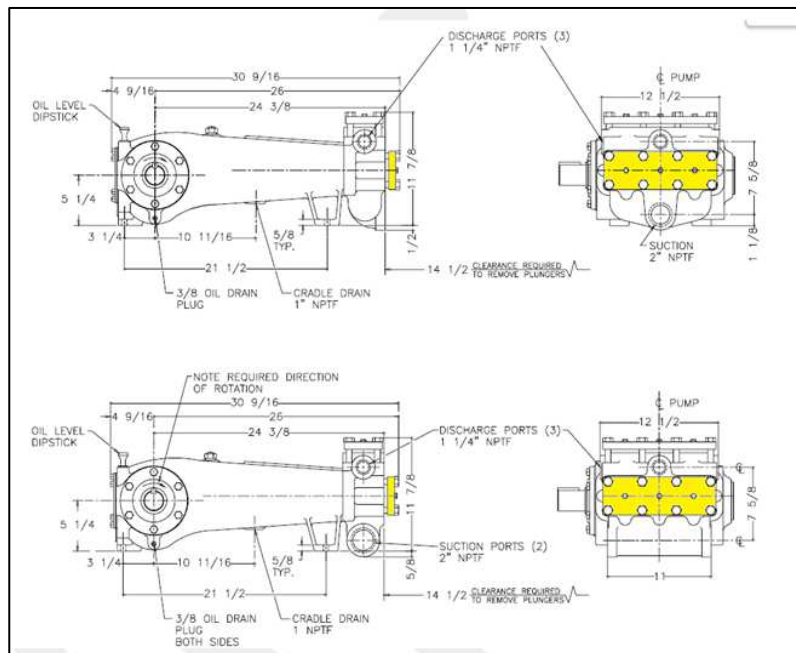
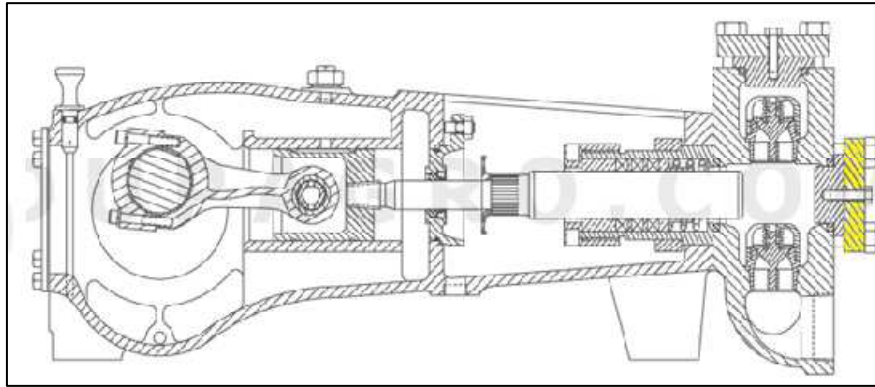


Aplex (EX1005), pp. 7, 8 (annotated): Cross-section from SC-65 Service Manual (left) demonstrating a very typical reciprocating power pump design, including valve details. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs. The same configuration and characteristics would be anticipated for the second plunger and bore as for the first plunger and bore.

j. 1.i “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores”

192. Recitation 1.i of claim 1 of Foster recites “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores.” As illustrated in the annotated figures below, the Kerr Pump includes such a plate.

193. As shown in the figure below, the pictures from Apex indicate using such a bolted-on plate to firmly secure the bore plugs against the casing. Accordingly, the Apex Pump includes “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores.”



Aplex (EX1005), pp. 7, 8 (annotated).

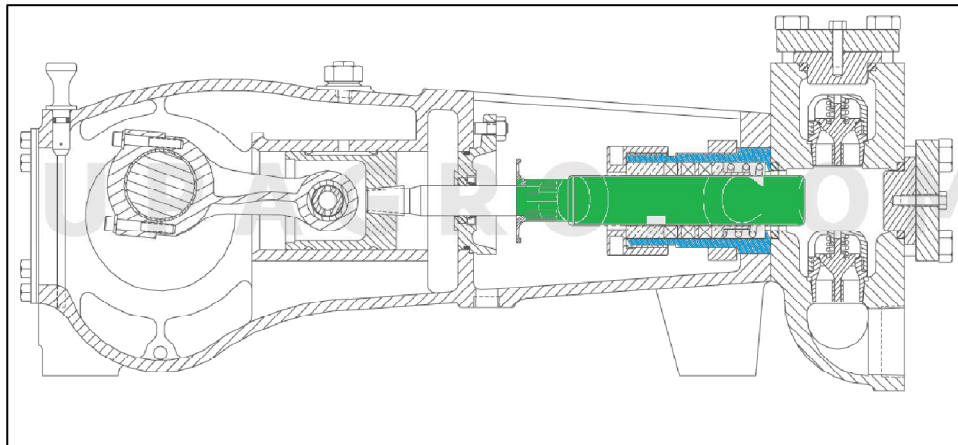
Recitations Disclosed in Stanton

- k. 1.j “a first component having a central opening formed therein, at least a portion of the first component installed within the first horizontal bore and at least a portion of the first reciprocating plunger installed within the central opening of the first component”

194. Recitation 1.j of claim 1 of Foster recites “a first component having a central opening formed therein, at least a portion of the first component installed

within the first horizontal bore and at least a portion of the first reciprocating plunger installed within the central opening of the first component.” Such a component is included in the fluid end of Stanton.

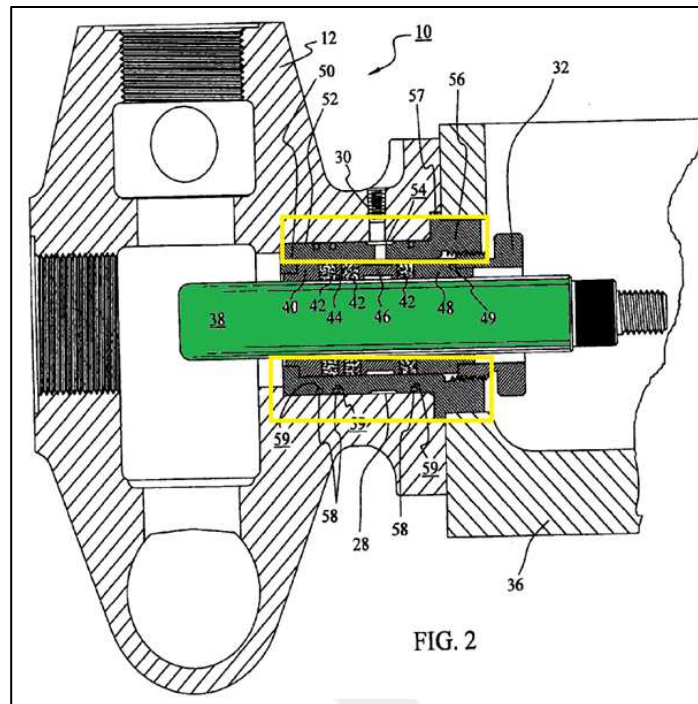
195. This claim recitations uses the broad term “component” that could correspond to almost any packing other than the later recited seals. I am therefore relying on a packing sleeve due to the teachings in the Foster specification. *See, e.g.,* EX1001, 4:12-16, 6:63-67, 9:14-20, 10:66-11:7. Apex includes a stuffing box (blue) including a central opening with a portion of a reciprocating plunger (green) installed within the box, as illustrated in the annotated figures below.



Apex (EX1005), p. 7 (annotated).

196. The Apex stuffing box, however, does not include “at least a portion ... installed within the first horizontal bore.” The packing assembly of Stanton, on the other hand, does include such a component in the form of a packing sleeve. As illustrated below, the Stanton packing sleeve (annotated in yellow) includes a portion

that is installed in the horizontal bore and in which the plunger (annotated in green) is partially installed within the packing sleeve. In Stanton the packing is arranged within a stuffing box 50 that acts as a packing sleeve. A gland nut 32 secures the packing within the horizontal bore as illustrated in FIG. 2. The packing assembly of Stanton illustrates the stuffing box (annotated in yellow) with a portion that is in the horizontal bore and the plunger (annotated in green) partially within the stuffing box.



Stanton (EX1007), FIG. 2 (annotated): Cross-section from Stanton demonstrating a very typical reciprocating power pump design, including stuffing box details. The pictures show a packing sleeve associated with the teachings in the specification of Foster, but generically called a “component” by Foster.

197. In fact, the stuffing box of Stanton includes the *unclaimed* features of packing sleeve described in Foster – a first portion with a larger diameter than a second portion in which part of the packing nut is arranged, as illustrated in the detail

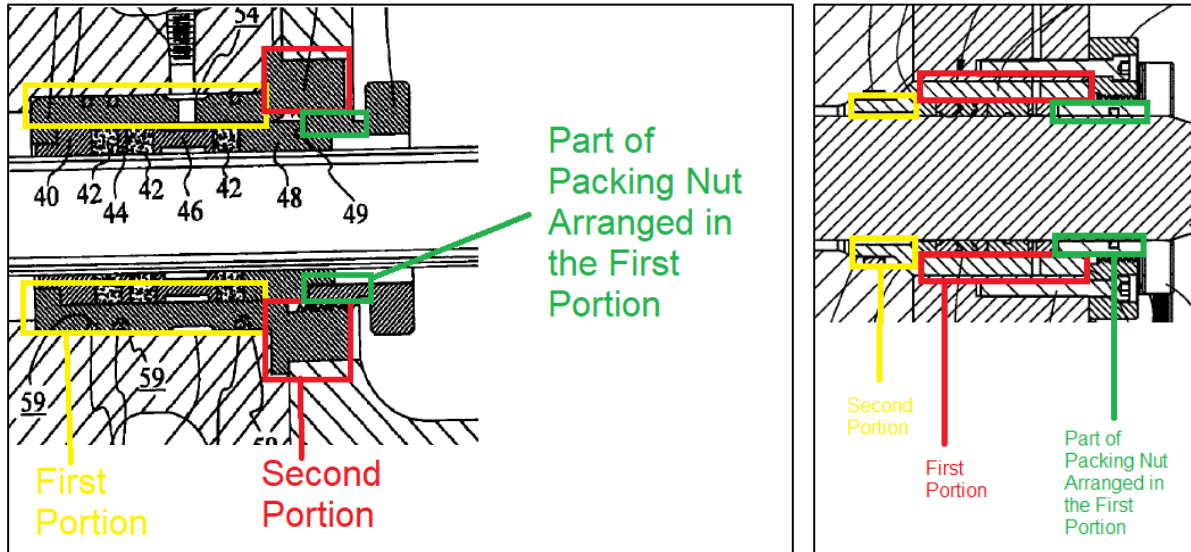
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of FIG. 2 from Stanton provided below and compared with a detail of FIG. 6 of Foster.

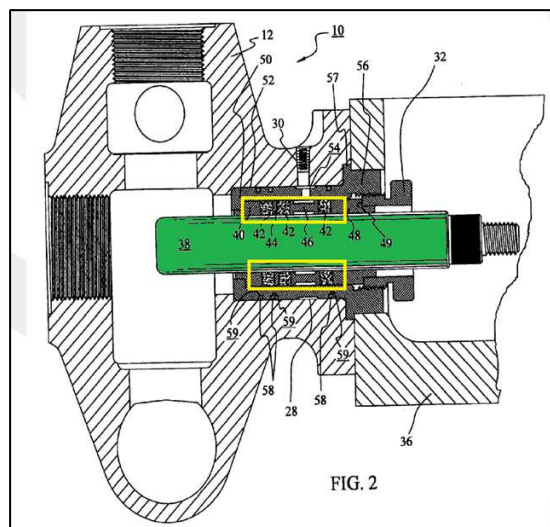


Comparison of the Packing Sleeve of Stanton with the Component of Foster.

198. It would have been obvious to the skilled artisan to replace the packing assembly of the Apex Pump with the stuffing box 50 of Stanton as it is replacing one known method of providing packing to a plunger pump with another with predictable results. Furthermore, the skilled artisan would have been motivated to make such a modification because the skilled artisan would understand that providing the packing/stuffing arrangement at least partially within the fluid end housing, as is illustrated in Stanton, may provide improved pressure/fluid isolation compared with the packing bolted to the outside of the fluid end as constructed in Apex, by avoiding an additional flange, which itself could leak.

l. 1.k “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger”

199. Recitation 1.k of claim 1 of Foster recites “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger.” This is a conventional feature of reciprocating plunger pumps that is included in the Apex Pump and Stanton. Because this ground of rejection is relying on the packing sleeve from Stanton, it also relies on the seals from Stanton. The annotated figures below illustrate “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger” in the Stanton fluid end, annotated in yellow. Accordingly, Stanton includes “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger.”

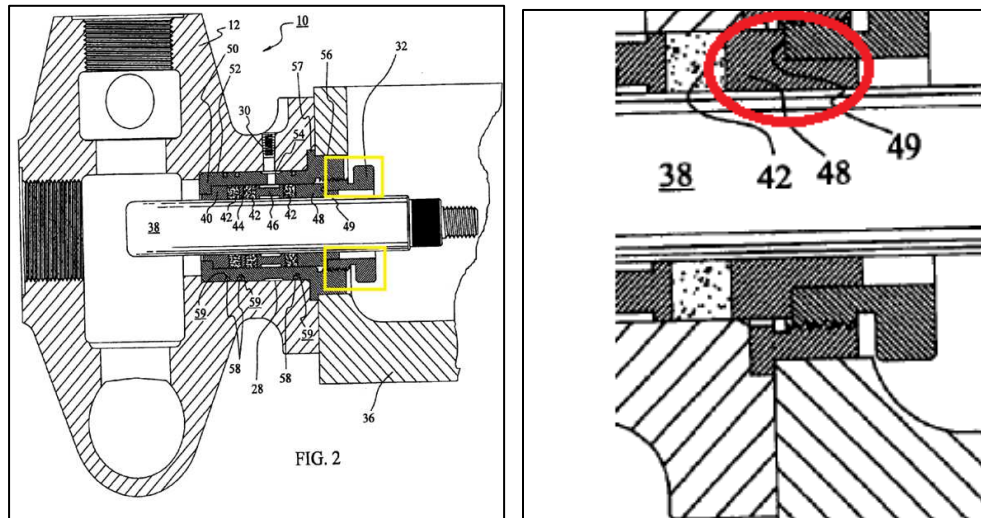


Stanton (EX1007), FIG. 2 (annotated).

m. 1.1 “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.”

200. Recitation 1.1 of claim 1 of Foster recites “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.” Such a packing nut is included in Stanton.

201. The annotated figures below, the packing nut (annotated in yellow) is attached to the sleeve with threading. This mimics how any packing nut “hold[s] the first plurality of packing seals within the first component” (EX1001, claims1) due to the compression of the packing. If there is no nut, then all the packing loses its fit and function, because the pressure ahead of the plunger would push the packing from the bore, and it could not seal around the plunger. This nut not only compresses the packing rings to squeeze out radial clearance around the plunger through which fluid could leak, but acts to hold the packing rings in the sleeve and as an additional fluid barrier at the rear of the packing box assembly, essentially acting as a detachable rear end of the packing sleeve, as circled in red in the figure below. Accordingly, Stanton includes “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.”



Stanton (EX1007), FIG. 2 (annotated): Illustrating packing nut shown along with packing assembly, both as disassembled component parts as well as an installed assembly.

ii. **Claim 2**

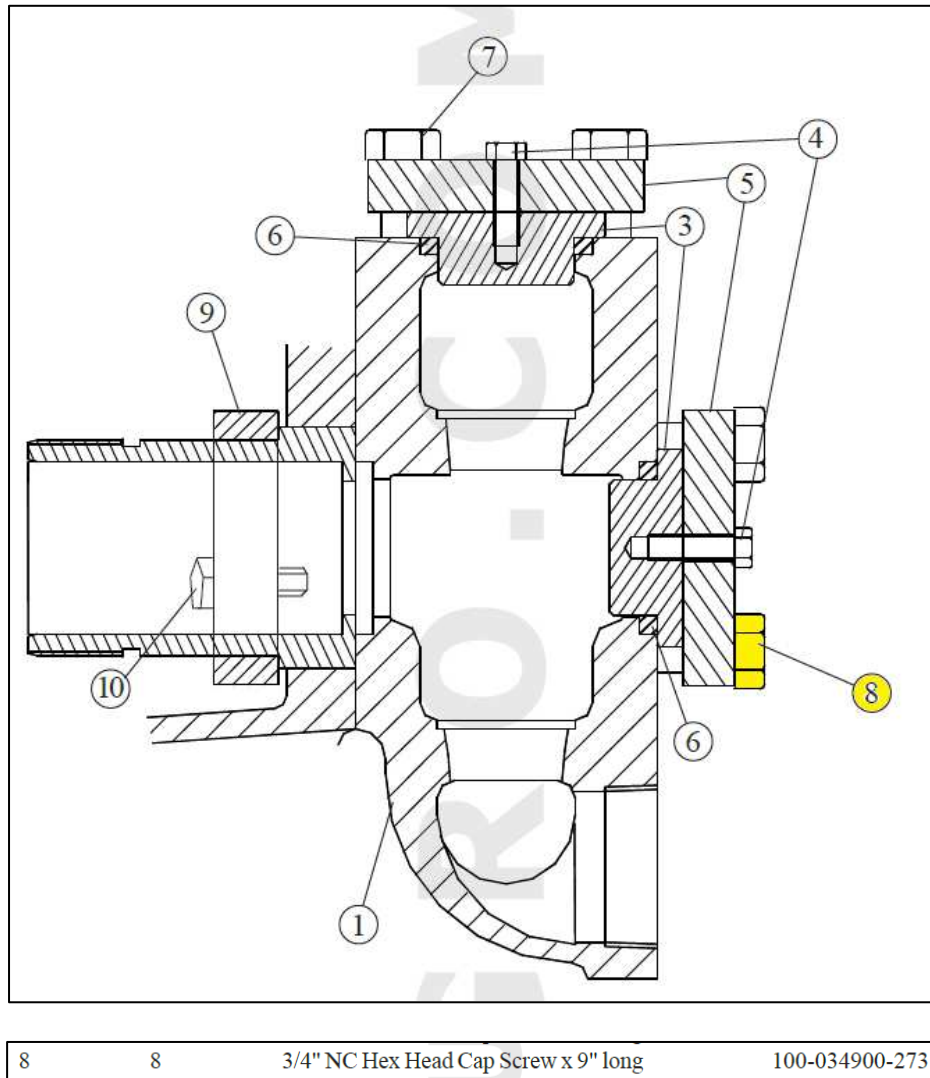
- a. **2.a “the plate comprises a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a one-to-one relationship”**

202. Recitation 2.a of claim 2 of Foster recites “a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a one-to-one relationship.” While these openings are not explicitly illustrated in Apex, they would have been obvious to the skilled artisan at the time of filing.

203. The annotated figures below are taken from Apex. The figures illustrate hex-headed fasteners that secure the cover plates to the fluid end housing. Apex also describes the fasteners as “cap screws.” The skilled artisan would understand that these hex-headed cap screw fasteners are threaded fasteners that pass through fastener openings in the plate and engage with threaded openings formed in

the housing in a one-to-one relationship to secure the plates to the fluid end housing. The threaded openings are not shown in sufficient detail to illustrate the actual threads. The presence of threads (in the fastener and its opposing hole or “opening”), however, would have been obvious to the skilled artisan given the fasteners are illustrated with a hex head and are described as being “cap screw” fasteners. The skilled artisan would understand that the hex head indicates that the fasteners are intended to be installed or removed with a ratchet or wrench. The description of the fasteners as being “cap screw” fasteners would indicate to the skilled artisan that the fasteners are threaded.

204. The skilled artisan would understand that a threaded fastener engaged in a one-to-one relationship with the threaded openings in the housing via fastener openings in the plate that align with the threaded openings in the housing. Accordingly, it would have been obvious to the skilled artisan that the features of recitation 2.a are present in the Apex Pump.



Aplex (EX1005), p. 38 (annotated).

- b. 2.b “a plurality of fasteners, each of the plurality of fasteners installed within a corresponding one of the aligned fastener openings and threaded openings”**

205. Recitation 2.b of claim 2 of Foster recites “a plurality of fasteners, each of the plurality of fasteners installed within a corresponding one of the aligned fastener openings and threaded openings.” Such fasteners are included in the Aplex Pump, the threaded fasteners discussed in section V.B.ii.a, *supra*.

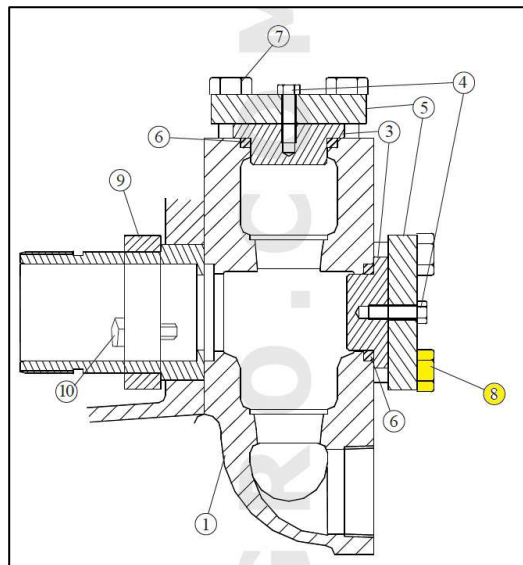
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206. The annotated figures below are taken from Apex. Illustrated in the figures are hex head fasteners. As explained in the preceding section, the skilled artisan would understand that such a fastener is a threaded fastener that would install within the aligned fastener openings in the plate and the threaded openings in the housing.

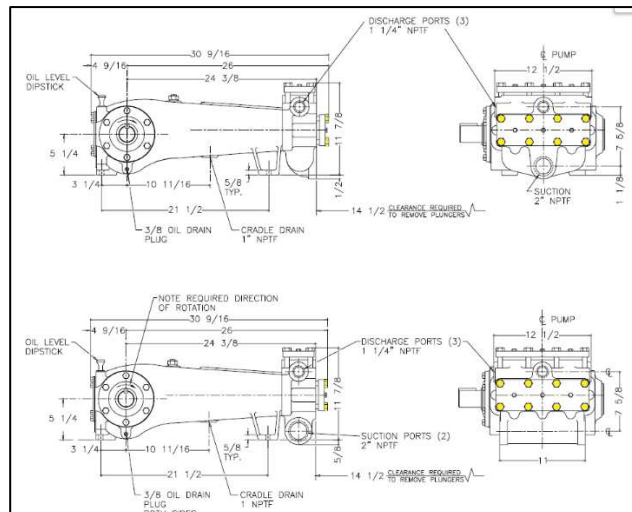


8

8

3/4" NC Hex Head Cap Screw x 9" long

100-034900-273



Apex (EX1005), pp. 8, 38 (annotated): Showing multiple threaded connections.

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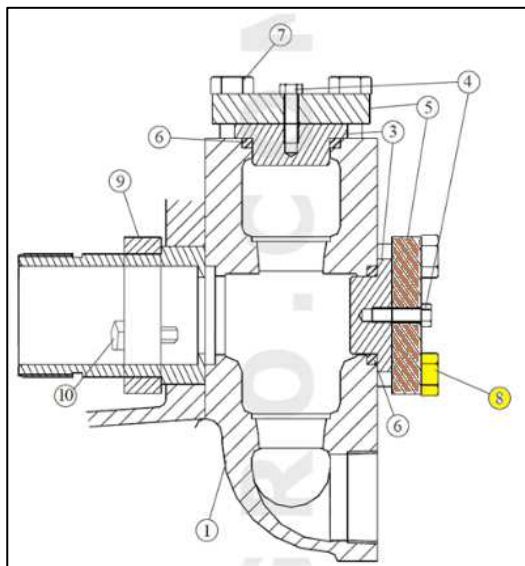
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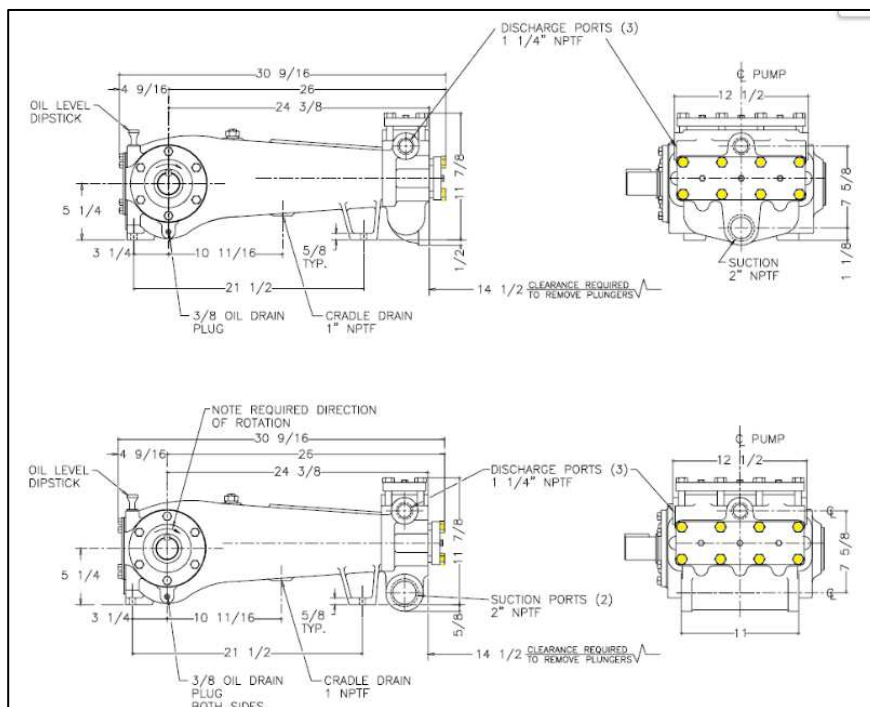
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iii. Claim 3 “a plurality of fasteners, each of the plurality of fasteners extending through the plate and into the housing to fasten the plate to the housing.”

207. Claim 3 of Foster recites “a plurality of fasteners, each of the plurality of fasteners extending through the plate and into the housing to fasten the plate to the housing.” The annotated figures below are taken from Apex and illustrates hex-headed cap screw fasteners that secure the cover plates to the fluid end housing. The skilled artisan would understand that these hex-headed cap screw fasteners extend through fastener openings in the plate and engage with threaded openings formed in the housing in a one-to-one relationship to fasten the plates to the fluid end housing.



5	2	Retainer Plate, Valve Cover & Cylinder Head	7203-0110-00B
6	6	Fluid Seal, Nitrile Rubber	7203-0118-00A
7	8	3/4" NC Hex Head Cap Screw x 3" long	100-034300-273
8	8	3/4" NC Hex Head Cap Screw x 9" long	100-034900-273

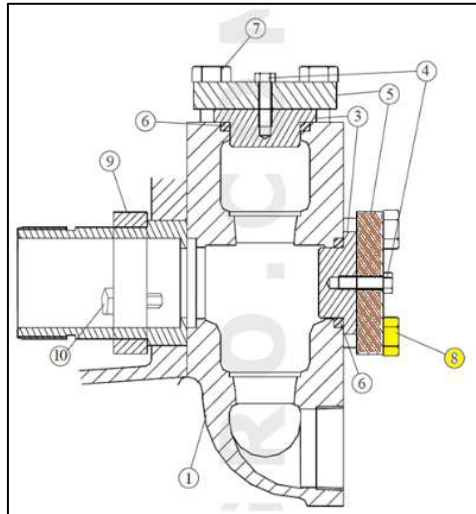


Apex (EX1005), pp. 8, 38 (annotated): Showing multiple threaded connections, and stating that capscrews are to be used to fasten the end cover plate in two places.

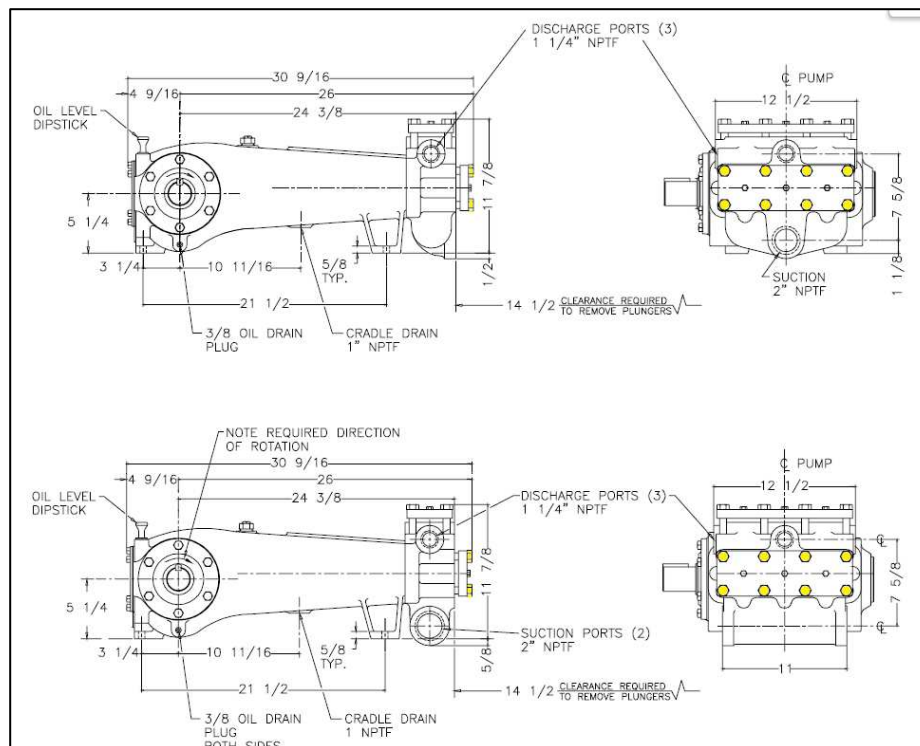
iv. Claim 4 “each of the plurality of fasteners is a threaded fastener”

208. Claim 4 of Foster recites that “each of the plurality of fasteners is a threaded fastener.”

209. The annotated figures below are taken from Apex and illustrate the hex head fasteners of the Apex Pump. The threaded fasteners are not shown in sufficient detail to clearly illustrate the actual threads. The presence of threads (in the fastener and its opposing hole or “opening”), however, would have been obvious to the skilled artisan given the fasteners are illustrated with a hex head and are described as being “cap screw” fasteners. The skilled artisan would understand that a cap screw fastener is a threaded fastener, that would need to engage with a threaded opening in order to secure the plate to the housing. Accordingly, it would have been obvious to the skilled artisan that the hex head fasteners used to fasten the cover plates to the fluid end housing would be threaded.



5	2	Retainer Plate, Valve Cover & Cylinder Head	7203-0110-00B
6	6	Fluid Seal, Nitrile Rubber	7203-0118-00A
7	8	3/4" NC Hex Head Cap Screw x 3" long	100-034300-273
8	8	3/4" NC Hex Head Cap Screw x 9" long	100-034900-273



Aplex (EX1005), pp. 8, 38 (annotated): Showing multiple threaded connections.

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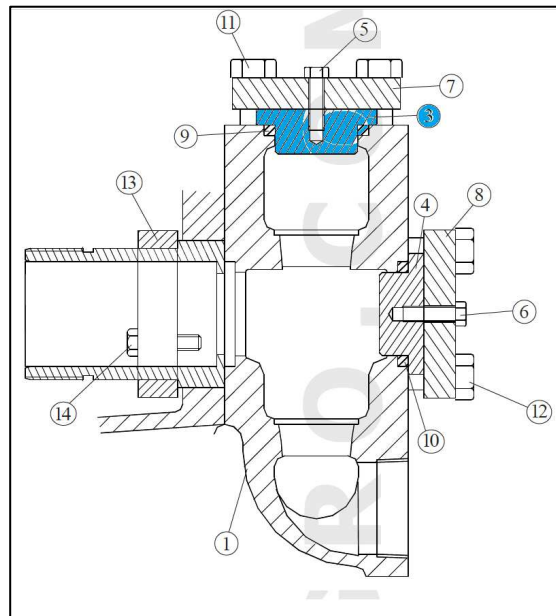
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- v. **Claim 5 “a third plug installed within the first vertical bore and positioned between an external surface of the housing and one of the first pair of valves.”**

210. Claim 5 recites “a third plug installed within the first vertical bore and positioned between an external surface of the housing and one of the first pair of valves.” This claim is broad enough to cover a top vertical bore plug or a bottom vertical bore plug. A top vertical bore plug is shown in the annotated figure below, from Apex, and is a conventional part of a plunger pump fluid end. These plugs provide a pressure retention seal, and in some fluid ends, retain the valves in the fluid end.



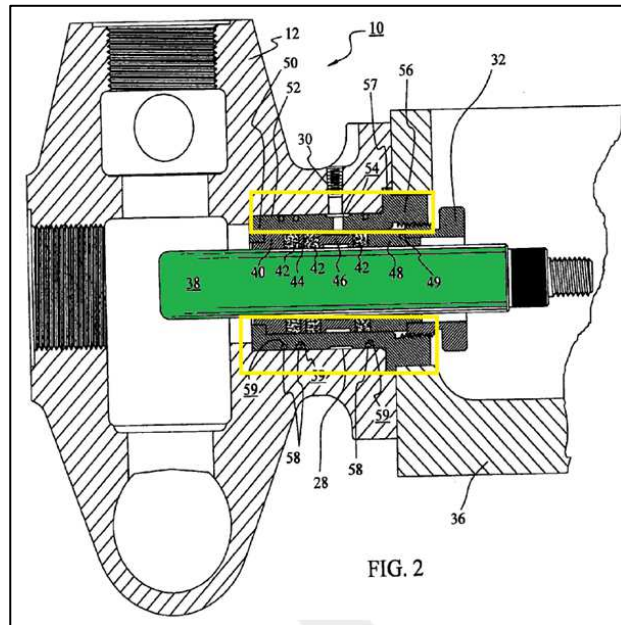
Apex (EX1005), p. 38 (annotated): Showing top bore plug (highlighted in blue).

vi. Claim 6

- a. 6.a “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore and at least a portion of the second reciprocating plunger installed within the central opening of the second component”**

211. Recitation 6.a of claim 6 recites “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore and at least a portion of the second reciprocating plunger installed within the central opening of the second component.” Where recitation 1.J of claim 1 recites the “first component” for a first plunger assembly, this recitation recites the corresponding “component” for a second plunger assembly of a multiplex pump. Accordingly, Apex modified by Stanton provides a second component for the same reasons as the first component of recitation 1.J.

212. While Apex and Stanton do not explicitly illustrate “first” and “second” components, it would have been obvious to the person of ordinary skill in the art that these features would be present in the references due their disclosures as triplex pumps. EX1005, *passim*; EX1007, ¶ [0009].



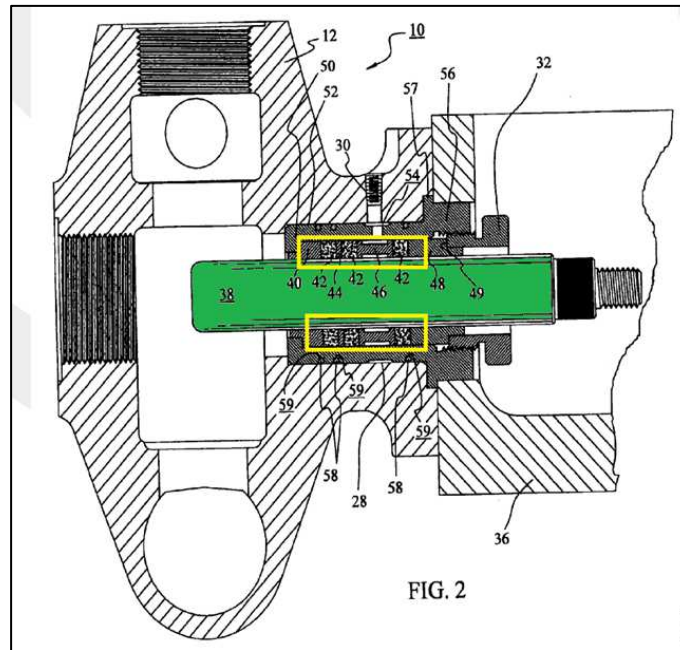
Stanton (EX1007), FIG. 2 (annotated).

- b. **6.b “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger”**

213. Recitation 6.b of claim 6 recites “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger.” Where recitation 1.K of claim 1 recites the “first plurality of packing seals” for a first plunger assembly, this recitation recites the corresponding “second plurality of packing seals” for a second plunger assembly of a multiplex pump. Accordingly, Apex modified by Stanton provides a second plurality of packing seals for the same reasons as the first component of recitation 1.K.

214. While Apex and Stanton do not explicitly illustrate “first” and “second” plurality of packing seals, it would have been obvious to the person of

ordinary skill in the art that these features would be present in the references due to their disclosures as triplex pumps. EX1005, *passim*; EX1007, ¶ [0009].



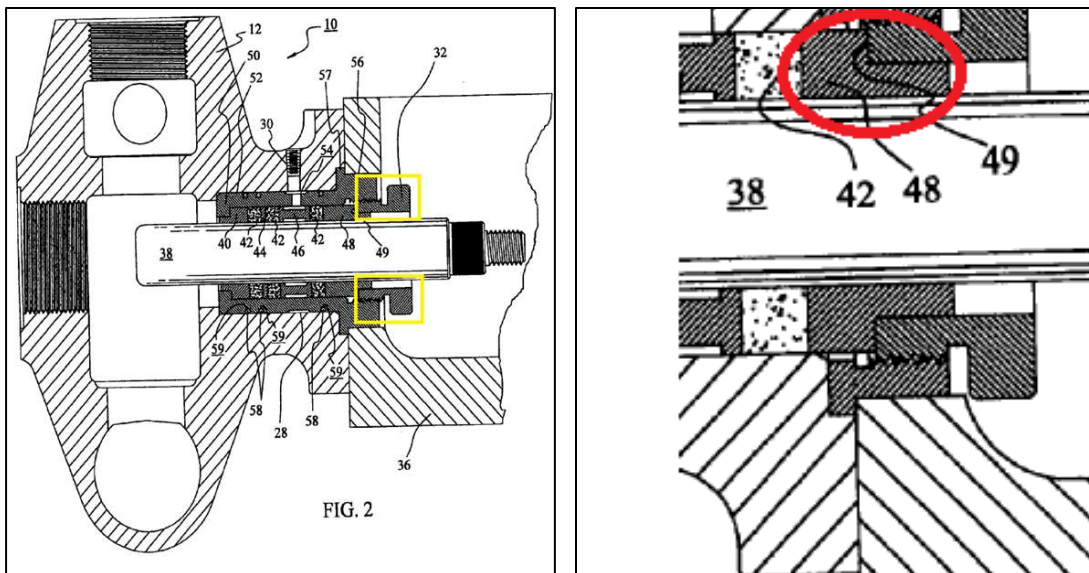
Stanton (EX1007), FIG. 2 (annotated).

- c. **6.c “a second packing nut attached to the second component and holding the second plurality of packing seals within the second component.”**

215. Recitation 6.c of claim 6 recites “a second packing nut attached to the second component and holding the second plurality of packing seals within the second component.” Where recitation 1.L of claim 1 recites the “first packing nut” for a first plunger assembly, this recitation recites the corresponding “second packing nut” for a second plunger assembly of a multiplex pump. Accordingly,

Aplex modified by Stanton provides a second packing nut for the same reasons as the first component of recitation 1.L.

216. While Aplex and Stanton do not explicitly illustrate “first” and “second” packing nuts, it would have been obvious to the person of ordinary skill in the art that these features would be present in the references due their disclosures as triplex pumps. EX1005, *passim*; EX1007, ¶ [0009].



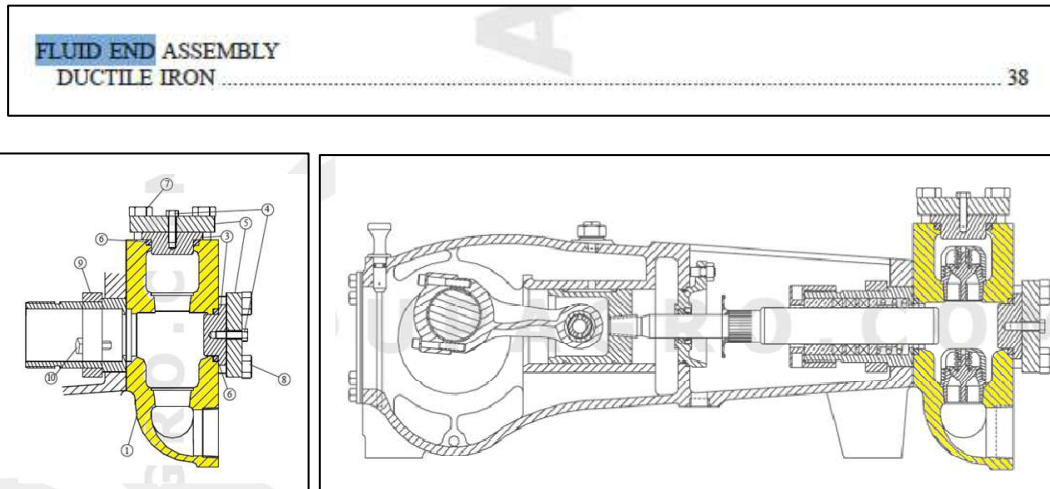
Stanton (EX1007), FIG. 2 (annotated).

vii. Claim 7

a. 7.P “a fluid end assembly”

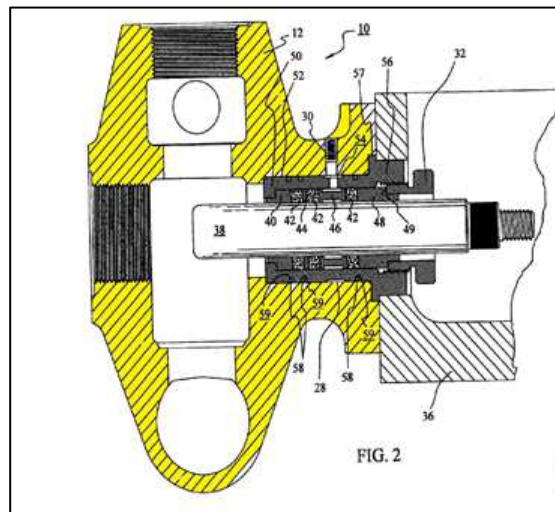
217. The preamble of claim 7 of Foster recites that the claims are directed to a “fluid end assembly.” While I understand that the preamble of a claim does not always recite patentably relevant subject matter, in this case I need not address that

issue as the Apex Pump clearly includes a “fluid end assembly.” Reproduced below are drawings from Apex, which illustrate the “fluid end assembly” of the pump.



Apex (EX1005), pp. 7, 38 (annotated): Illustrating the disclosure of the fluid end assembly.

218. For completeness, I also note that Stanton also includes a fluid end assembly.

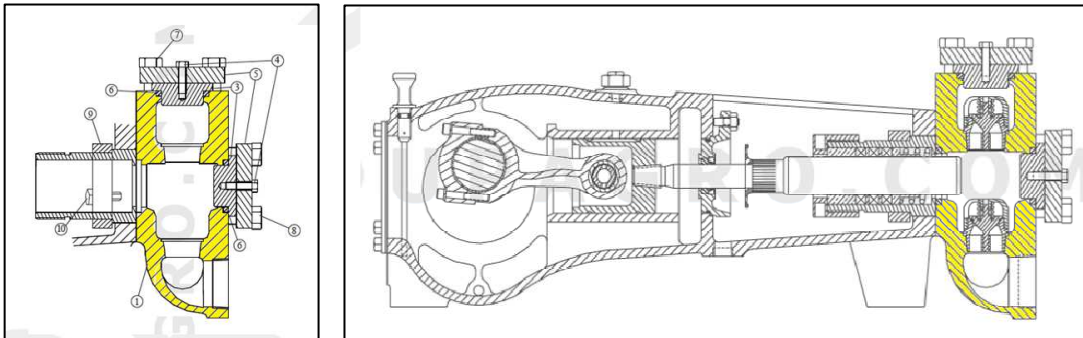


Stanton (EX1007), FIG. 2 (annotated).

b. 7.a “a housing made of a single integrally formed piece”

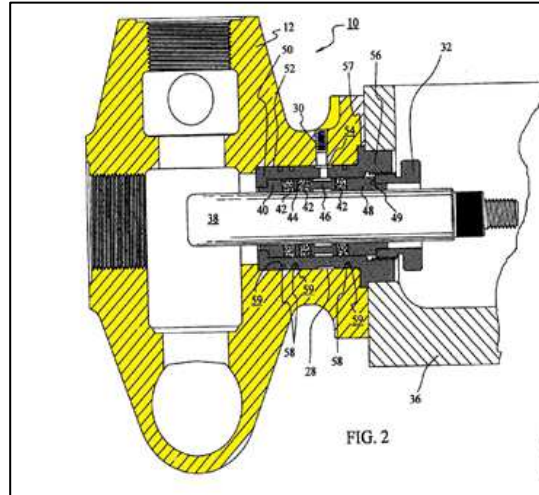
219. The recitation 7.a of claim 1 recites that the fluid end includes “a housing made of a single integrally formed piece.” This is conventionally how fluid end housings are formed – because of the high pressure developed and contained therein; in order to not split the fluid end housing, the housings are machined as an integral piece or “monoblock.” Such an integral monoblock housing is illustrated in Apex.

220. The figure below is from Apex. Note that the fluid end of the pump consists of a single piece, such that no breaks or seams are illustrated. This renders as obvious, and not novel, recitation 1.A of Foster: “A fluid end assembly, comprising a housing made of a single, integrally formed piece.” As also illustrated below, Stanton also includes a monoblock fluid end.



Apex (EX1005), pp. 7, 38 (annotated): External views and cross-section of liquid end of the KP-3300, from its Service Manual, illustrating the Monoblock design, with no splits in the casing. The lower section of the picture is a representation of the power end assembly, including (starting from the bottom) the crankshaft, connecting rods, the crosshead, and the pony rod, which in turn is coupled to the back-side of the plunger.

221. For completeness, I note that the fluid end of Stanton is also illustrated with a monoblock construction.

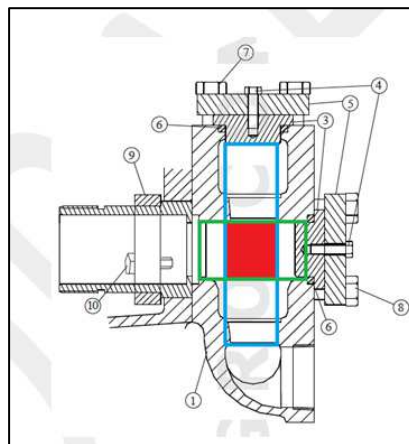


Stanton (EX1007), FIG. 2 (annotated).

- c. **7.b “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber”**

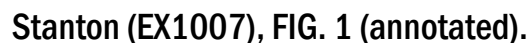
222. Recitation 7.b of claim 1 of Foster recites “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber.” Such an internal chamber is a conventional part of a fluid end, as illustrated in the discussion of the prior art I provide above. Furthermore, the figure from Apex that I have reproduced below clearly illustrates that the Apex Pump includes such an internal chamber formed by the intersection of a first vertical bore formed in the housing and a first horizontal bore formed in the housing.

223. “First” as used here refers to the bores associated with one of the plunger assemblies of the triplex pump provided as an exemplar in Foster, shown in the figures below. The purpose of this internal chamber is to contain the plunger in the horizontal bore and the suction and discharge valves in the intersecting vertical bore. The resulting internal chamber provides a conduit for the suction fluid as the plunger moves backward, and a conduit for the discharge fluid as it is pressurized by the plunger and moves forward within the bore of the horizontal plunger bore and vertical discharge bore of the internal chamber. This is a conventional design for a reciprocating power pump. As such, the POSITA would understand that the Apex Pump includes “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber.” This is illustrated in the figure below:



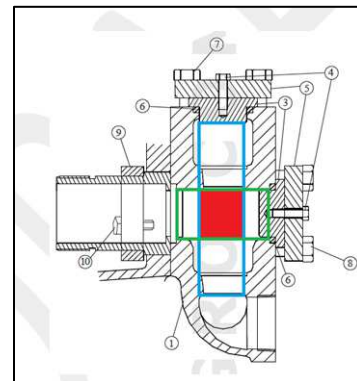
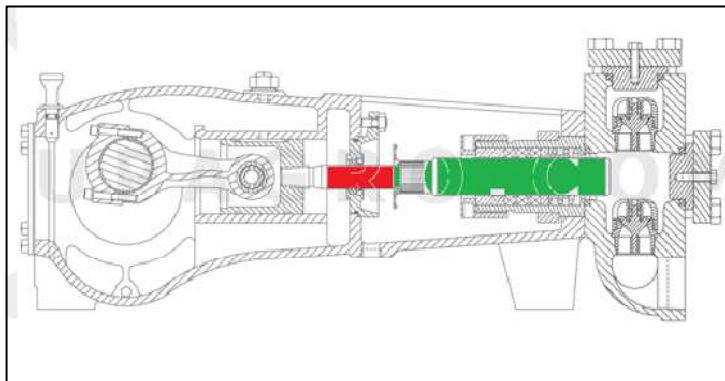
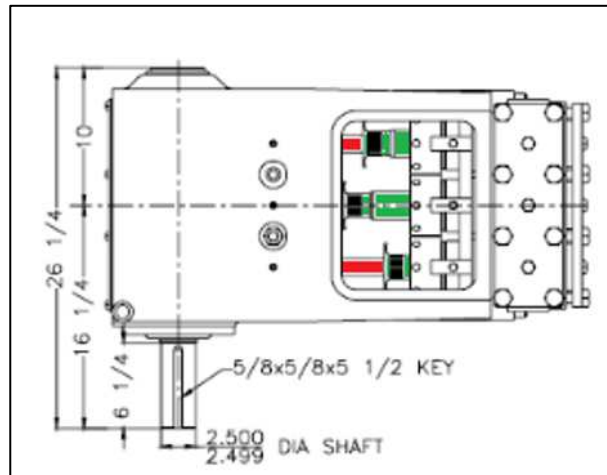
Apex (EX1005), p. 38 (annotated): Cross-section from the Pentair Apex, demonstrating a very typical reciprocating power pump design. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve

224. For completeness, I note that the fluid end of Stanton also includes “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber,” as illustrated below.



- d. **7.c “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber;”**

225. Recitation 7.c of claim 7 of Foster recites “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber.” “Second” as used here refers to the bores associated with a second of the plungers of the example triplex pump. *See, e.g.,* EX1001, 8:13-23 (“each set of paired bores...” (emphasis added)). Only one such plunger assembly is illustrated in the drawings (*e.g.* the figure above) because the POSITA would understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in this case, given the triplex pump being the example), each member of which has the same structure. While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the Apex Pump has these features, as would be typical of any reciprocating power pump.

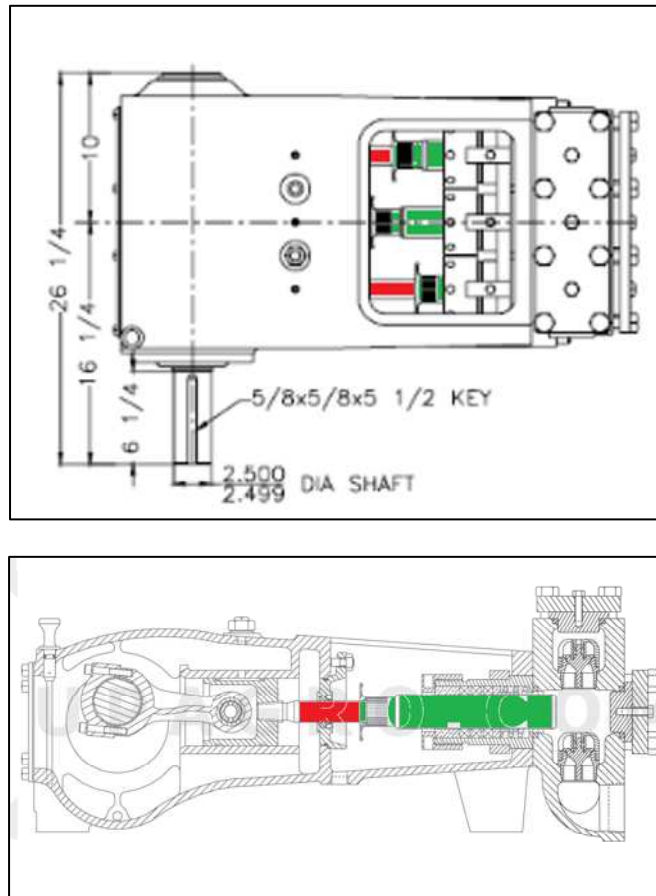


Applex (EX1005), pp. 7, 8, 38 (annotated): Showing intersecting of the vertical and horizontal bores.

- e. **7.d “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber;”**

226. Recitation 7.d of claim of Foster recites that the “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.” The skilled artisan would understand that this feature of claim 1 is present in the Apex Pump as the Apex Pump is a triplex pump. Furthermore, the

drawing in the figure below shows side-by-side arrangement of plunger assemblies. It would have been obvious to the person of ordinary skill in the art that the Aplex Pump has its plunger arrangements in side-by-side relationship, which is typical of reciprocating power pump design, and has been for many decades. While the three bores of the fluid end are not explicitly illustrated in Aplex, the three plunger assemblies are illustrated. In the annotated figures from Aplex, the three connecting rods (annotated in red) of the power end connect to three plungers (annotated in green). Each of the three plungers is configured to reciprocate within the horizontal bore, pumping fluid in through the intake or suction valve of the vertical bore to the internal chamber, and out the discharge valve of the vertical bore. Accordingly, the Aplex Pump includes “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber” as recited in claim 1.



Applix (EX1005), pp. 7, 8 (annotated): Cross-section from Pentair Aplix demonstrating a very typical reciprocating power pump design. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers and plunger bores, stuffing box assemblies, and valve pairs, in a side-by-side arrangement.

- f. 7.e “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber”

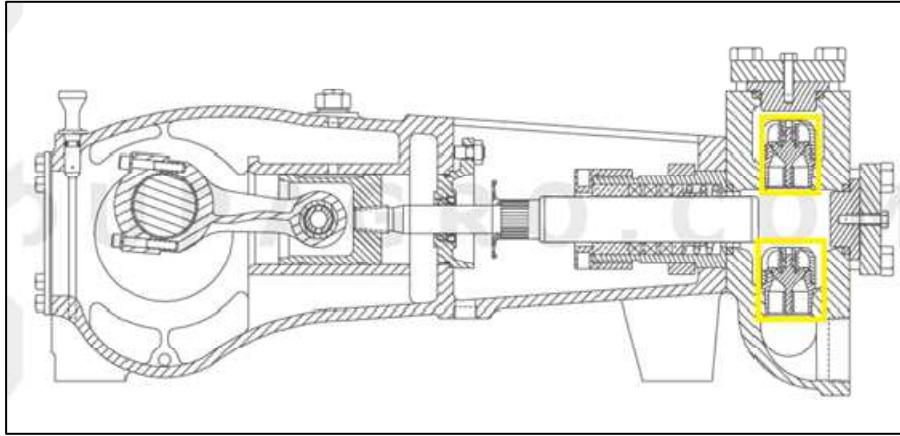
227. Recitation 7.e of claim 7 recites “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber.” As illustrated below, the Aplix Pump includes a pair of valves (a suction valve and a discharge valve) arranged in the vertical bore and positioned on opposites side of the internal chamber, as illustrated in the figure below.

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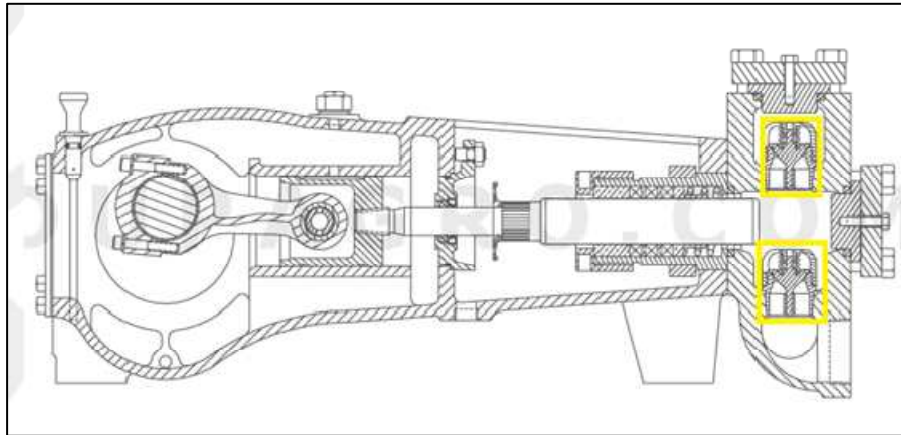


Apflex (EX1005), p. 7 (annotated): Cross-section from the SC-65 Service Manual (left) demonstrating a very typical reciprocating power pump design, including valve details. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs.

- g. 7.f “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber”

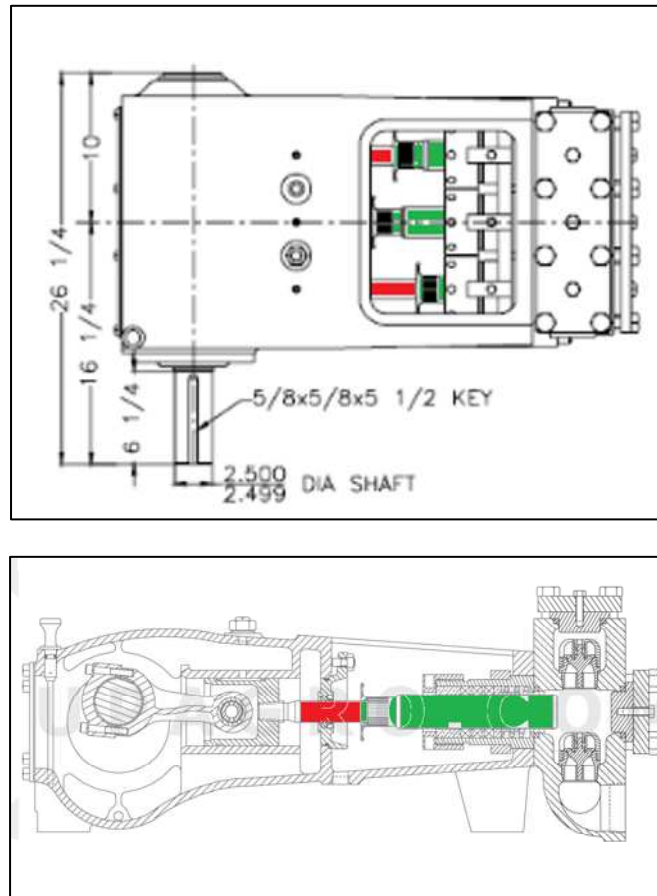
228. Recitation 7.f of the claim 7 recites “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber.”

229. The POSITA would understand that each of the triplex plunger arrangements of the Apflex Pump would include the valves (suction and discharge) placed as illustrated in the figure below.



Apflex (EX1005), p. 7 (annotated): Cross-section from SC-65 Service Manual (left) demonstrating a very typical reciprocating power pump design, including valve details. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs.

230. While a second set of valves in the fluid end is not explicitly illustrated in Apflex, the three plunger assemblies are illustrated. In the annotated figures from Apflex, the three connecting rods (annotated in red) of the power end connect to three plungers (annotated in green). Each of the three plungers is configured to reciprocate within the horizontal bore, pumping fluid in through the intake or suction valve of the vertical bore to the internal chamber, and out the discharge valve of the vertical bore. Accordingly, the Apflex Pump includes “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber” as recited in claim 1.

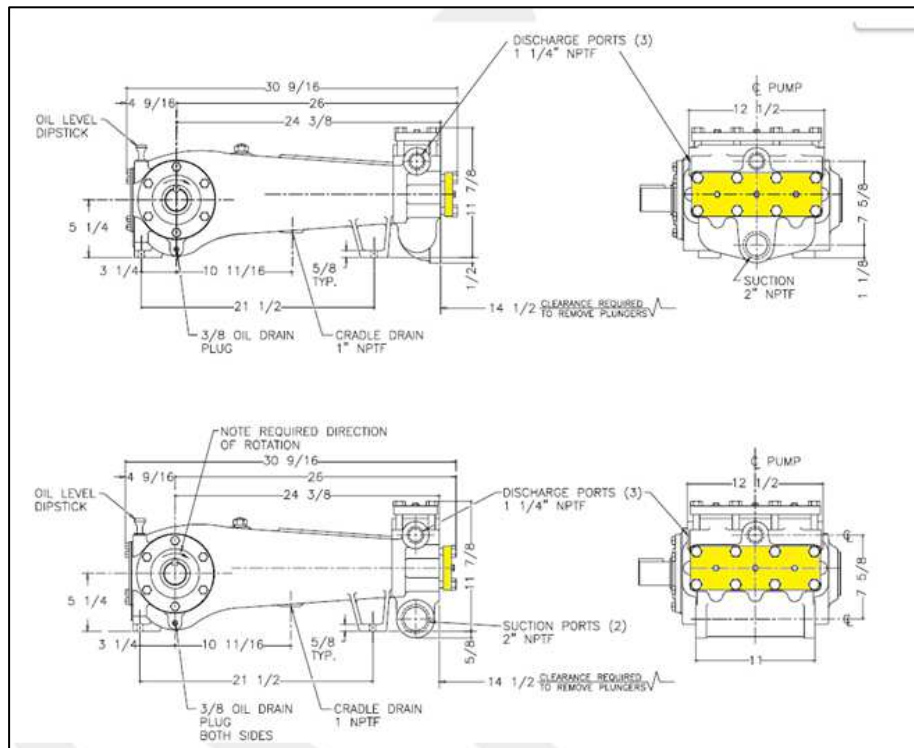
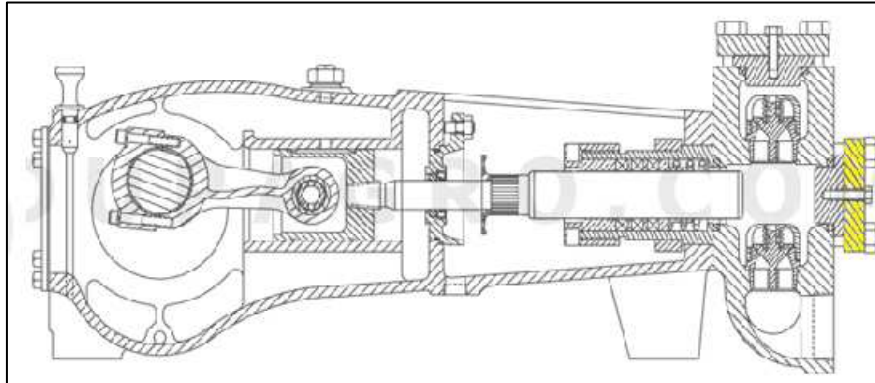


Applix (EX1005), pp. 7, 8 (annotated): Cross-section from Pentair Aplix demonstrating a very typical reciprocating power pump design. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers and plunger bores, stuffing box assemblies, and valve pairs, in a side-by-side arrangement.

h. 7.g “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores”

231. Recitation 7.g of claim 7 of Foster recites “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores.” As illustrated in the figures below, the Kerr Pump includes such a plate.

232. As shown in the figure below, the pictures from Apex indicate using such a bolted-on plate to firmly secure the bore plugs against the casing. Accordingly, the Apex Pump includes “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores.”

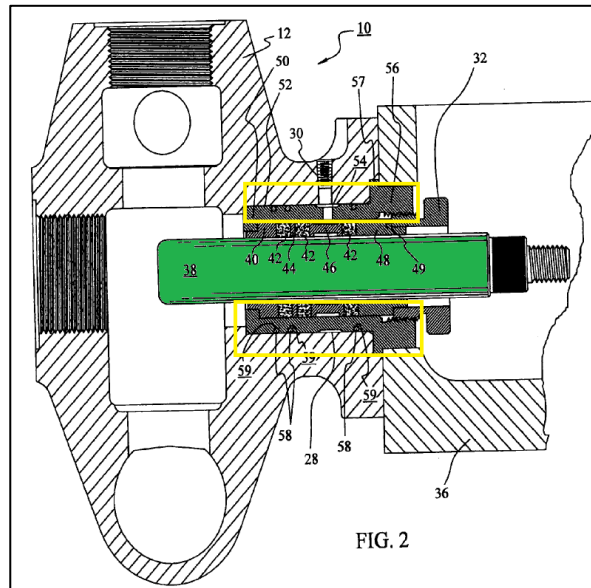


Apex (EX1005), pp. 7, 8 (annotated).

- i. **7.h “a first component having a central opening formed therein, at least a portion of the first component installed within the first horizontal bore;”**

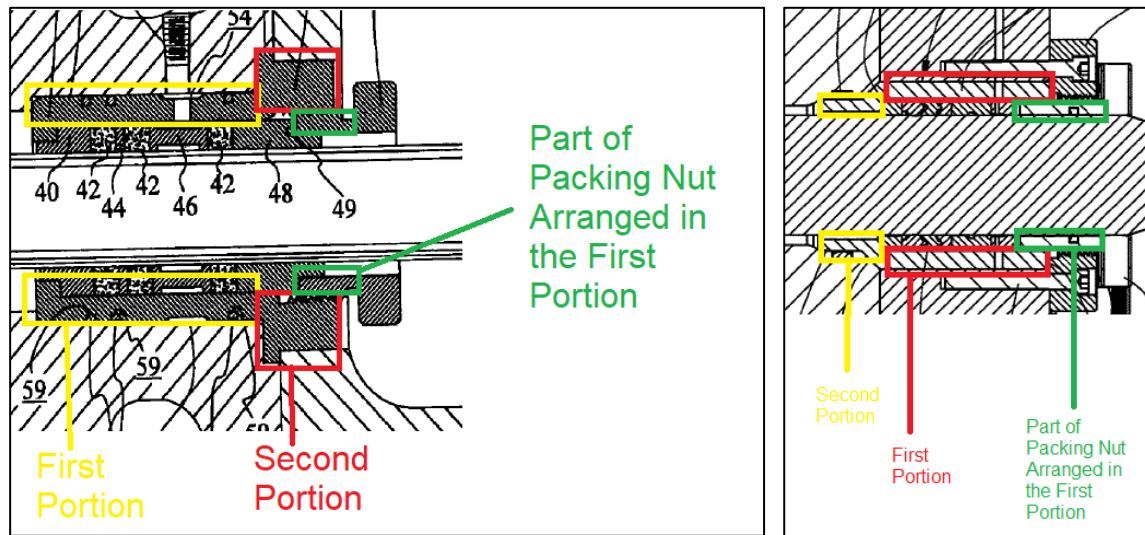
233. Recitation 7.h of claim 7 of Foster recites “a first component having a central opening formed therein, at least a portion of the first component installed within the first horizontal bore.” Such a component is included in the fluid end of Stanton.

234. This claim recitations uses the broad term “component” that could correspond to almost any packing other than the later recited seals. I am therefore relying on a packing sleeve due to the teachings in Foster’s specification. *See, e.g.*, EX1001, 4:12-16, 6:63-67, 9:14-20, 10:66-11:7. The Apex Pump includes a packing assembly where the assembly is secured within the fluid end via a packing or gland nut, but this just one way of securing the packing. Another way of securing that packing is illustrated in FIG. 2 of Stanton. In Stanton the packing is arranged within a stuffing box 50 that acts as a packing sleeve. A gland nut 32 secures the packing within the horizontal bore as illustrated in FIG. 2. The packing assembly of Stanton illustrates the stuffing box (annotated in yellow) with a portion that is in the horizontal bore and the plunger (annotated in green) partially within the stuffing box.



Stanton (EX1007), FIG. 2 (annotated): Cross-section from Stanton, demonstrating a very typical reciprocating power pump design, including stuffing box details. The pictures show a packing sleeve associated with the teachings in the specification of Foster, but generically called a “component” by Foster.

235. In fact, the stuffing box of Stanton includes the *unclaimed* features of packing sleeve described in Foster – a first portion with a larger diameter than a second portion in which part of the packing nut is arranged, as illustrated in the detail of FIG. 2 from Stanton provided below and compared with a detail of FIG. 6 of Foster.

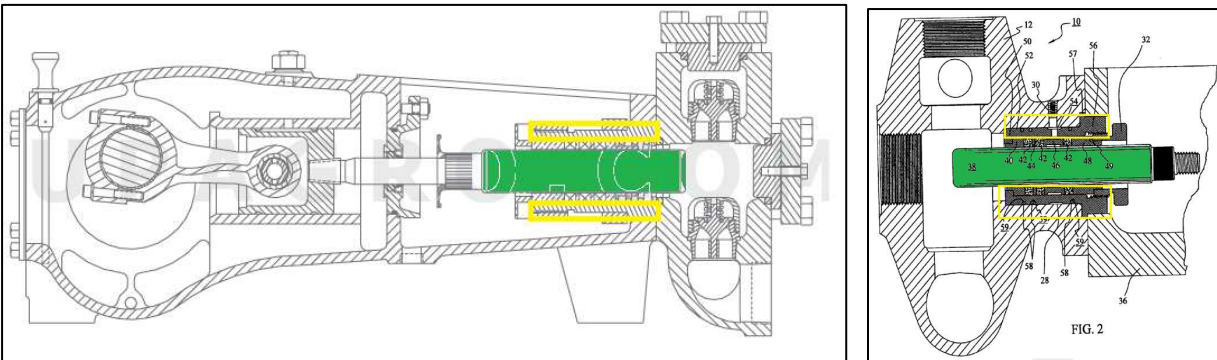


Comparison of the Packing Sleeve of Stanton with the Component of Foster.

236. It would have been obvious to the skilled artisan to replace the packing assembly of the Apex Pump with the stuffing box 50 of Stanton as it is replacing one known method of providing packing to a plunger pump with another with predictable results. Furthermore, the skilled artisan would have been motivated to make such a modification because the skilled artisan would understand that providing the packing/stuffing arrangement at least partially within the fluid end housing, as is illustrated in Stanton, may provide improved pressure/fluid isolation compared with the packing bolted to the outside of the fluid end as constructed in Apex.

j. 7.i “a first reciprocating plunger, at least a portion of the first reciprocating plunger installed within the central opening of the first component”

237. Recitation 7.i of the ‘534 Patent recites “a first reciprocating plunger, at least a portion of the first reciprocating plunger installed within the central opening of the first component.” The figures below, from the Apex Pump and Stanton, exhibit a typical fluid end arrangement for a reciprocating power pump. Note the green plunger partially within the packing/stuffing box/sleeve (yellow), showing that such a configuration is not novel in Foster.

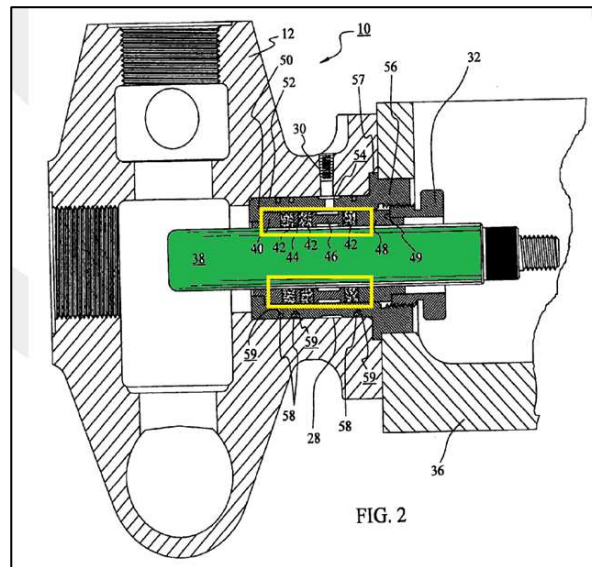


Drawings from Apex (EX1005), p7 (annotated) (left side) and Stanton (EX1007), FIG. 2 (annotated) (right side).

k. 7.j “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger”

238. Recitation 7.j of claim 7 of Foster recites “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger.” This is a conventional feature of reciprocating plunger pumps that is included in the Apex Pump and Stanton. Because this ground of rejection is relying

on the packing sleeve from Stanton, it also relies on the seals from Stanton. The figure below illustrates “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger” in the Stanton fluid end, annotated in yellow. Accordingly, Stanton includes “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger.”



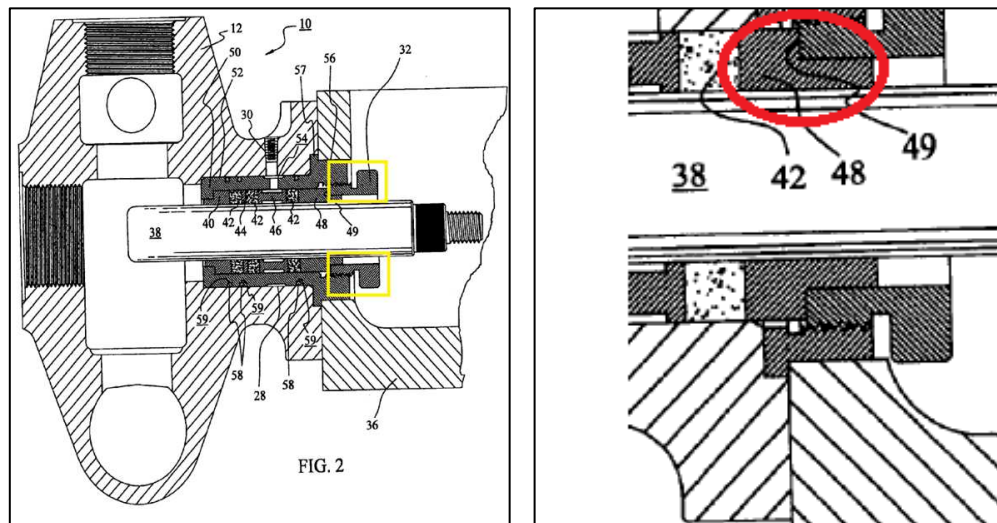
Stanton (EX1007), FIG. 2 (annotated).

- I. **7.k “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.”**

239. Recitation 7.k of claim 7 of Foster recites “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.” Such a packing nut is included in Stanton.

240. In the figures below, the packing nut (annotated in yellow) is attached to the sleeve with threading. This mimics how any packing nut “hold[s] the first

plurality of packing seals within the first component” (EX1001, claim 7) due to the compression of the packing. If there is no nut, then all the packing loses its fit and function, because the pressure ahead of the plunger would push the packing from the bore, and it could not seal around the plunger. This nut not only compresses the packing rings to squeeze out radial clearance around the plunger through which fluid could leak, but acts to hold the packing rings in the sleeve and as an additional fluid barrier at the rear of the packing box assembly, essentially acting as a detachable rear end of the packing sleeve, as circled in red in the figure below. Accordingly, Stanton includes “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.”

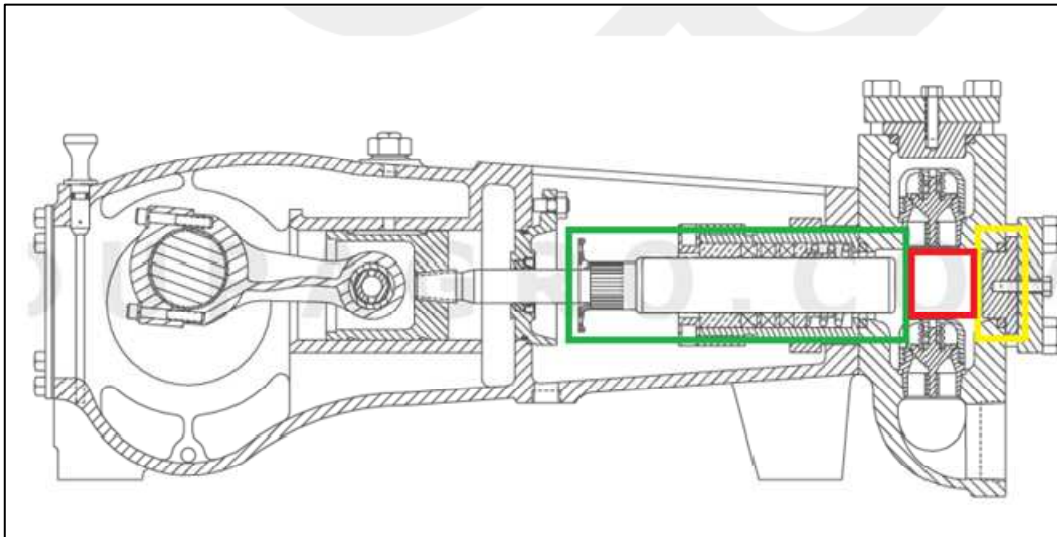


Stanton (EX1007), FIG. 2 (annotated): Illustrating the packing nut shown along with packing assembly, both as disassembled component parts as well as an installed assembly.

viii. Claim 8

a. 8.a “a first plug and the first reciprocating plunger installed within the first horizontal bore and positioned on opposite sides of the first internal chamber”

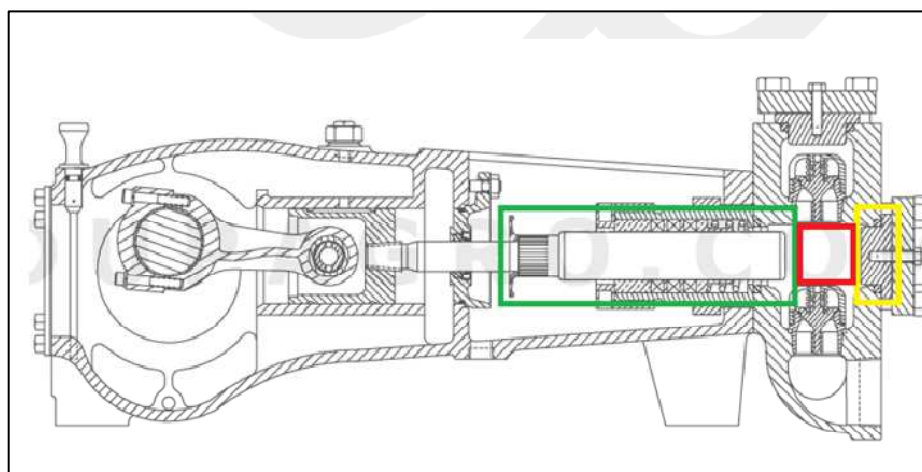
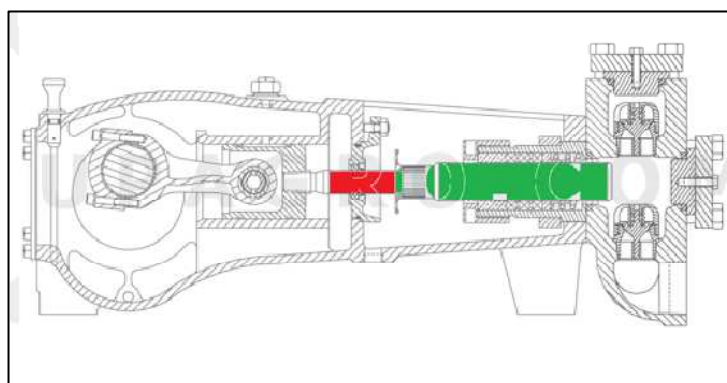
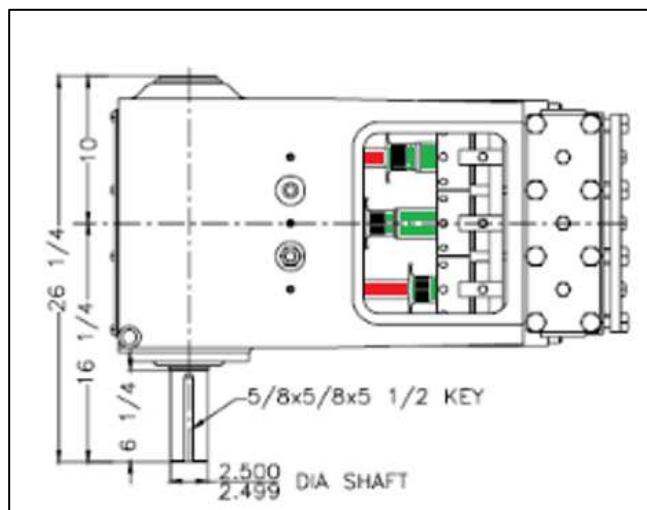
241. Recitation 8.a recites “a first plug and the first reciprocating plunger installed within the first horizontal bore and positioned on opposite sides of the first internal chamber.” Apex includes such a “first plug” and “first reciprocating plunger.” This claim describes a typical reciprocating power pump components and their standard configuration. This is illustrated in the figure below, taken from the SC-65 Triplex Service Manual. As illustrated, a plug (yellow) is installed within the horizontal bore on the opposite side of the internal chamber (red) from the plunger (green).



Apex (EX1005), p. 7 (annotated).

b. 8.b “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber”

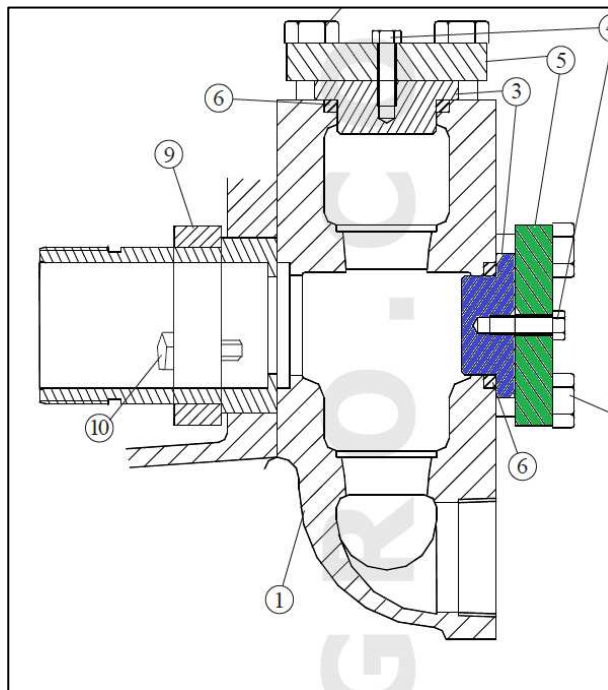
242. Recitation 8.a recites “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber.” Apex does not explicitly illustrate such “a second plug” and “second reciprocating plunger.” Nevertheless, such a “second plug” and “second plunger” would have been obvious to the skilled artisan because each plunger assembly would have the same structure as that illustrated in the figure below in which a plug (yellow) is installed within the horizontal bore on the opposite side of the internal chamber (red) from the plunger (green). Specifically, “second” as used here refers to the horizontal bore and plunger of a second plunger assembly of the example triplex pump. *See, e.g.*, EX1001, 9:60-65. Only one such plunger assembly is illustrated in the drawings (*e.g.* the figure above) because the POSITA would understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in this case, given the triplex pump being the example), each member of which has the same structure. While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the Apex Pump has these features, as would be typical of any reciprocating power pump.



Aplex (EX1005), pp.7 and 8 (annotated): Showing the reciprocating plunger and horizontal bore of a second plunger arrangement.

c. 8.c “in which the first plug is positioned adjacent the plate”

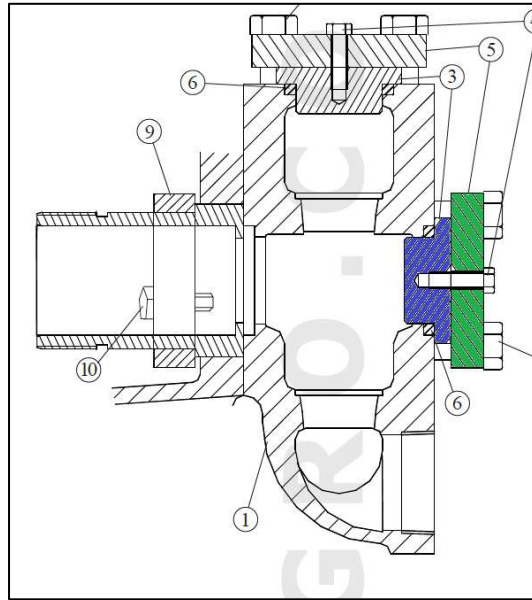
243. Recitation 8.c recites that “the first plug is positioned adjacent the plate.” The “first plug” of Apex is “positioned adjacent the plate,” as illustrated in the annotated figure provided below. Specifically, the first plug (blue) is adjacent to the plate (green), and also abuts the plate.



Apex (EX1005), p. 38 (annotated).

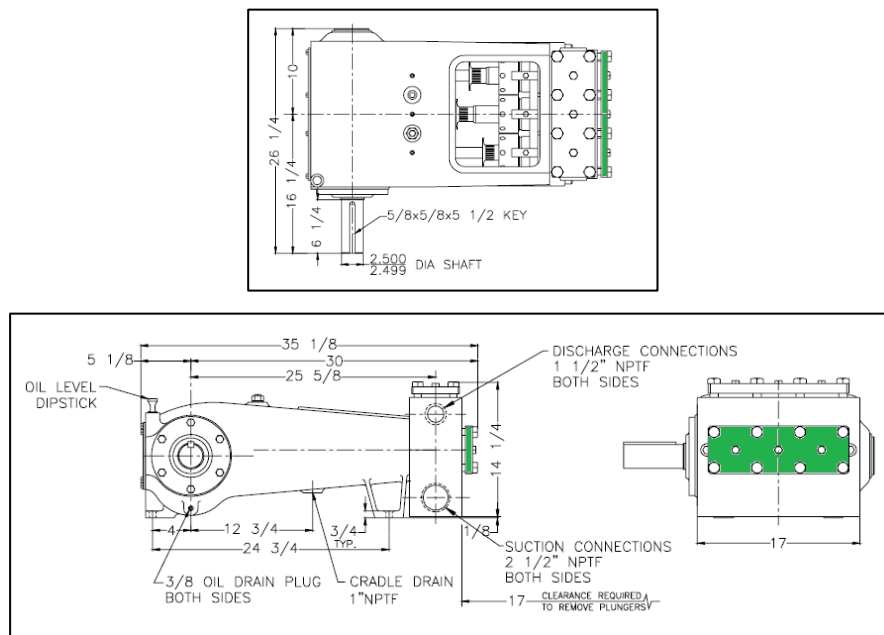
d. 8.d “in which the second plug is positioned adjacent the plate”

244. Recitation 8.d recites that “the second plug is positioned adjacent the plate.” The “second plug” of Apex is “positioned adjacent the plate,” as illustrated in the annotated figure provided below. Specifically, the first plug (blue) is adjacent to the plate (green), and also abuts the plate.



Aplex (EX1005), p. 38 (annotated).

245. For completeness, I note that the plate of Aplex covers both horizontal bores of the fluid end, as illustrated below. This confirms that the plate is adjacent to and abuts both of the “first plug” and the “second plug.”



Aplex (EX1005), p. 8 (annotated).

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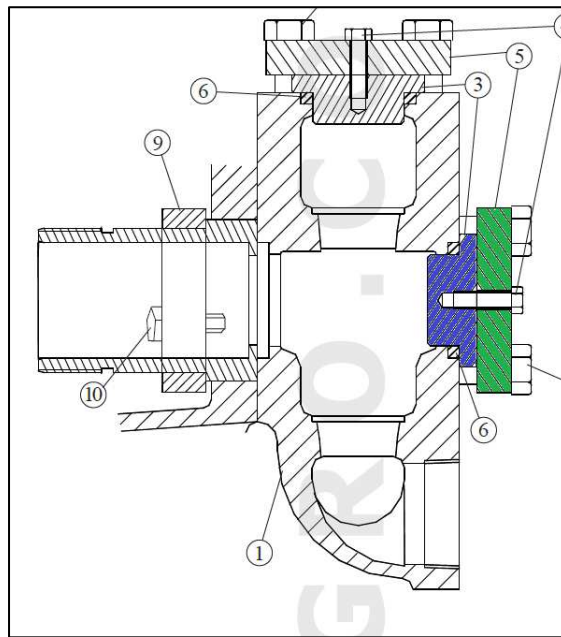
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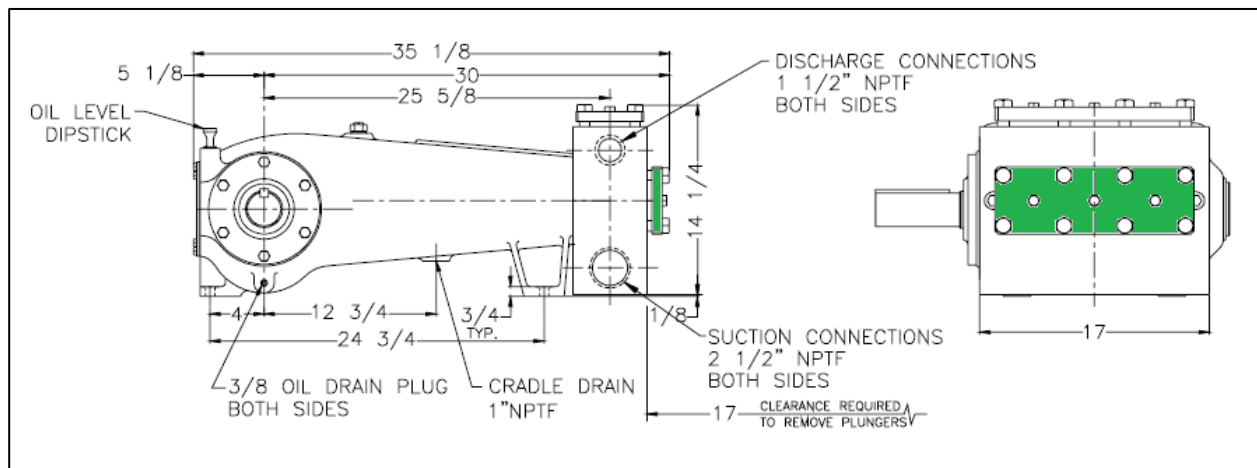
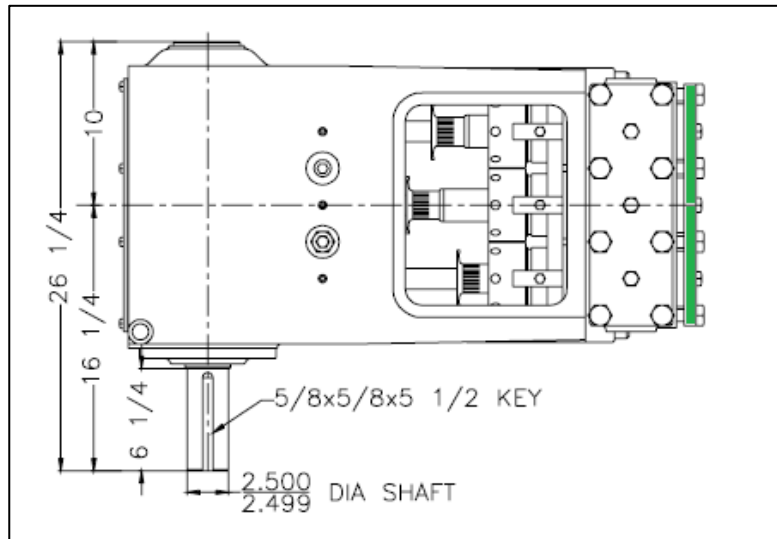
ix. Claim 9 “which the plate abuts the first plug; and in which the plate abuts the second plug.”

246. Claim 9 recites “in which the plate abuts the first plug; and in which the plate abuts the second plug.” As explained above, the plate of Apex is adjacent to and abuts the “first plug” and the “second plug.” As illustrated in the annotated figure provided below, the plate (green) abuts the first plug (blue).



Apex (EX1005), p. 38 (annotated).

247. As I explain above, the “second plug” would have the same structure as the first plug. Accordingly, the plate (green) also abuts the second plug (blue). For completeness, I note that the plate of Apex covers both horizontal bores of the fluid end, as illustrated below. This confirms that the plate abuts both of the “first plug” and the “second plug.”

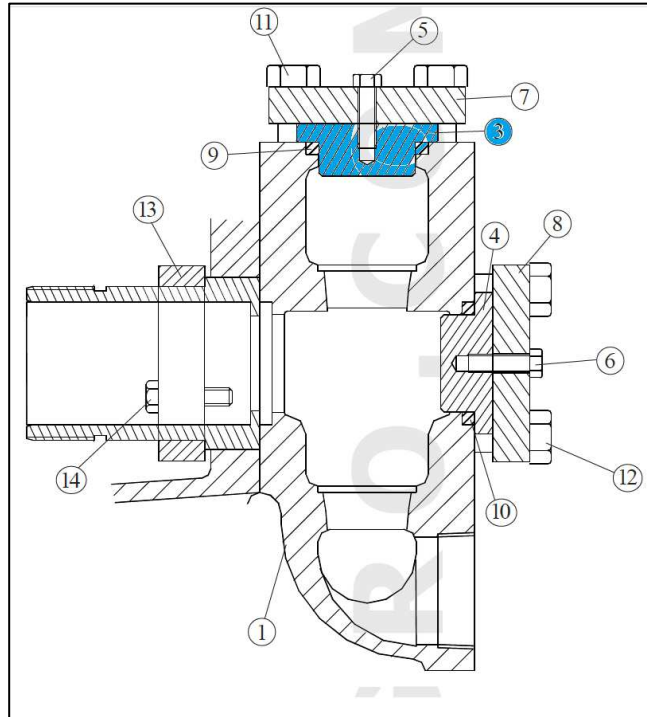


Aplex (EX1005), p. 8 (annotated).

- x. **Claim 10 “a third plug installed within the first vertical bore and positioned between an external surface of the housing and one of the first pair of valves.”**

248. Claim 10 recites “a third plug installed within the first vertical bore and positioned between an external surface of the housing and one of the first pair of valves.” This claim is broad enough to cover a top vertical bore plug or a bottom vertical bore plug. A top vertical bore plug is shown in the annotated figure below, from Aplex, and is a conventional part of a plunger pump fluid end. These plugs

provide a pressure retention seal, and in some fluid ends, retain the valves in the fluid end.



Aplex (EX1005), p. 38 (annotated).

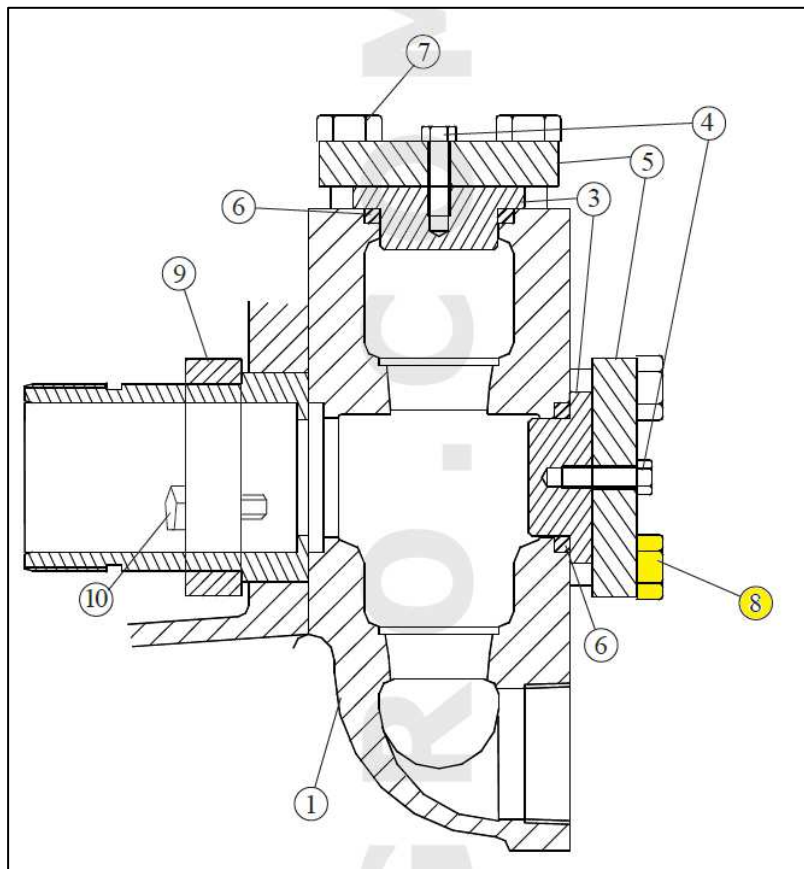
xi. Claim 11

- a. 11.a “which the plate comprises a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a one-to-one relationship,”**

249. Recitation 11.a of claim 11 of Foster recites “a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a one-to-one relationship.” While these openings are not explicitly illustrated in Aplex, they would have been obvious to the skilled artisan at the time of filing.

250. The annotated figures below are taken from Apex. The figures illustrate hex-headed fasteners that secure the cover plates to the fluid end housing. Apex also describes the fasteners as “cap screws.” The skilled artisan would understand that these hex-headed cap screw fasteners are threaded fasteners that pass through fastener openings in the plate and engage with threaded openings formed in the housing in a one-to-one relationship to secure the plates to the fluid end housing. The threaded openings are not shown in sufficient detail to illustrate the actual threads. The presence of threads (in the fastener and its opposing hole or “opening”), however, would have been obvious to the skilled artisan given the fasteners are illustrated with a hex head and are described as being “cap screw” fasteners. The skilled artisan would understand that the hex head indicates that the fasteners are intended to be installed or removed with a ratchet or wrench. The description of the fasteners as being “cap screw” fasteners would indicate to the skilled artisan that the fasteners are threaded.

251. The skilled artisan would understand that a threaded fastener engaged in a one-to-one relationship with the threaded openings in the housing via fastener openings in the plate that align with the threaded openings in the housing. Accordingly, it would have been obvious to the skilled artisan that the features of recitation 2.a are present in the Apex Pump.



8

8

3/4" NC Hex Head Cap Screw x 9" long

100-034900-273

Aplex (EX1005), p. 38 (annotated).

- b. **11.b “a plurality of fasteners, each of the plurality of fasteners installed within a corresponding one of the aligned fastener openings and threaded openings”**

252. Recitation 11.b of claim 11 of Foster recites “a plurality of fasteners, each of the plurality of fasteners installed within a corresponding one of the aligned fastener openings and threaded openings.” Such fasteners are included in the Aplex Pump, the threaded fasteners discussed in section V.B.ii.a, *supra*.

253. The annotated figures below are taken from Aplex. Illustrated in the figures are hex head fasteners. As explained in the preceding section, the skilled

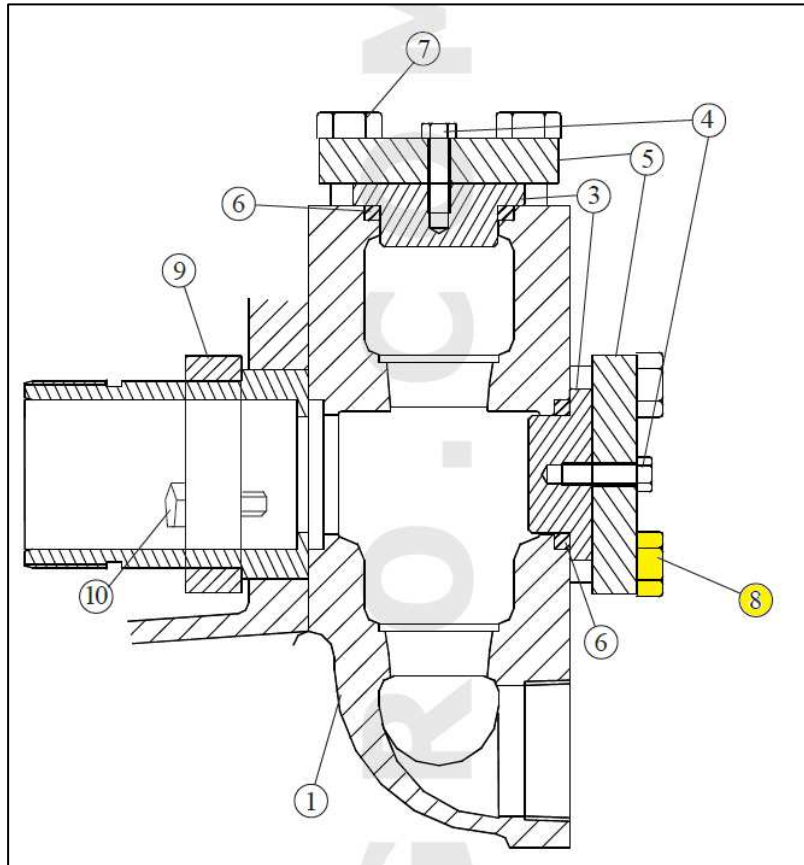
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artisan would understand that such a fastener is a threaded fastener that would install within the aligned fastener openings in the plate and the threaded openings in the housing.



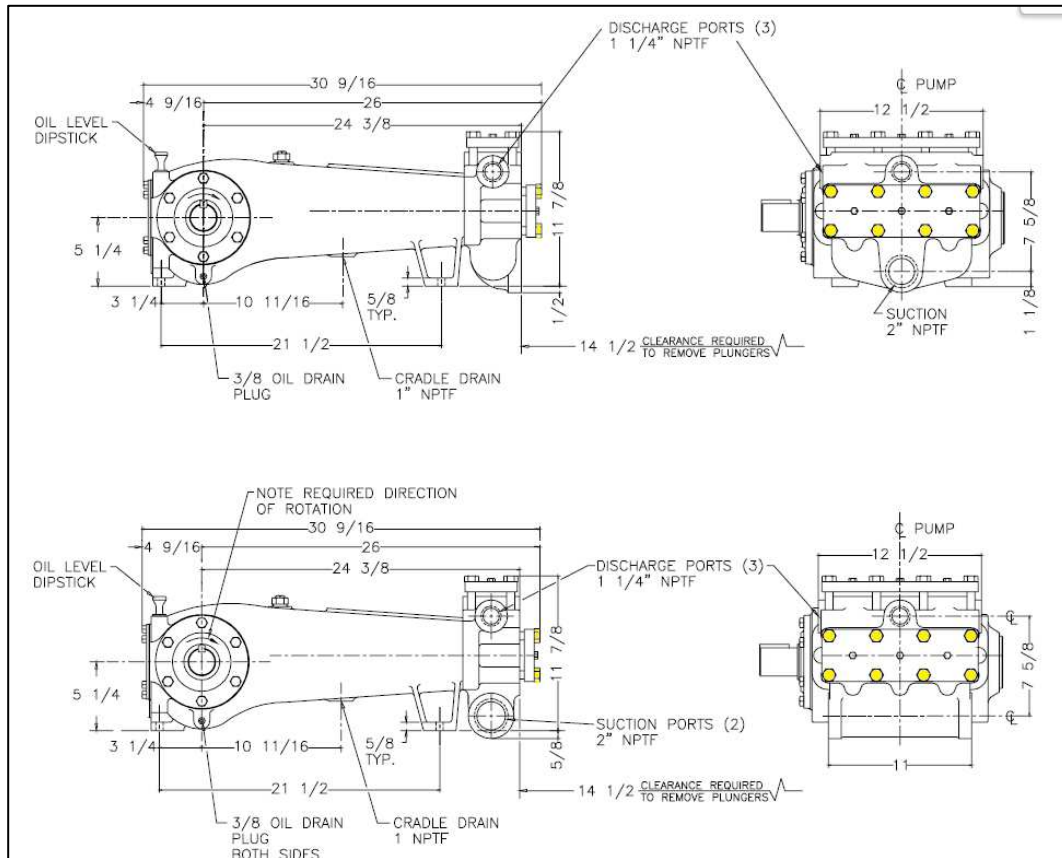
8

8

3/4" NC Hex Head Cap Screw x 9" long

100-034900-273

Aplex (EX1005), p. 38 (annotated): Showing multiple threaded connections.

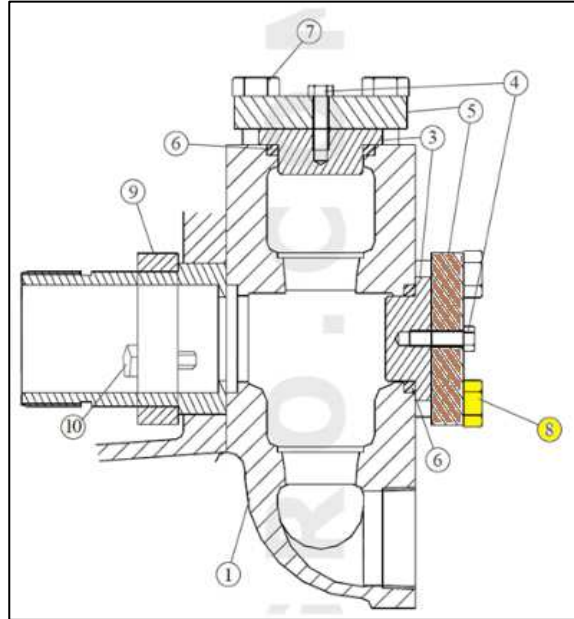


Apex (EX1005), p. 8 (annotated): Showing multiple threaded connections.

- xii. Claim 12 “a plurality of fasteners, each of the plurality of fasteners extending through the plate and into the housing to fasten the plate to the housing.”**

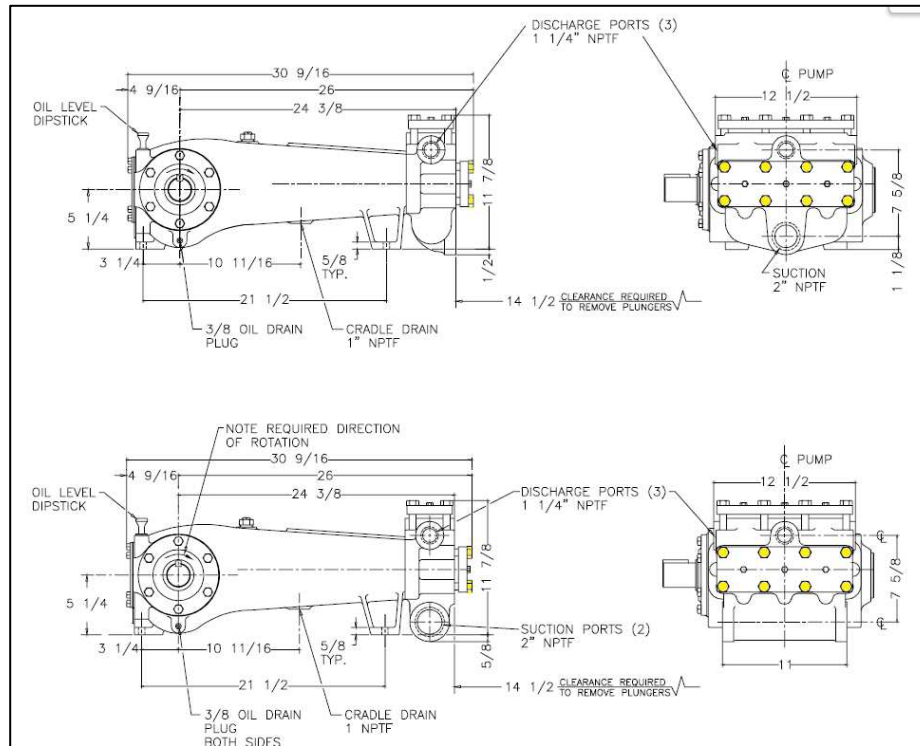
254. Claim 12 of Foster recites “a plurality of fasteners, each of the plurality of fasteners extending through the plate and into the housing to fasten the plate to the housing.” The annotated figures below are taken from Apex and illustrate hex-headed fasteners that secure the cover plates to the fluid end housing. these fasteners are described as “hex head cap screws,” the threaded cap screw fasteners discussed above. The skilled artisan would understand that a hex-headed cap screw fastener (yellow) would need to pass through a fastener opening in the plate (brown) and

engage with an aligned threaded opening in the fluid end housing in order to fasten the plate to the housing.



5	2	Retainer Plate, Valve Cover & Cylinder Head	7203-0110-00B
6	6	Fluid Seal, Nitrile Rubber	7203-0118-00A
7	8	3/4" NC Hex Head Cap Screw x 3" long	100-034300-273
8	8	3/4" NC Hex Head Cap Screw x 9" long	100-034900-273

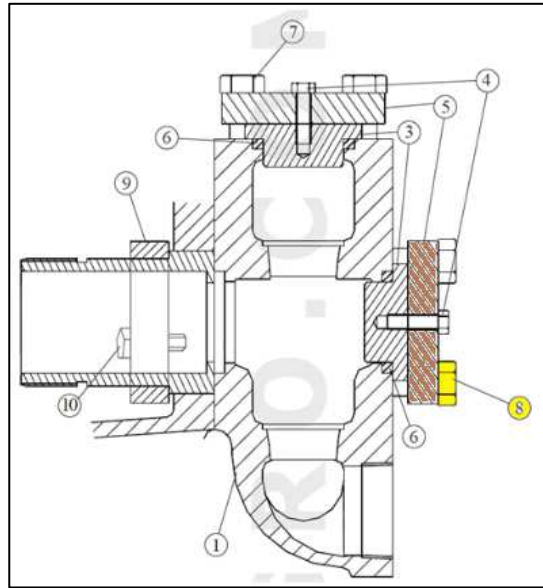
Aplex (EX1005), p. 38 (annotated): Showing multiple threaded connections.



Apex (EX1005), p. 8 (annotated): Showing multiple threaded connections.

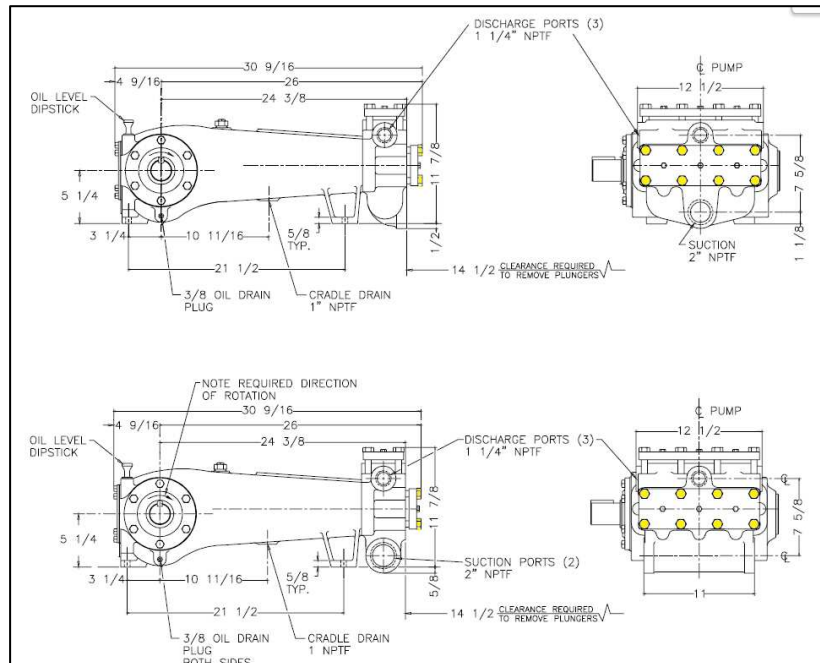
xiii. Claim 13 “each of the plurality of fasteners is a threaded fastener.”

255. Claim 13 of Foster recites that “each of the plurality of fasteners is a threaded fastener.” The capscrew hex head fasteners of Apex would have been understood by the POSITA to be a threaded fastener. A “cap screw” is a type of threaded fastener and the hex head would suggest to the skilled artisan that the cap screw fastener was intended to be secured to the housing via ratchet or wrench. Accordingly, it would have been obvious to the POSITA that each of the Apex hex head cap screw fasteners is a threaded fastener.



5	2	Retainer Plate, Valve Cover & Cylinder Head	7203-0110-00B
6	6	Fluid Seal, Nitrile Rubber	7203-0118-00A
7	8	3/4" NC Hex Head Cap Screw x 3" long	100-034300-273
8	8	3/4" NC Hex Head Cap Screw x 9" long	100-034900-273

Aplex (EX1005), p. 38 (annotated): Showing multiple threaded connections.



Aplex (EX1005), p. 8 (annotated): Showing multiple threaded connections.

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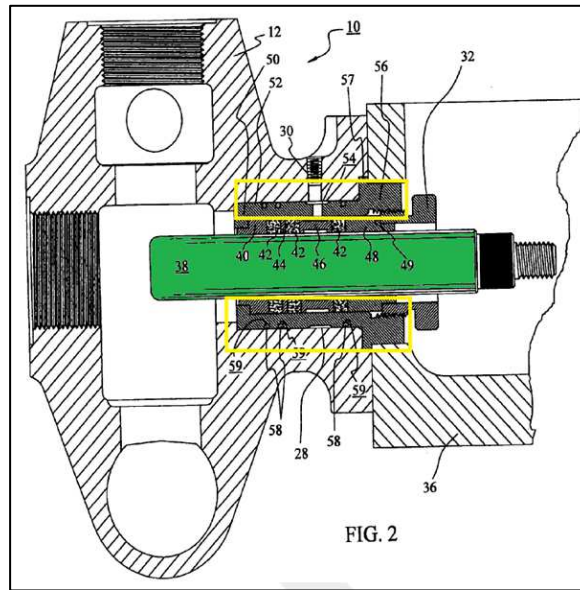
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xiv. Claim 14

- a. 14.a “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore”**

256. Recitation 14.A of claim 14 recites “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore” Where recitation 7.j of claim 7 recites the “first component” for a first plunger assembly, this recitation recites the corresponding “component” for a second plunger assembly of a multiplex pump. Accordingly, Apex modified by Stanton provides a second component for the same reasons as the first component of recitation 7.J.

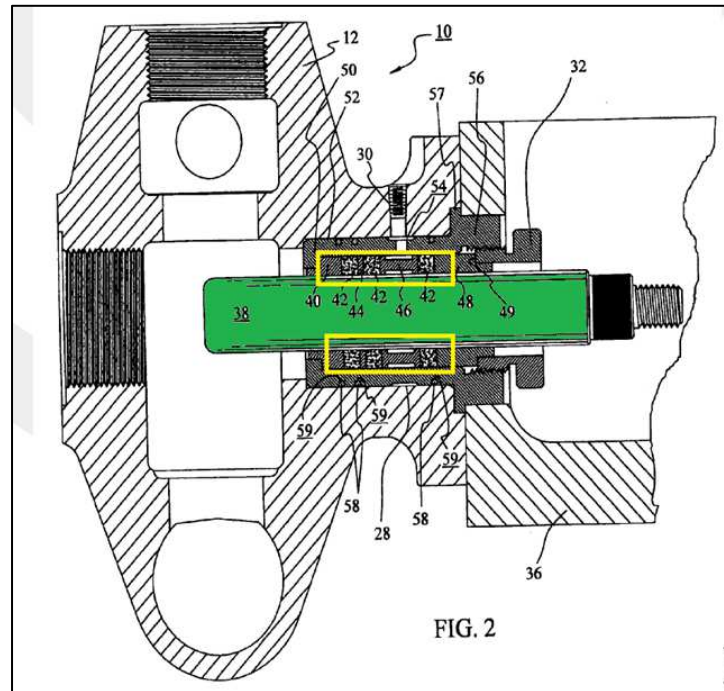
257. While Apex and Stanton do not explicitly illustrate “first” and “second” components, it would have been obvious to the person of ordinary skill in the art that these features would be present in the references due their disclosures as triplex pumps. EX1005, *passim*; Stanton, ¶ [0009].



Stanton (EX1007), FIG. 2 (annotated).

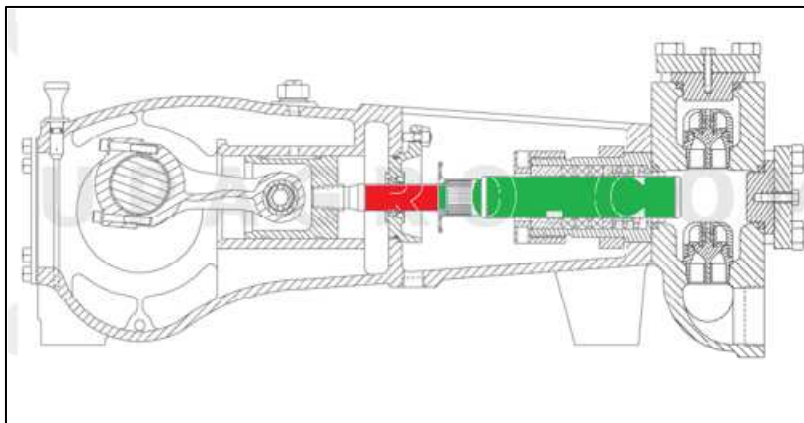
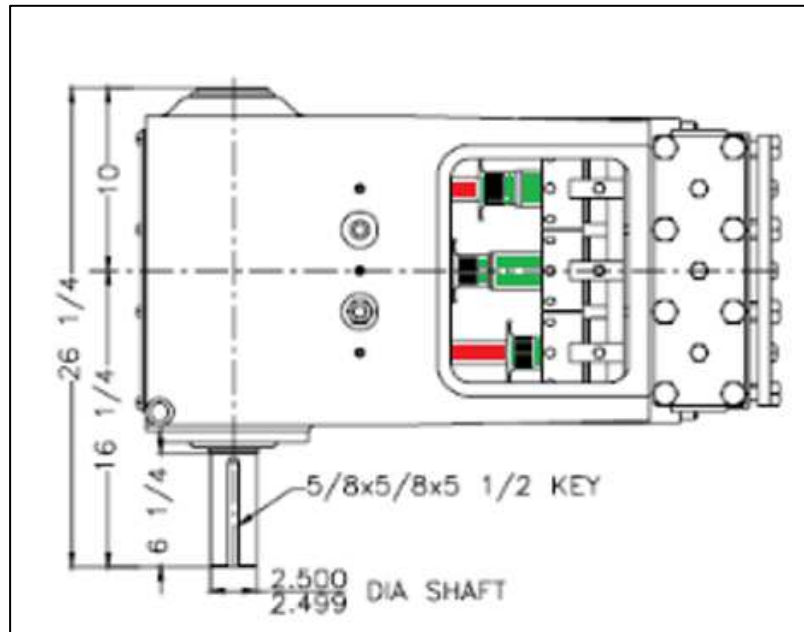
- b. **14.b “a second reciprocating plunger, at least a portion of the second reciprocating plunger installed within the central opening of the second component;”**

258. Recitation 14.b of claim 14 recites “a second reciprocating plunger, at least a portion of the second reciprocating plunger installed within the central opening of the second component” Where recitation 7.i of claim 7 recites the “first reciprocating plunger”, wherein “at least a portion of first reciprocating plunger installed within the central opening of the first component,” this recitation recites the corresponding “second reciprocating plunger” for a second plunger assembly of a multiplex pump. Accordingly, Apex provides “a second reciprocating plunger installed within the central opening of the second component” for the same reasons as the first component of recitation 7.i.



Stanton (EX1007), FIG. 2 (annotated).

259. For completeness, reproduced below are figures from Apex which illustrate the three plunger assemblies of the triplex pumps disclosed in the reference. The skilled artisan would understand that three such plunger assemblies would have the same plunger arrangement, and therefore, the triplex Apex Pump and the triplex pump from Stanton would understand that the Apex Pump as modified to include the stuffing/packing sleeve of Stanton would include “a second reciprocating plunger, at least a portion of the second reciprocating plunger installed within the central opening of the second component.”



Aplex (EX1005), pp. 7 and 8 (annotated).

- c. **14.c “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger;”**

260. Recitation 14.c of claim 14 recites “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger.” Where recitation 7.K of claim 1 recites the “first plurality of packing seals” for a first plunger assembly, this recitation recites the corresponding “second

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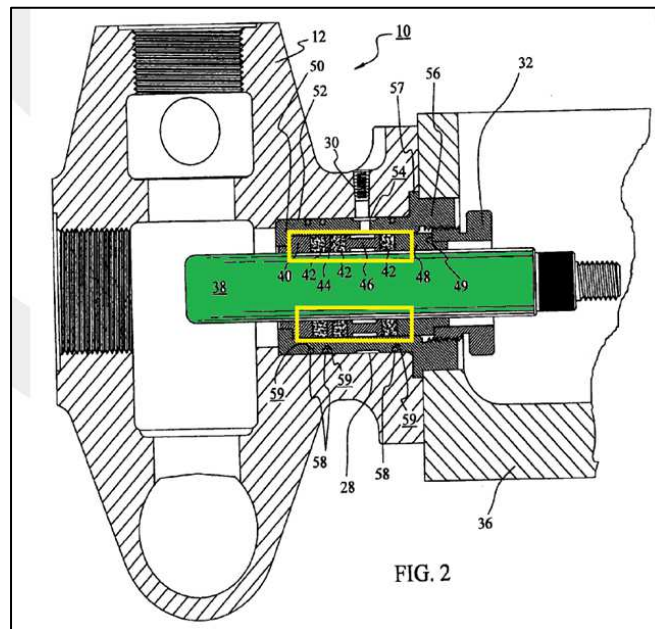
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plurality of packing seals” for a second plunger assembly of a multiplex pump. Accordingly, the Apex Pump modified by Stanton provides a second plurality of packing seals for the same reasons as the first component of recitation 7.K.

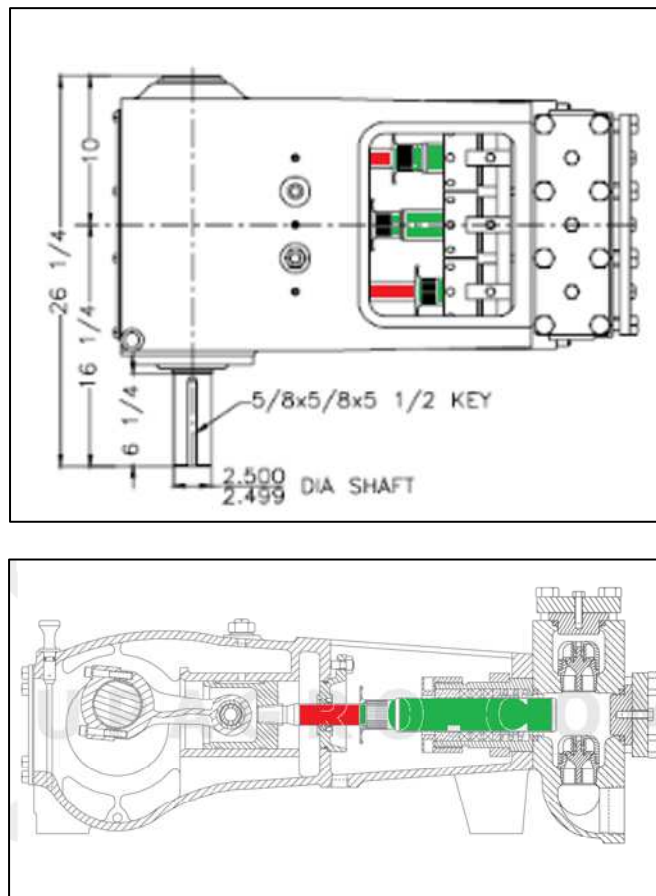
261. While Apex and Stanton do not explicitly illustrate “first” and “second” plurality of packing seals, it would have been obvious to the person of ordinary skill in the art that these features would be present in the references due to their disclosures as triplex pumps. Ex1005, *passim*; Stanton, ¶ [0009].



Stanton (EX1007), FIG. 2 (annotated).

262. For completeness, reproduced below are figures from Apex which illustrate the three plunger assemblies of the triplex pumps disclosed in the reference. The skilled artisan would understand that three such plunger assemblies would have the same plunger arrangement, and therefore, the triplex Apex Pump and the triplex

pump from Stanton would understand that the Apex Pump as modified to include the stuffing/packing sleeve of Stanton would include “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger.”

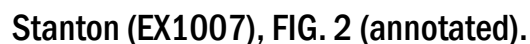


Apex (EX1005), pp. 7 and 8 (annotated).

- d. **14.d “a second packing nut holding the second plurality of packing seals within the second component”**

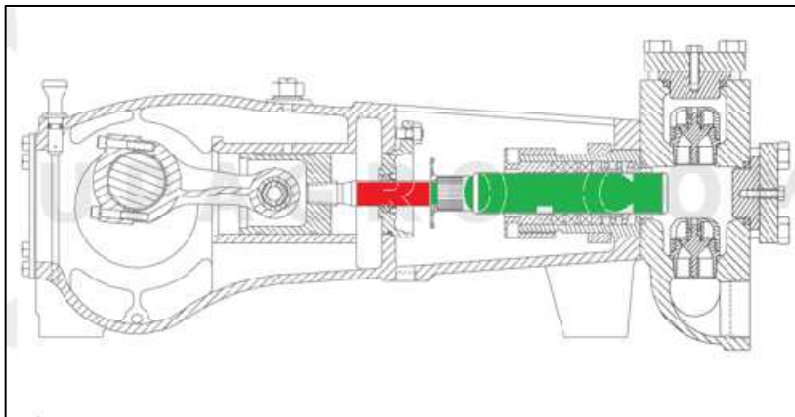
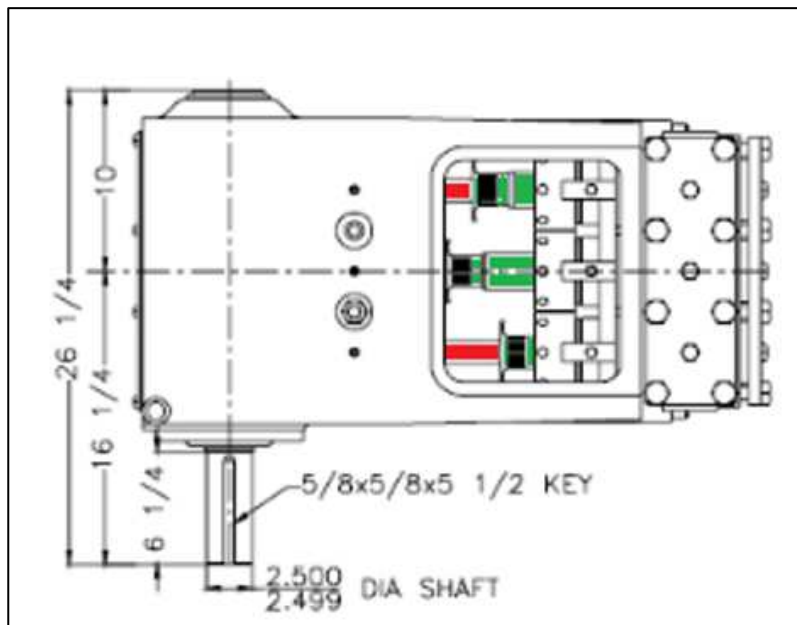
263. Recitation 14.d of claim 14 recites “a second packing nut attached to the second component and holding the second plurality of packing seals within the

264. While Apex and Stanton do not explicitly illustrate “first” and “second” packing nuts, it would have been obvious to the person of ordinary skill in the art that these features would be present in the references due their disclosures as triplex pumps. EX1005, *passim*; Stanton, ¶ [0009].



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the same plunger arrangement, and therefore, the POSITA would understand that Apex as modified to include the stuffing/packing sleeve of Stanton would include “a second packing nut holding the second plurality of packing seals within the second component.”



Apex (EX1005), pp. 7 and 8 (annotated).

xv. Conclusion With Respect to the Second Ground

266. As illustrated through the discussion above, it is my opinion that every recitation of claims 1-14 of Foster would have been obvious at the time of filing.

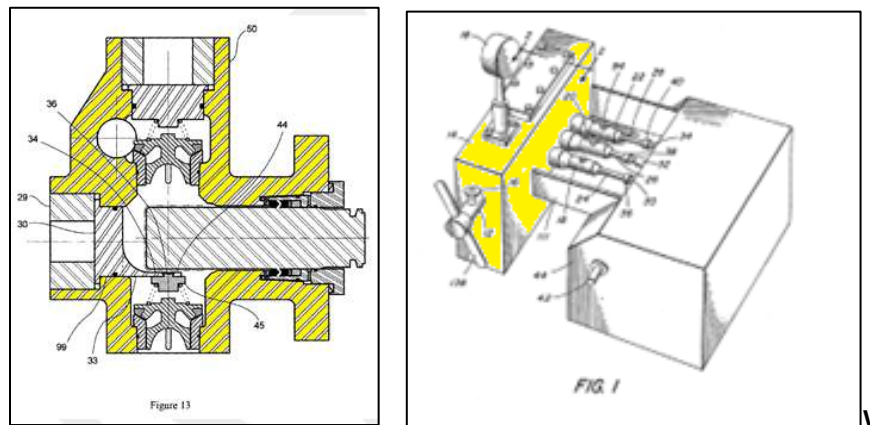
C. Ground 3 – Claims 1-14 are Obvious under 35 U.S.C. § 103 over Blume in view of Wilkinson, and in Further View of Stanton.

i. Claim 1

Features disclosed in Blume

a. 1.P “A fluid end assembly”

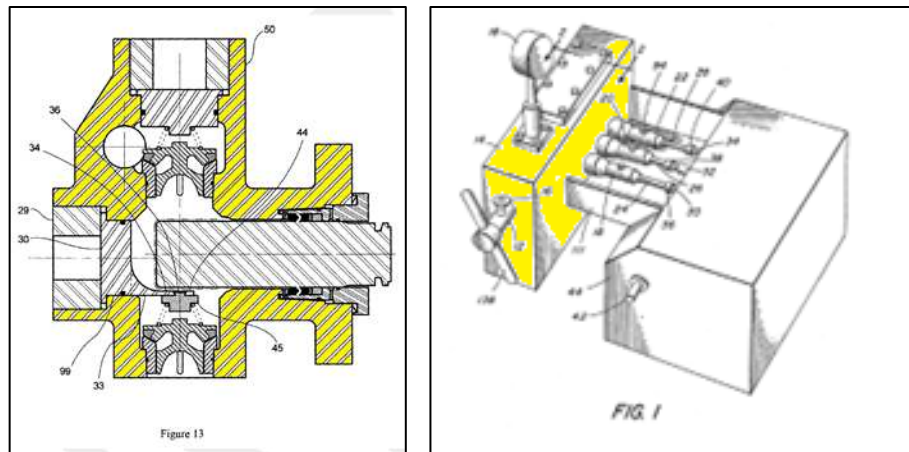
267. The preamble of claim 1 of Foster recites that the claims are directed to a “fluid end assembly.” While I understand that the preamble of a claim does not always recite patentably relevant subject matter, in this case I need not address that issue as Blume, Wilkinson and Stanton all include a “fluid end assembly.”



**Blume (EX1006), FIG. 13 (annotated) (left) and Wilkinson (EX1008) (annotated) (right):
Showing fluid ends.**

b. 1.a “a housing made of a single integrally formed piece”

268. Recitation 1.a. of claim 1 recites “a housing made of a single integrally formed piece.” The annotated figures below are from Blume, Wilkinson, and Stanton. Note that the fluid end of the respective pumps consists of a single piece, such that no breaks or seams are illustrated. This renders as obvious, and not novel, the recitation of “a housing made of a single integrally formed piece.” Indeed, a typical reciprocating power pump, because of the high pressure it develops and contains, would not split the pump liquid end frame or “casing”, but would machine it as a “monoblock”.



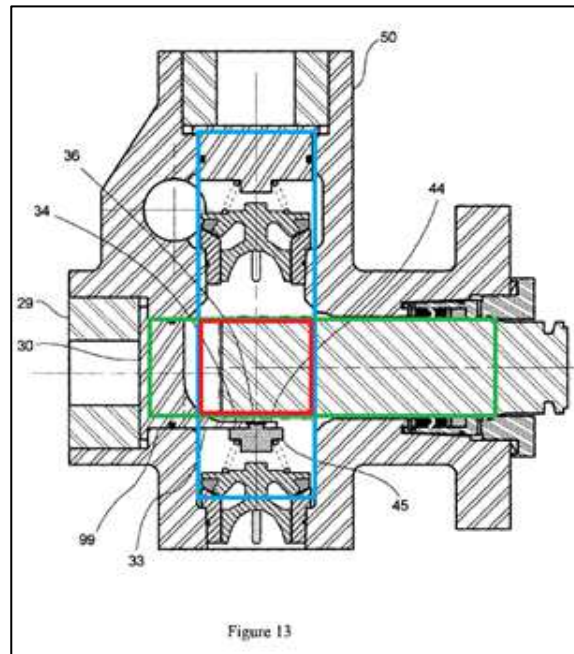
c. 1.b “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber”

269. Recitation 1.b of claim 1 of Foster recites “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber.” Such an internal chamber is a conventional part of a fluid end, as illustrated in the discussion of the prior art I provide above. Furthermore, the figure from Blume that I have reproduced below clearly illustrates that the Blume fluid end includes such an internal chamber (annotated in red) formed by the intersection of a first vertical bore (annotated in blue) formed in the housing and a first horizontal bore (annotated in green) formed in the housing.

270. “First” as used here refers to the bores associated with one of the plungers of the triplex pump provided as an exemplar in Foster, shown in the figure below. The purpose of this internal chamber is to contain the plunger in the horizontal bore and the suction and discharge valves in the intersecting vertical bore. The resulting internal chamber provides a conduit for the suction fluid as the plunger moves backward, and a conduit for the discharge fluid as it is pressurized by the plunger and moves forward within the bore of the horizontal plunger bore and vertical discharge bore of the internal chamber. This is a conventional design for a reciprocating power pump. As such, this falsifies any novelty of Foster’s claim to “a

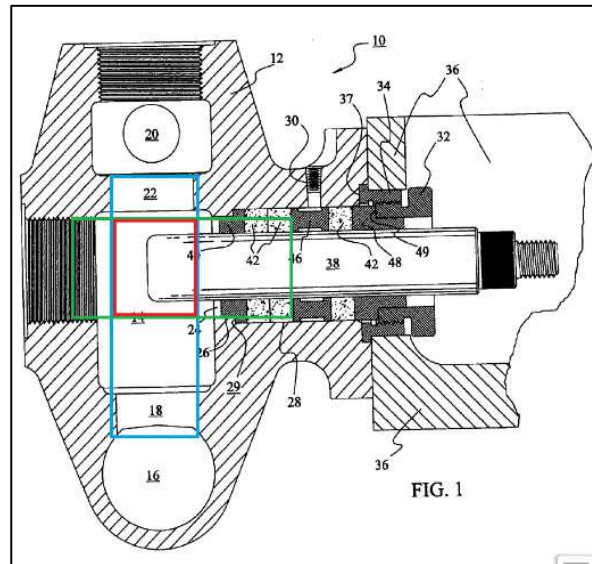
first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber.”

This is illustrated in the figure below:



Blume (EX1006), FIG. 13 (annotated): Cross-section from Blume, demonstrating a very typical reciprocating power pump design.

271. For completeness, I note that the fluid end of Stanton also includes “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber,” as illustrated below.

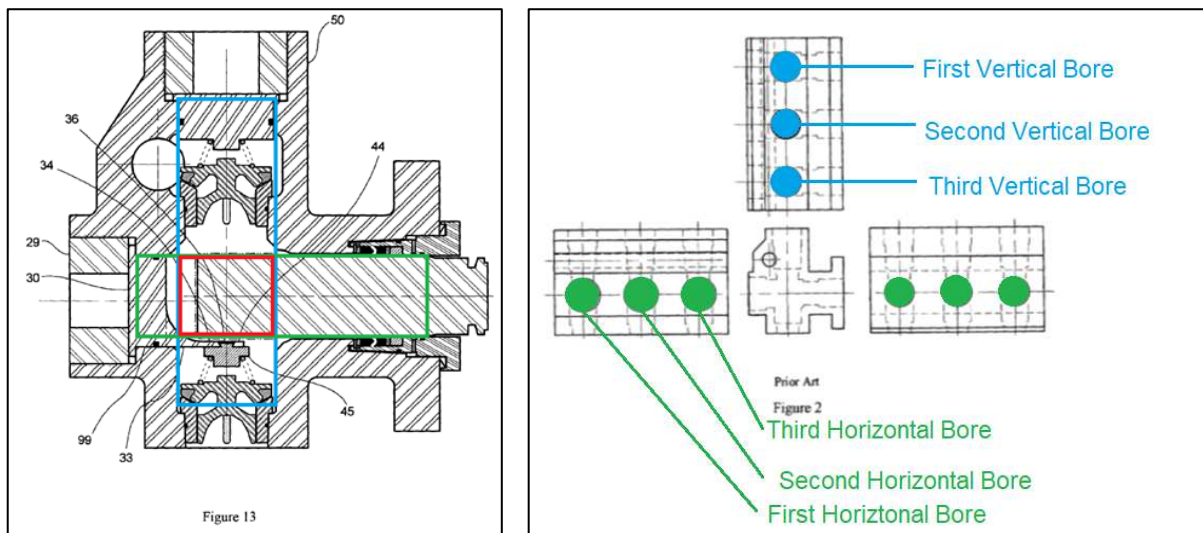


Stanton (EX1007), FIG. 1 (annotated): Cross-section from Stanton, demonstrating a very typical reciprocating power pump design.

- d. 1.c “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber”

272. Recitation 1.c of claim 1 of Foster recites that the “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.” The skilled artisan would understand that this feature of claim 1 is present in the fluid end of Blume as this fluid end is described as being the fluid end for a triplex pump. *E.g.*, EX1006, 1:39-32; 6:66-67. Specifically, “second” as used here refers to the bores associated with a second of the plungers of the example triplex pump. *See, e.g.*, EX1001, 9:60-65. Only one such internal chamber is illustrated in the drawings (e.g. the figure above) because the POSITA would

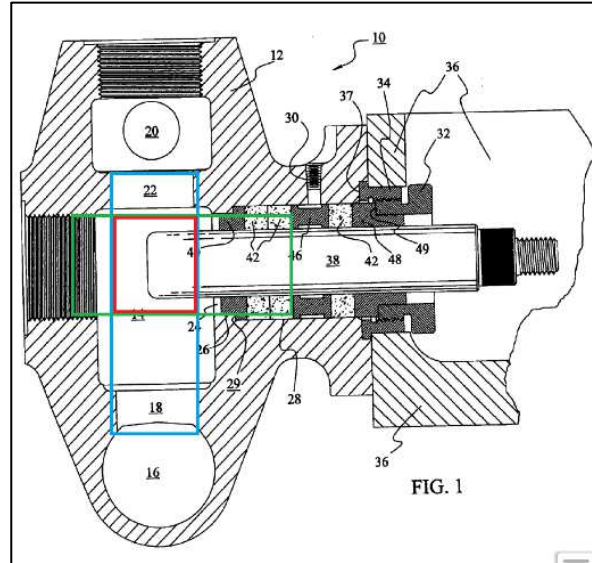
understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in this case, given the triplex pump being the example), each member of which has the same structure. While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the pump illustrated has these features, as would be typical of any reciprocating power pump.



Blume (EX1006), FIGs. 13 and 2 (annotated).

273. For completeness, I note that the fluid end of Stanton also includes “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber,” as illustrated below. Specifically, Stanton discloses that its fluid ends may be used in duplex pumps and in multiplex pumps such as triplex pumps (EX1007, ¶ [0009]), and therefore, it would have been obvious to the skilled artisan that the fluid end of Stanton would include “a second horizontal bore and a second vertical bore

formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber.”

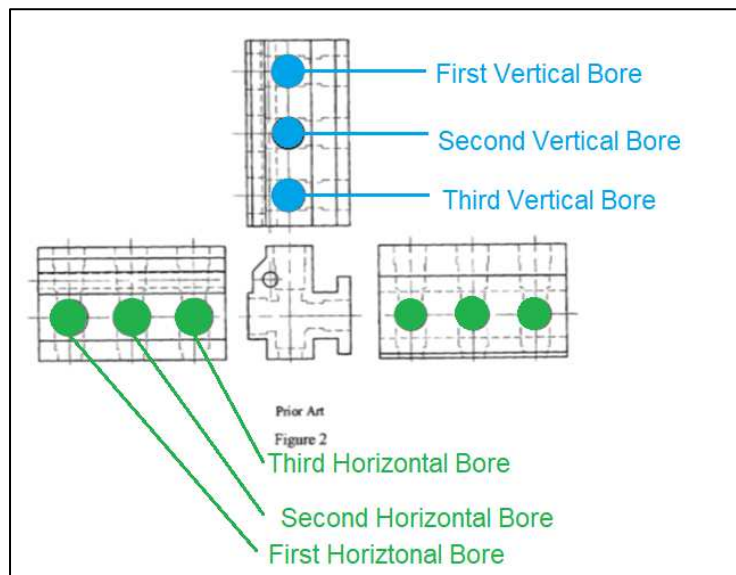


Stanton (EX1007), FIG. 1 (annotated): Cross-section from Stanton, demonstrating a very typical reciprocating power pump design.

- e. **1.d “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber”**

274. Recitation 1.d of claim 1 of Foster recites that the “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.” The skilled artisan would understand that this feature of claim 1 is present in the fluid end of Blume because the fluid end of Blume is described as being suitable for a duplex or multiplex (e.g. triplex) pump. EX1008, 1:29-32; 6:66-67. Furthermore, the drawing in the figure below from Blume shows

side-by-side arrangement of the plugs covering the horizontal and vertical bores of the fluid end. Accordingly, the skilled artisan would understand that the fluid end of Blume includes “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.”



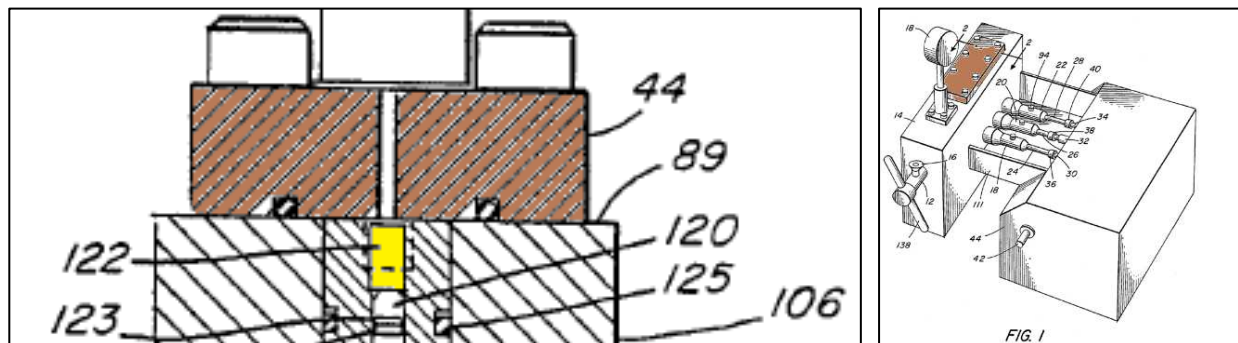
Blume (EX1006), FIG. 2 (annotated).

275. For completeness, I note that Stanton and Wilkinson also would have rendered obvious “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.”

276. Stanton discloses that its fluid ends may be used in duplex and multiplex (e.g. triplex) pumps (EX1007, ¶ [0009]), and therefore, it would have been obvious to the skilled artisan that the fluid end of Stanton would include “the second

horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.”

277. The figure below from Wilkinson shows side-by-side arrangement of the plunger assemblies of the fluid end. Accordingly, the skilled artisan would understand that the fluid end of Wilkinson includes “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.”

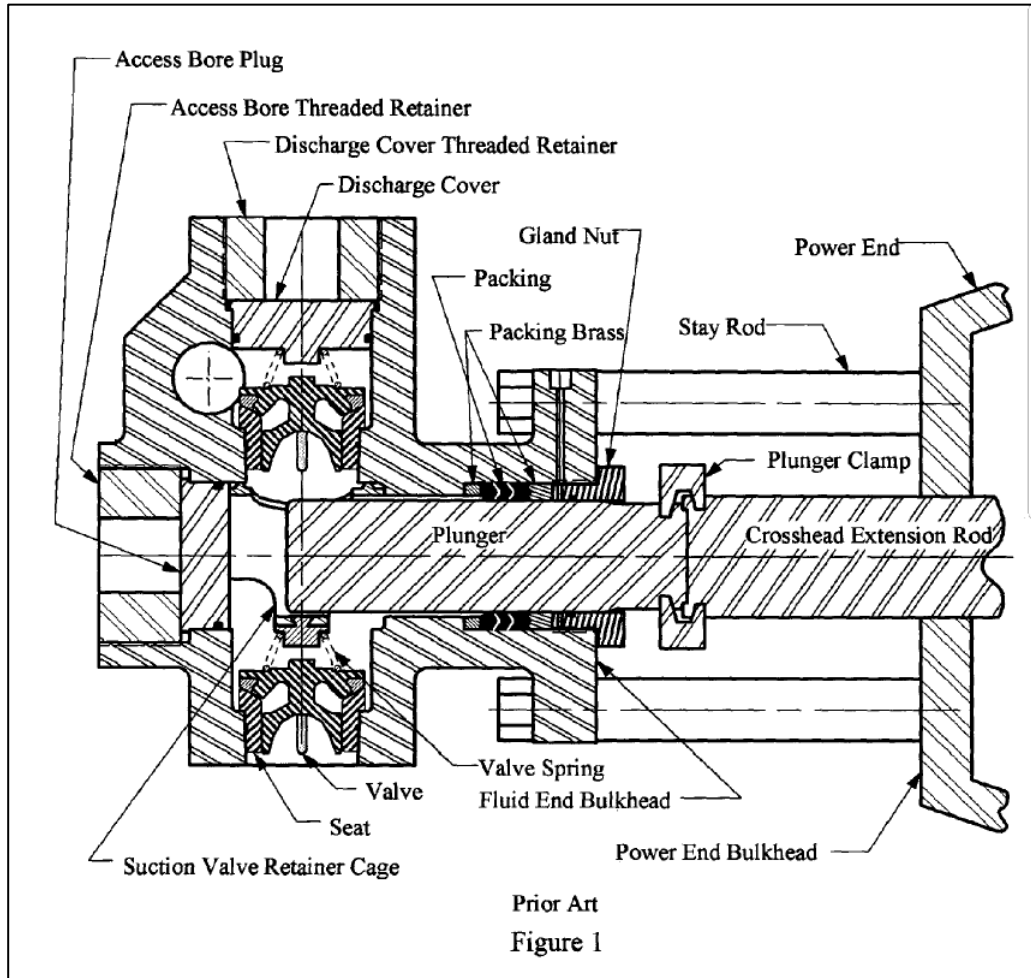


Wilkinson (EX1008), FIGs. 1 and 2 (annotated).

- f. **1.e “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber”**

278. Recitation 1.e of claim 1 recites “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber.” As illustrated below, fluid end from Blume includes a pair of

valves (a suction valve and a discharge valve) positioned on opposite side of the internal chamber.



Blume (EX1008), FIG. 1: Demonstrating a very typical reciprocating power pump design, including valve details.

279. For completeness I note that Stanton and Wilkinson also disclose “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber.” Stanton discloses the following:

[0020]. **The suction valve** is usually a spring-loaded check valve for allowing the flow of fluid from the low-pressure side of the pump through the suction port into the pumping chamber while preventing

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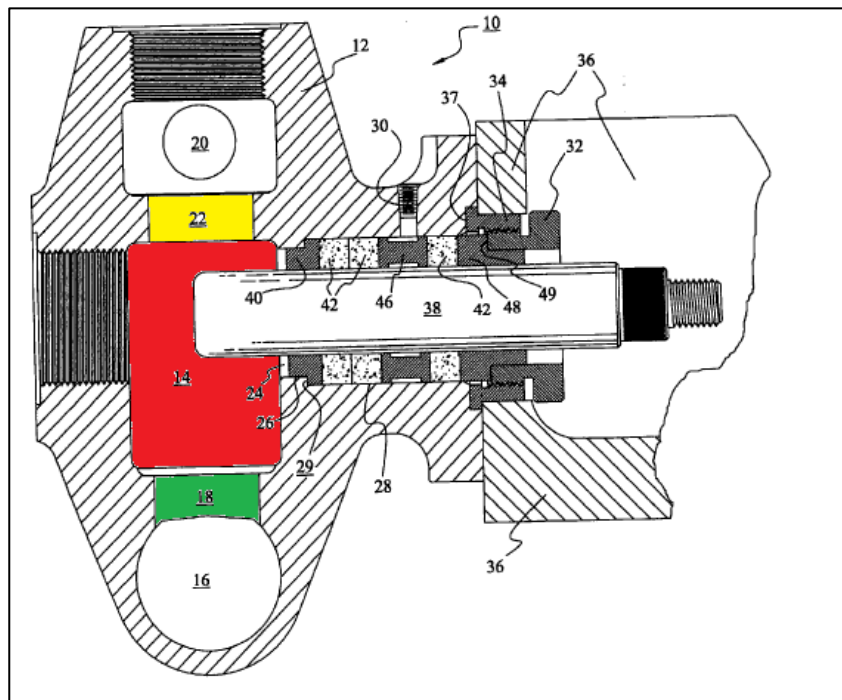
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the backflow of fluid through the suction port. **The discharge valve** is usually a spring-loaded check valve for allowing the flow of fluid from the liquid cylinder through the discharge port to the high-pressure side of the pump with preventing backflow of fluid through the discharge port. **Preferably, although not necessarily, the suction and discharge valves are vertically disposed in the pump, that is, the axis of each of the generally cylindrical valves is vertically oriented in the pump body. Furthermore, the vertical axes of the suction and discharge valves are preferably, although not necessarily, co-axially aligned.**

EX1007, ¶[0020] (emphasis supplied).

280. As illustrated in the annotated version of FIG. 1 from Stanton provided below, the suction valve “deck” 18 (per his nomenclature, where the suction valve is arranged, annotated in green) is positioned on the opposite side of the pumping chamber 14 (annotated in red) from the discharge valve “deck” 22 (per his nomenclature, where the discharge valve is arranged, annotated in yellow).



Stanton (EX1007), FIG. 1 (annotated).

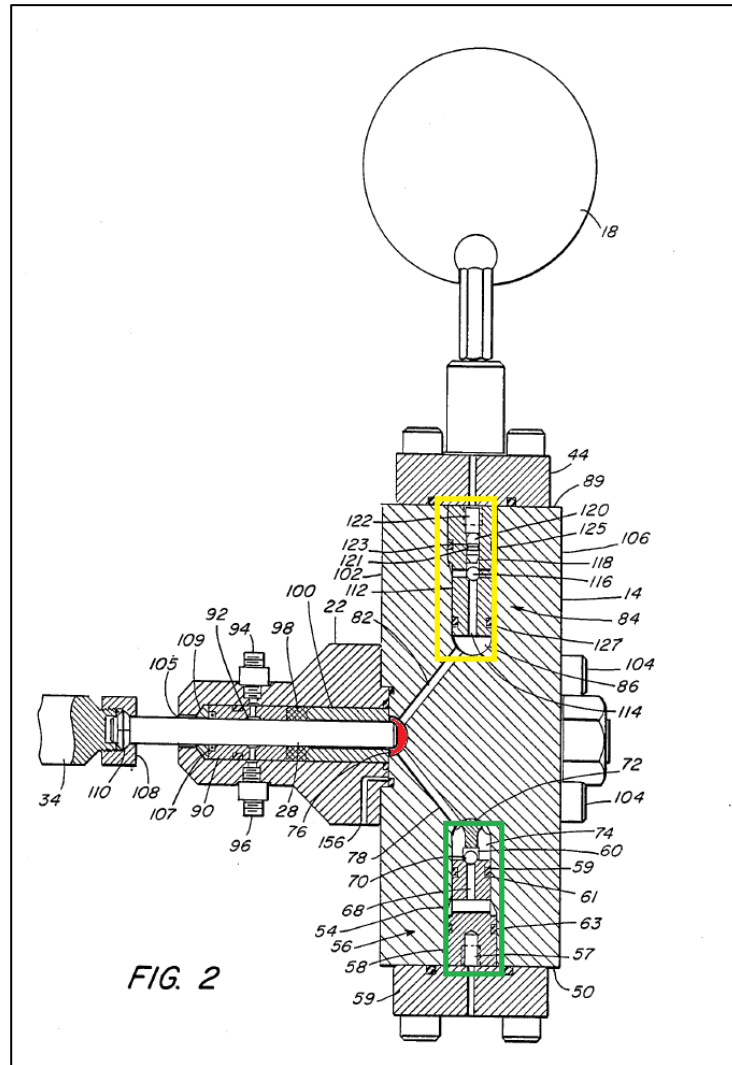
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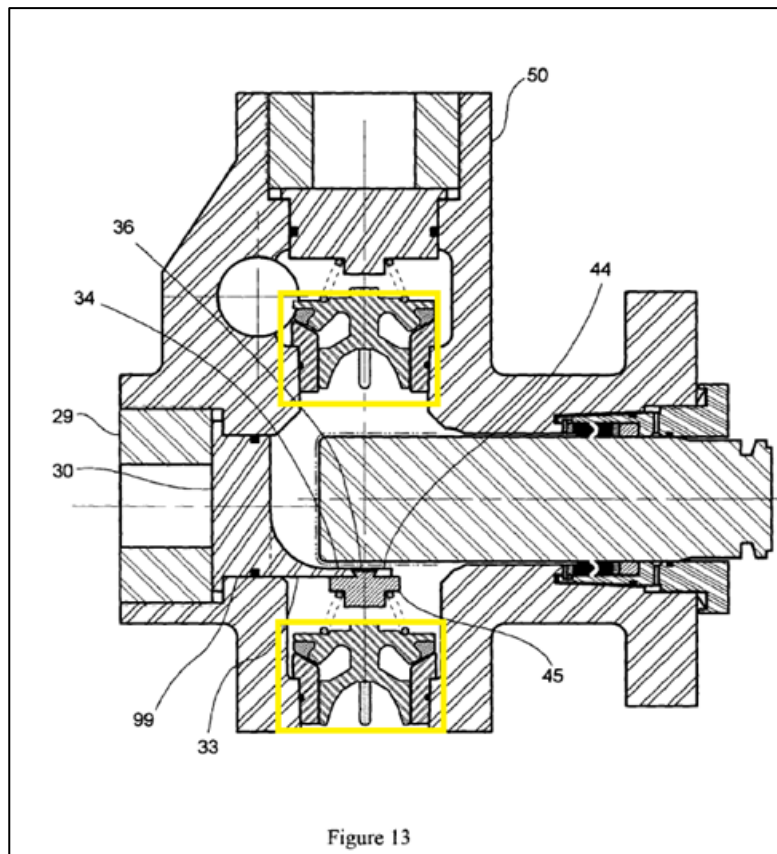
281. As illustrated in the annotated version of FIG. 2 from Wilkinson provided below, the suction valve (annotated in green) is positioned on the opposite side of the pumping chamber 76 (annotated in red) from the discharge valve (annotated in yellow).



Wilkinson (EX1008), FIG. 2 (annotated).

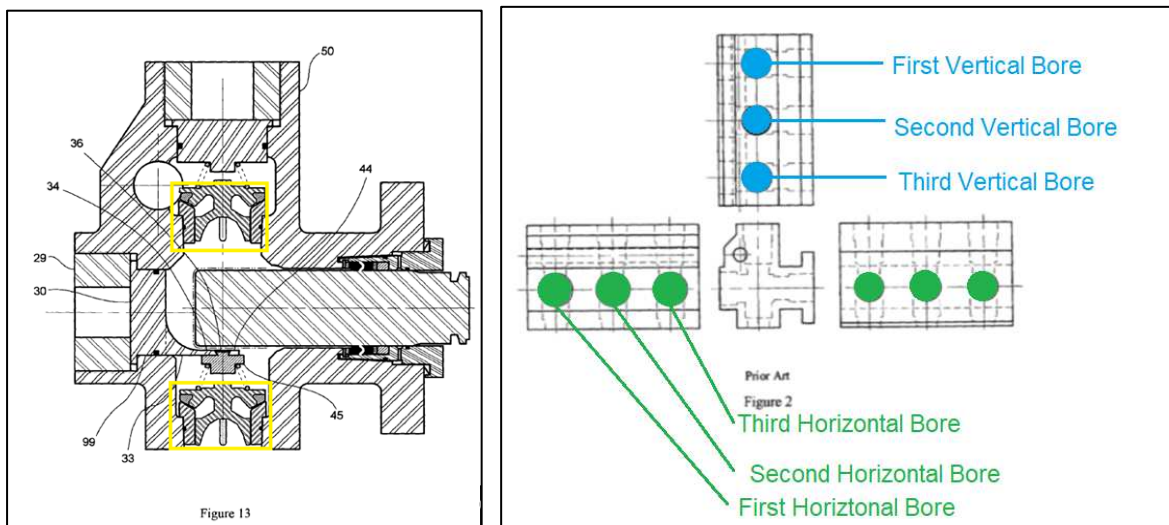
- g. **1.f “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber”**

282. Recitation 1.f of the claim 1 recites “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber.” The POSITA would understand that each of the triplex plunger arrangements of the fluid ends of Stanton would include the valves (suction and discharge) placed as illustrated in the figure below.



Blume (EX1008), FIG. 13 (annotated).

283. As discussed above with respect to recitation 1.C, “second” as used in Foster refers to the additional plunger arrangements in a multiplex, duplex or triplex pump. *See, e.g.*, EX1001, 9:60-65. The POSITA would understand that the each of the plunger arrangements of the Blume fluid end would include substantially the same structure, including the valves illustrated above. Accordingly, “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber” would have been obvious at the time of filing to the skilled artisan from the teachings of Blume.



Blume (EX1006), FIGs. 2 and 13 (annotated).

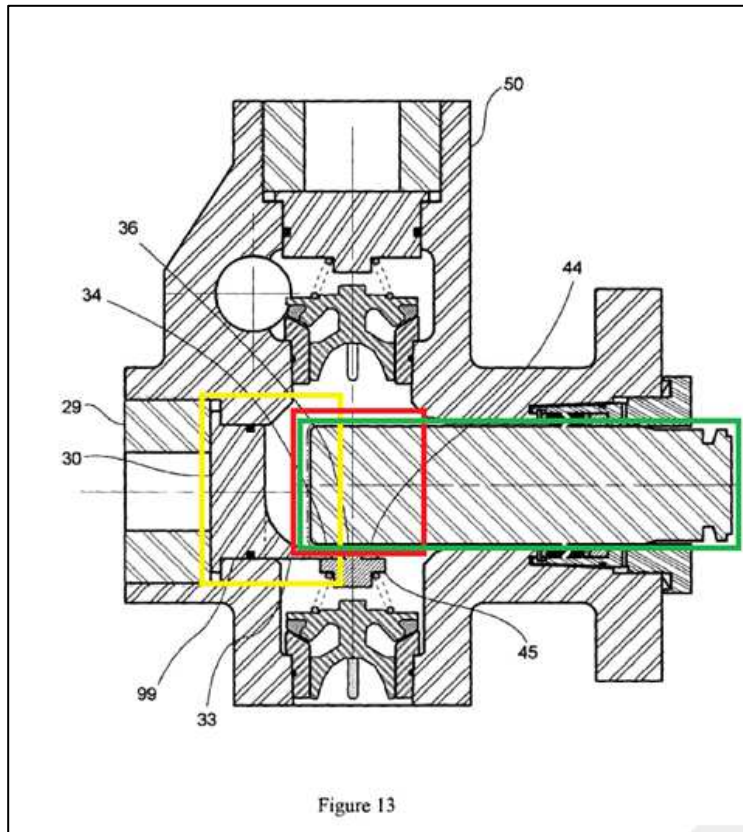
284. Similarly, because Stanton and Wilkinson also disclose multiplex, duplex and triplex pumps, “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber” would have been obvious to the POSITA from these references as well.

Specifically, as illustrated in the figures provided in the discussion above regarding recitation 1.E of claim 1, the POSITA would understand that each of the plunger assemblies of the Stanton and the Wilkinson fluid ends would include the valves highlighted in the above-annotated figures.

h. 1.g “a first plug and a first reciprocating plunger installed within the first horizontal bore and positioned on opposite sides of the first internal chamber”

285. Recitation 1.g recites “a first plug and a first reciprocating plunger installed within the first horizontal bore and positioned on opposite sides of the first internal chamber.” Such a plug is disclosed in Blume.

286. The figure below, from Blume, exhibits a typical liquid end arrangement for a reciprocating power pump. In order to maintain a monoblock (single piece, non-segmented casing) concept, the horizontal bore, within which the plunger (annotated in green) moves and pressurizes the fluid during operation, is closed by a plug (annotated in yellow) rather than being retained as a closed end during the fabrication process. As illustrated, the plug is positioned on an opposite of the internal chamber (annotated in red) from the plunger. This approach allows free access of the boring tool when it is machining the horizontal bore.

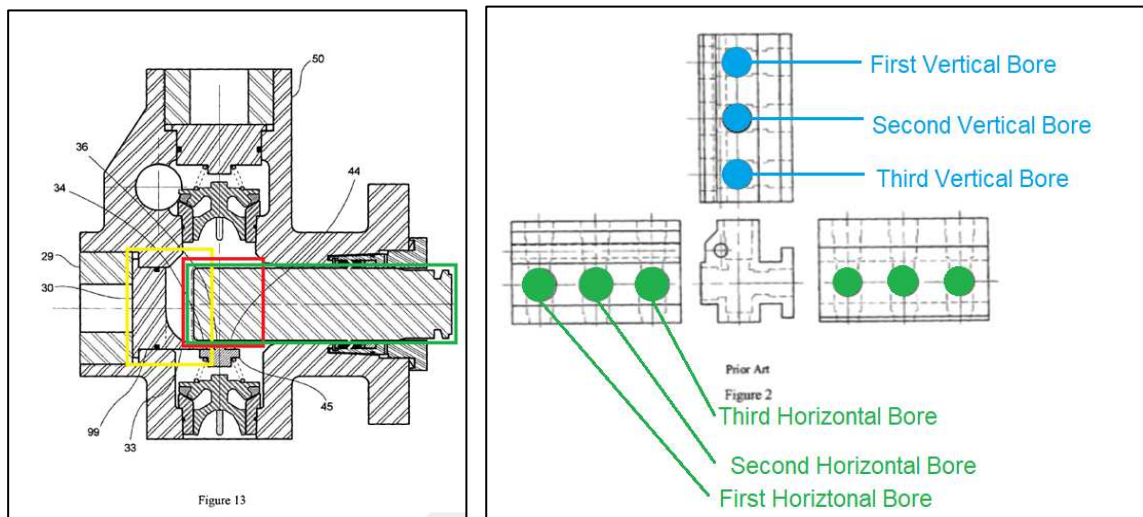


Blume (EX1006), FIG. 13 (annotated): Cross-section demonstrating a very typical reciprocating power pump design, including valve details. Power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs.

- i. 1.h “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber”

287. Recitation 1.h recites “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber.” Such a “second plug” and “second plunger” would have been obvious to the POSITA at the time of filing from the disclosures of Blume. As discussed above with respect to recitation 1.C, “second” as used in Foster refers to

the additional plunger arrangements in a multiplex, duplex or triplex pump. *See, e.g.*, EX1001, 9:60-65. The POSITA would understand that the each of the plunger arrangements of the Blume fluid end would include substantially the same structure, including a plug (annotated in yellow) on an opposite side of the internal chamber (annotated in red) from the plunger (annotated in green) as illustrated in the figure below. Accordingly, “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber” would have been obvious at the time of filing to the skilled artisan from the teachings of Blume.



Blume (EX1006), FIGs. 2 and 13 (annotated): Demonstrating a very typical reciprocating power pump design, including valve details.

j. 1.i “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores”

288. Recitation 1.i of claim 1 of Foster recites “a plate fastened to the housing along an exterior surface containing openings to the first and second

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horizontal bores.” Such a plate would have been obvious to the POSITA based on the combined teachings of Blume and Wilkinson.

289. First, the nature of the recited plate is conventional, and has been used for many years prior to the priority date for the ‘582 Application, including by Kerr themselves. EX1004, *passim*; EX1009, 23. Such a plate also would have been obvious from the patent art at the time of filing of Foster.

290. For example, as shown in the figure below, Wilkinson indicates using such a bolted-on plate to firmly secure the bore plugs against the casing. As described in column 3 line 25 of Wilkinson:

A set of three suction valves are accessed through the bottom of the block 14, and a set of three discharge valves are accessed through the top of the block by removal of a plate 44.

EX1008, 3:25.

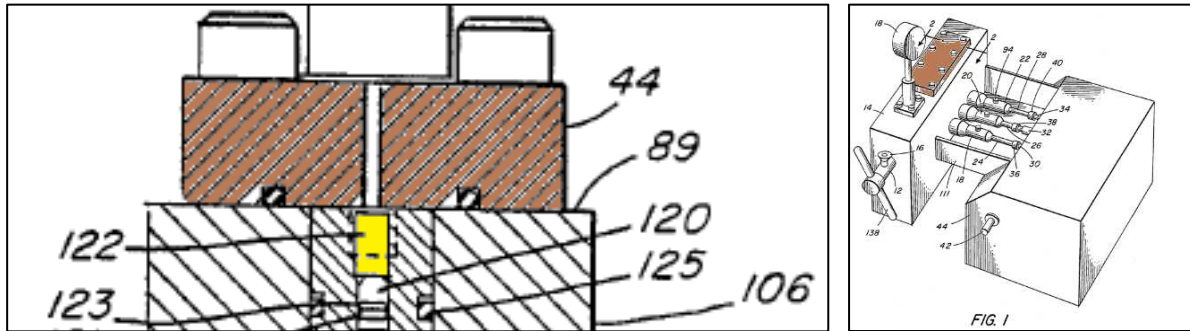
291. As further explained in Wilkinson:

Each discharge valve assembly comprises a valve seat 112 having a center channel 114 in communication with the hemispherical termination of the valve bore. A ball 116 is guided within a bore 118 above the valve seat. A valve stop 120 is positioned in bore 118 of the valve seat and is retained by a removable plug 122.

EX1008, 4:55-60 (emphasis added).

292. As indicated in the detail from FIG. 2 of Wilkinson provided below, plate 44 is fastened along the surface of the fluid end to retain the valve assembly,

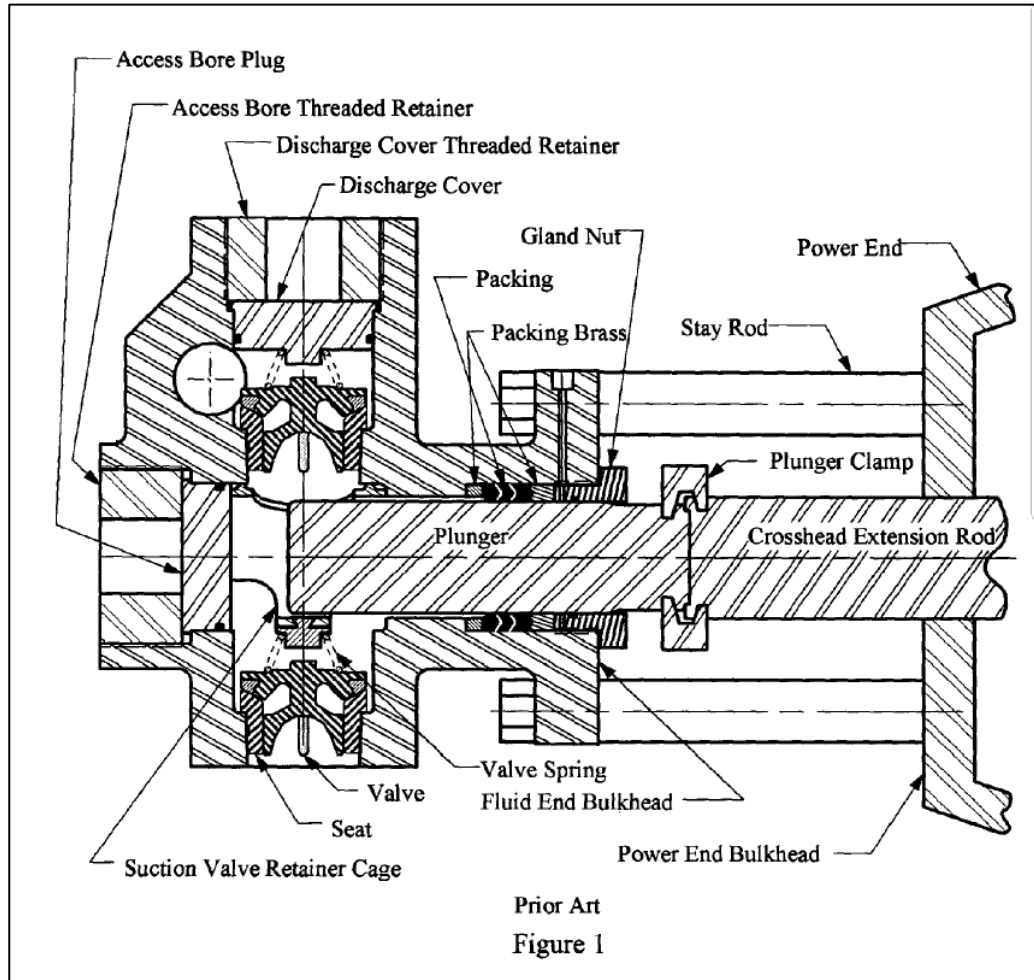
including plug 122. As illustrate in FIG. 1 from Wilkinson, plate 44 covers the three bores associated with the three plunger assemblies of the Wilkinson fluid end.



Wilkinson (EX1008), FIGs. 1 and 2 (annotated).

293. Claim 1 of Foster recites a plate that covers a horizontal bore, not a vertical bore. It would, however, have been obvious to the POSITA to use the plates from Wilkinson on the Blume fluid end. The POSITA would understand that there are numerous ways to secure a bore plug in a bore, such as the threaded plug of Blume or the cover plate as illustrated in Wilkinson. While Wilkinson uses the plates 44 and 59 to secure the assemblies and plugs in the discharge bores and suction bores, respectively, Blume shows that the same method of securing the plugs in the suction and discharge bores (*i.e.* the plates) can be used to retain the plug in its access bore. More specifically, Blume uses the same retention technique to secure the plugs in both their horizontal and vertical bores. As illustrated below, an essentially identical threaded retainer is used to retain the discharge cover in the vertical bore as is used to retain the access bore plug in the horizontal bore. This would suggest

to the POSITA that the same retention method, which ever one is selected, may be used to cover both the vertical and horizontal bores of a fluid end.



Blume (EX1006), FIG. 1.

294. Accordingly, it would have been obvious to the skilled artisan to use a plate, such as plate 44 or 59 of Wilkinson, to secure the plug in the access bore of the Blume fluid end. Specifically, the skilled artisan would understand that if a cover plate can be used to cover a vertical bore, then a structurally similar or identical plate could be used to cover a horizontal bore. Therefore, using a cover plate to cover the

horizontal bore of Blume would be nothing more than replacing one method of securing a bore plug with another known method with predictable results.

295. The skilled artisan would also understand that the structural and functional requirements for a vertical bore cover in Wilkinson are the same as those for the horizontal bore cover of Blume. The skilled artisan would understand that the vertical bore pressure experienced by Blume and Wilkinson, would be equivalent to the pressure experienced by the horizontal bore. Therefore, the skilled artisan would understand that using the vertical bore cover plate from Wilkinson would be an obvious and viable alternative for the bore plug retainer 29 of Blume.¹

296. For completeness, I note that the patentee of Foster argued that it would not be obvious to provide a plate as disclosed in Blume as a cover for a horizontal bore. EX1002. 49-50. This argument, however, was premised on Blume being applied to a modular bore block in which a separate structure is provided for each plunger assembly:

¹ Furthermore, numerous other prior references, including those cited here (*e.g.*, Kerr (EX1004), Apex (EX1005), the Kerr website (EX1009, 23-24), the Kere Spec Sheet (EX1011), would have informed the POSITA's knowledge, reinforcing the obvious conclusion that the Wilkson vertical bore plate could be used to cover a horizontal bore of a fluid end like that in Blume.

The Examiner claims it would be obvious to modify Orr to become a "housing made of a single, integrally-formed piece" with a "plate fastened to the housing". Action at 5. Applicant disagrees. As discussed above, **Orr distinctly teaches modular fluid blocks 52, each block having an individual ring 60 attached thereto - not a plate.** Even if an artisan were to combine two Orr fluid blocks into one, he or she would merely scale up Orr's own teaching, and use two locking rings. To combine multiple rings into one would not be advantageous, as an artisan would thereafter have to remove the entire combined ring from the surface during maintenance, as opposed to selective rings. It would therefore not be obvious to modify the plates 44/59 taught in Wilkinson along with the rings 60 taught in Orr to accomplish the features of claim 1.

EX1002, 49-50 (emphasis supplied).

297. In the present ground of rejection, the plate of Wilkinson is not being applied to a modular fluid end, but the monolithic fluid end of Blume. Accordingly, it is my opinion that this argument by the patentee in no way affects the strong obviousness rationale presented herein.

298. Elsewhere during prosecution, the patentee argued that it would not have been obvious to apply the cover plate from Wilkinson to a horizontal bore simply because Wilkinson only illustrates vertical bore covers, and therefore, the skilled artisan would not think to use a cover plate on the horizontal bore. *See, e.g.,* Prosecution History at 49 ("the plates cover vertical discharge and suction valve openings on the top and bottom surfaces of the block."). This seems disingenuous given the patentees repeated use of horizontal bore covers (EX1004, *passim*, EX1009, 23). Furthermore, Foster itself draws no distinctions between its horizontal

bore covers and its vertical bore covers, giving them the same reference number (“316”), illustrating them with identical structure, and describing them as having identical function. EX1001, 8:41-51. The skilled artisan would clearly understand that a cover plate suitable to cover a vertical bore would similarly be suitable to cover a horizontal bore.

299. Finally, based on my reading of the Examiner’s reasons for allowance of the claims of Foster, I understand that the examiner misunderstood the scope of the claims under examination. As noted in the reasons for allowance:

While Wilkinson (US 4773833) teaches a single plate (44 or 59) and a single housing where the plate spans multiple fluid end bores, **the plate does not have openings that open to the bores.**

EX1002, 13 (emphasis added).

300. The feature of a bore cover with “openings that open to the bores” was cancelled from the claims in the amendment immediately preceding the notice of allowance:

a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores; and having a first and a second opening formed therein, the first opening aligned with the first horizontal bore and the second opening aligned with the second horizontal bore, the first opening exposing the first plug and the second opening exposing the second plug;

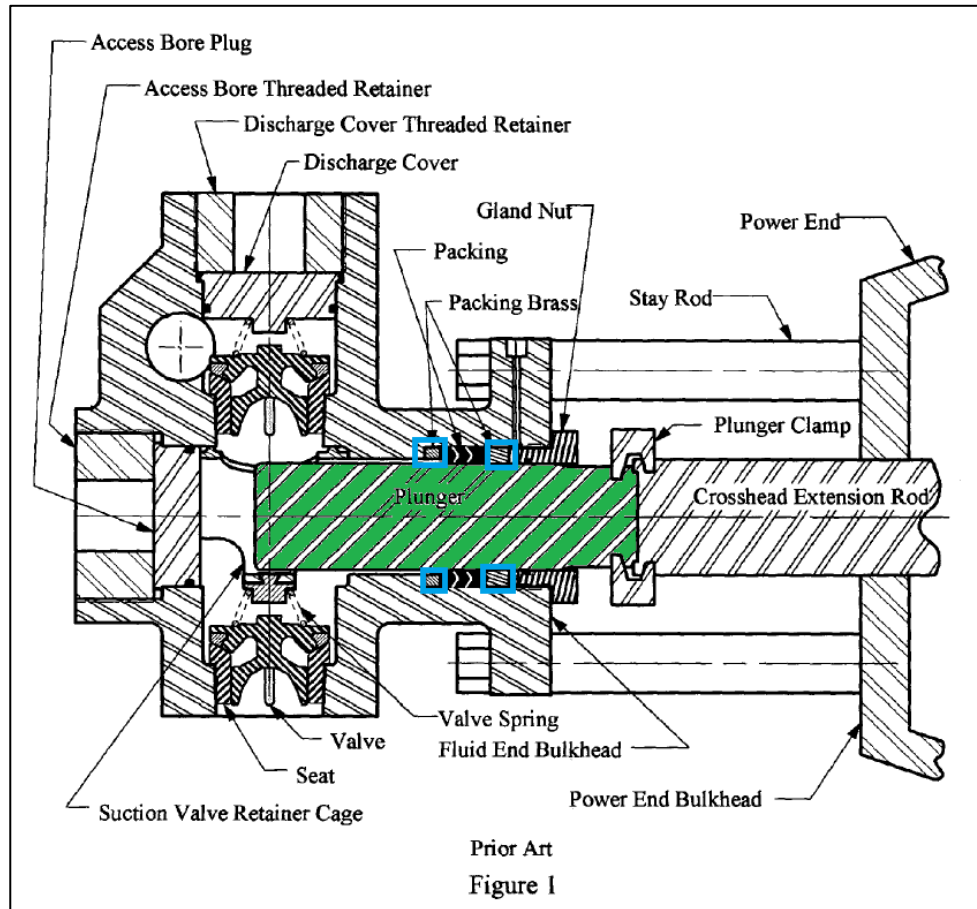
EX1002, 43.

301. Accordingly, it is my opinion that the examiner was clearly mistaken in allowing the claims of Foster over the prior art and Wilkinson in particular.

k. 1.j “a first component having a central opening formed therein, at least a portion of the first component installed within the first horizontal bore and at least a portion of the first reciprocating plunger installed within the central opening of the first component”

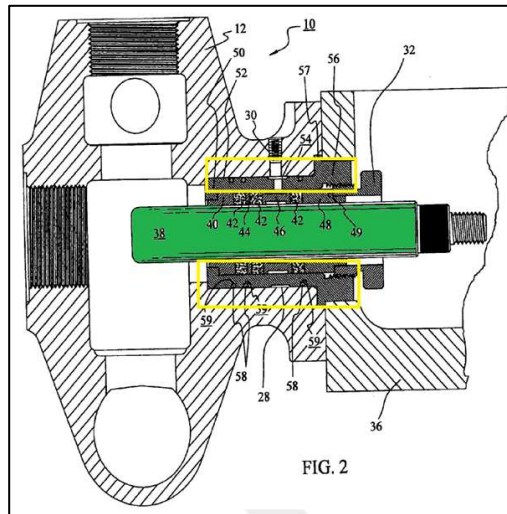
302. Recitation 1.j of claim 1 of Foster recites “a first component having a central opening formed therein, at least a portion of the first component installed within the first horizontal bore and at least a portion of the first reciprocating plunger installed within the central opening of the first component.” Blume in view of Stanton and Wilkinson would have rendered obvious “a first component having a central opening formed therein, at least a portion of the first component installed within the first horizontal bore and at least a portion of the first reciprocating plunger installed within the central opening of the first component.”

303. First, “component” is a broad term that could refer to almost any structure arranged within the first horizontal bore other than the later recited “seals.” Foster, however, describes a “stuffing box sleeves” as potential component. *See, e.g.,* EX1001 at 4:15-16; 6:66-67; 9:17-20; 11:2-4. Blume includes a component (blue) including a central opening with a portion of a reciprocating plunger (green) installed within the sleeve, as illustrated in the annotated figures below.



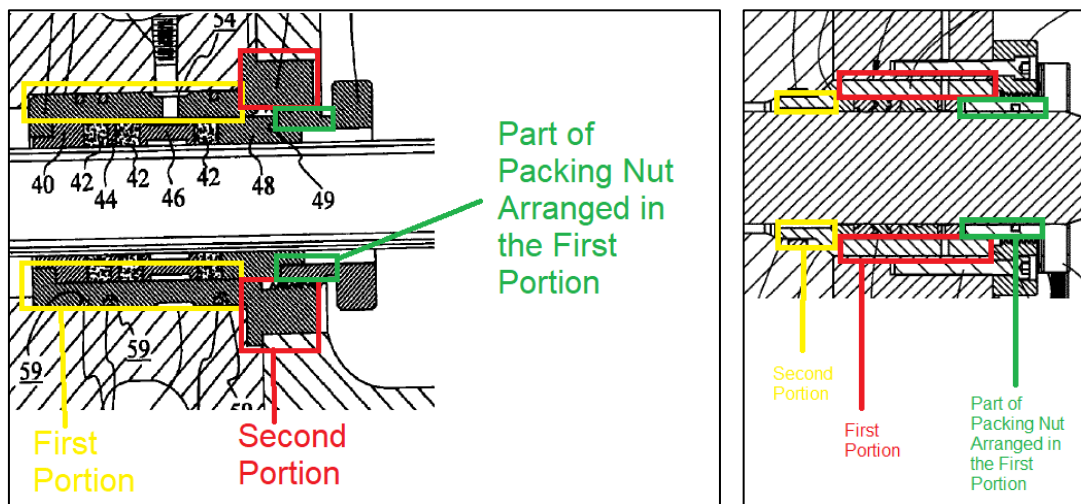
Blume (EX1006), FIG. 1 (annotated).

304. Blume component, however, is not explicitly illustrated as being a sleeve. While a sleeve is not necessary to disclose the broad term “component,” I use the sleeve of Stanton in the present ground of rejection because a packing sleeve is an example of a “component” that is disclosed Foster. As illustrated below, the Stanton packing sleeve (annotated in yellow) includes a portion that is installed in the horizontal bore and in which the plunger (annotated in green) is partially installed within the packing sleeve.



Stanton (EX1007), FIG. 2 (annotated).

305. In fact, the stuffing box of the reference includes the *unclaimed* features of the packing sleeve described in Foster – a first portion with a larger diameter than a second portion in which part of the packing nut is arranged, as illustrated in the detail of FIG. 2 from Stanton provided below and compared with a detail of FIG. 6 of Foster.



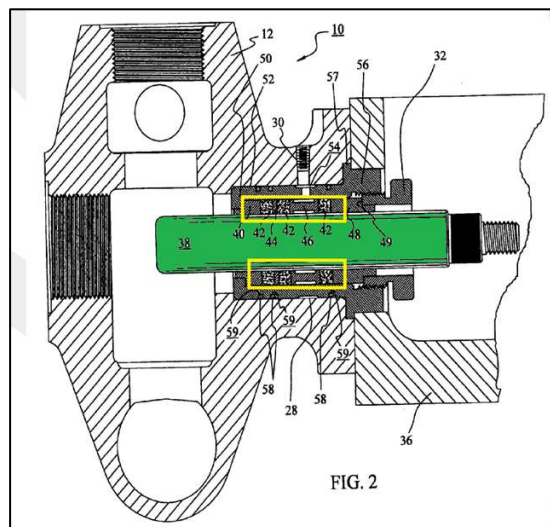
Comparison of the Packing Sleeve of Stanton with the Component of Foster.

306. The skilled artisan would have understood that replacing the packing/stuffing arrangement of Blume with that of Stanton would be replacing one known method of providing packing to a plunger pump with another known method with predictable results. Furthermore, the skilled artisan would have been motivated to make such a modification because the skilled artisan would understand that providing a packing nut that screws into the stuffing box sleeve, as provided in Stanton, allows the compression of the packing arranged within the stuffing box sleeve to be set by torquing the packing nut 32 to a particular value. The arrangement of Blume requires a spring or other additional parts within the sleeve to set the pressure.

307. Having a packing nut that screws into a packing sleeve, as provided for in Stanton, also provides for easier repair in the event of damaged threads in that the stuffing box sleeve may be replaced in the event of the damaged threads. In contrast, in the Blume design, the packing nut screws into the fluid end housing, making damaged threads much more difficult to replaced or repair, requiring repair or replacement of the fluid end housing. The above-described design choices would provide ample motivation for the skilled artisan to include a packing arrangement as provided for in Stanton in the place of the packing arrangement of Blume.

l. 1.k “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger”

308. Recitation 1.k of claim 1 of Foster recites “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger.” Blume as modified by Stanton and Wilkinson would have rendered such a “first plurality of packing seals” obvious. This is a conventional feature of reciprocating plunger pumps that is included in the fluid ends of this ground of rejection. Because this ground of rejection is relying on the packing sleeve from Stanton, it also relies on the seals from Stanton. The figures below illustrate “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger” in the Stanton fluid end, annotated in yellow. Accordingly, Stanton includes “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger.”



Stanton (EX1007), FIG. 2 (annotated).

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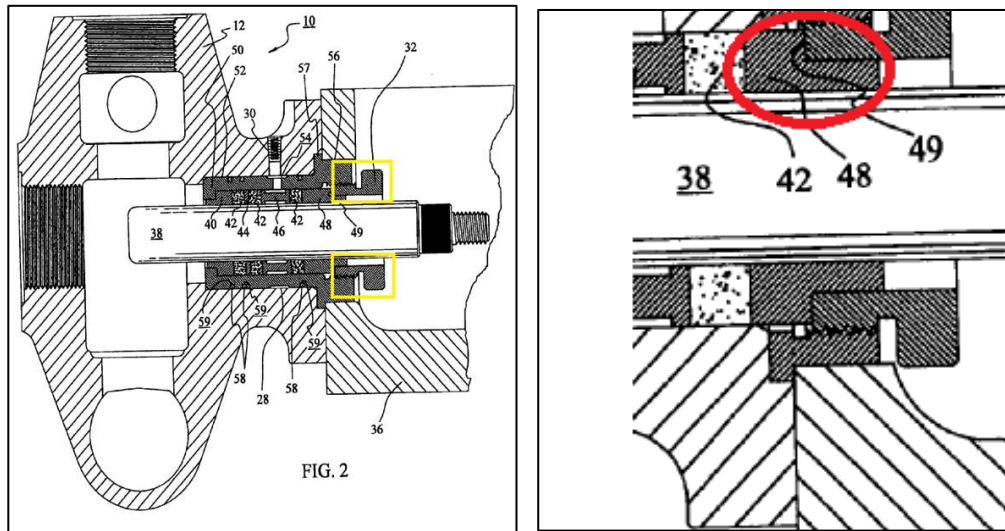
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m. 1.1 “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.”

309. Recitation 1.1 of claim 1 of Foster recites “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.” Such a packing nut is included in Stanton.

310. The annotated figures below, the packing nut (annotated in yellow) is attached to the sleeve with threading. This mimics how any packing nut “hold[s] the first plurality of packing seals within the first component” (EX1001, claim 1) due to the compression of the packing. If there is no nut, then all the packing loses its fit and function, because the pressure ahead of the plunger would push the packing from the bore, and it could not seal around the plunger. This nut not only compresses the packing rings to squeeze out radial clearance around the plunger through which fluid could leak, but acts to hold the packing rings in the sleeve and as an additional fluid barrier at the rear of the packing box assembly, essentially acting as a detachable rear end of the packing sleeve, as circled in red in the figure below. Accordingly, Stanton includes “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.”



Stanton (EX1007), FIG. 2 (annotated): Illustrating the packing nut along with packing assembly.

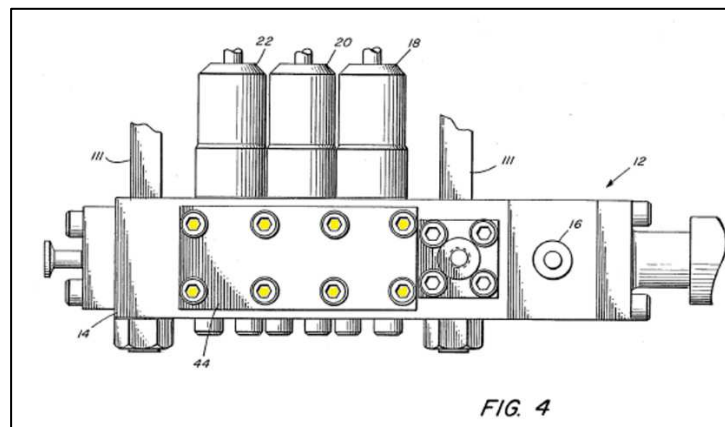
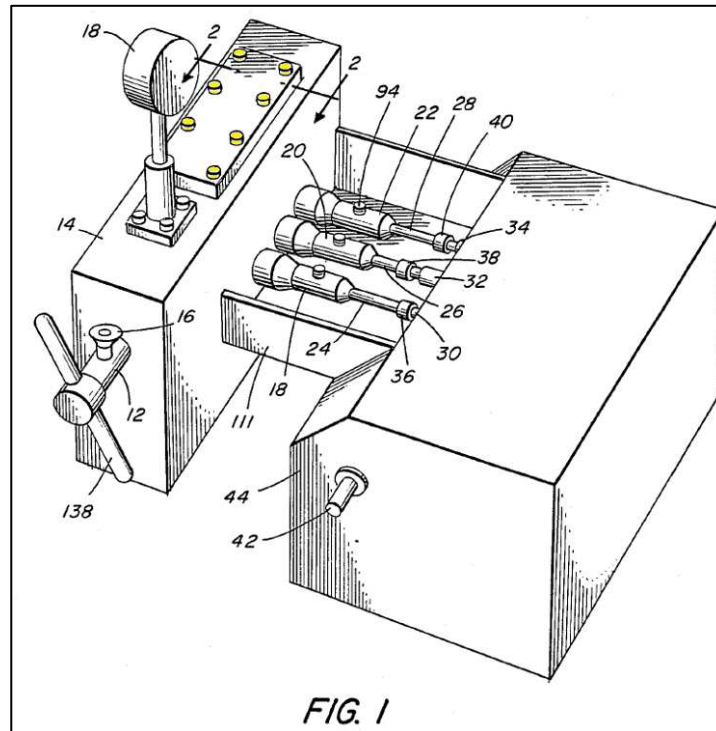
ii. **Claim 2**

- a. **2.a “the plate comprises a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a one-to-one relationship”**

311. Recitation 2.a of claim 2 of Foster recites “a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a one-to-one relationship.” While these openings are not explicitly illustrated in Wilkinson, they would have been obvious to the skilled artisan at the time of filing.

312. The annotated figures below are taken from Wilkinson. The figures illustrate hex-headed fasteners that secure the cover plates to the fluid end housing. The skilled artisan would understand that a hex head is used to torque a threaded fastener within a threaded opening in order to secure the fastener within the opening. The skilled artisan would understand that these hex-headed fasteners pass through

fastener openings in the plate and engage with threaded openings formed in the housing in a one-to-one relationship to secure the plates to the fluid end housing. Specifically, the skilled artisan would understand that a hex head is used to torque a threaded fastener within a threaded opening in order to secure the fastener within the opening. The threaded openings are not shown in sufficient detail to illustrate the actual threads. The presence of threads (in the fastener and its opposing hole or “opening”), however, would have been obvious to the skilled artisan given the fasteners and are illustrated with a hex head. The skilled artisan would understand that a hex head is used to torque a threaded fastener within a threaded opening in order to secure the fastener within the opening. The skilled artisan would understand that a threaded fastener would need to engage with a threaded opening in order to secure the plate to the housing. Accordingly, it would have been obvious to the skilled artisan that the openings formed in the fluid end housing would be threaded.



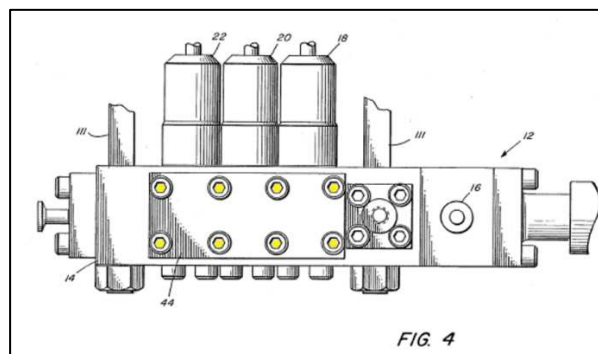
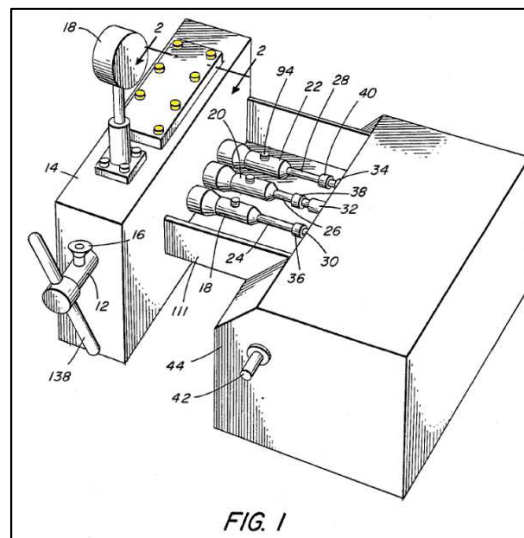
Wilkinson (EX1008), FIGs. 1 and 4 (annotated): Showing multiple threaded connections fastening down the top plate.

- b. 2.b “a plurality of fasteners, each of the plurality of fasteners installed within a corresponding one of the aligned fastener openings and threaded openings”**

313. Recitation 2.b of claim 2 of Foster recites “a plurality of fasteners, each of the plurality of fasteners installed within a corresponding one of the aligned

fastener openings and threaded openings.” Such fasteners are included in the fluid end of Wilkinson, the threaded fasteners discussed in section V.C.ii.a, *supra*.

314. The annotated figures below are taken from Wilkinson. Illustrated in the figures are hex head fasteners. The skilled artisan would understand that a hex head is used to torque a threaded fastener within a threaded opening in order to secure the fastener within the opening. The skilled artisan would understand that such a fastener is a threaded fastener that would install within the aligned fastener openings in the plate and the threaded openings in the housing.



Wilkinson (EX1008), FIGs. 1 and 4 (annotated): Showing multiple threaded connections fastening down the top plate.

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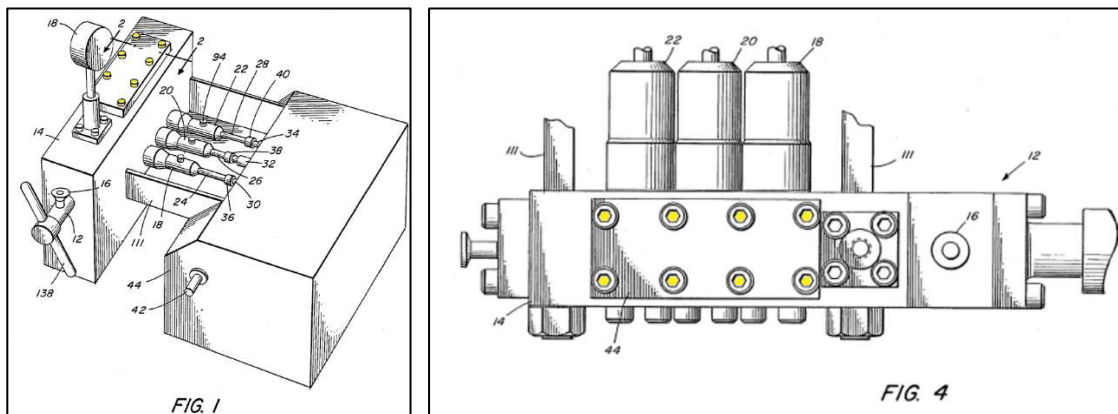
EX1003

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iii. Claim 3 “a plurality of fasteners, each of the plurality of fasteners extending through the plate and into the housing to fasten the plate to the housing.”

315. Claim 3 of Foster recites “a plurality of fasteners, each of the plurality of fasteners extending through the plate and into the housing to fasten the plate to the housing.” Such fasteners are included in the fluid end of Wilkinson, the threaded fasteners discussed in section V.C.ii.a, *supra*.

316. The annotated figures below are taken from Wilkinson. Illustrated in the figures are hex head fasteners. The skilled artisan would understand that such fasteners extend through the plate and into the housing to fasten the plate to the housing.



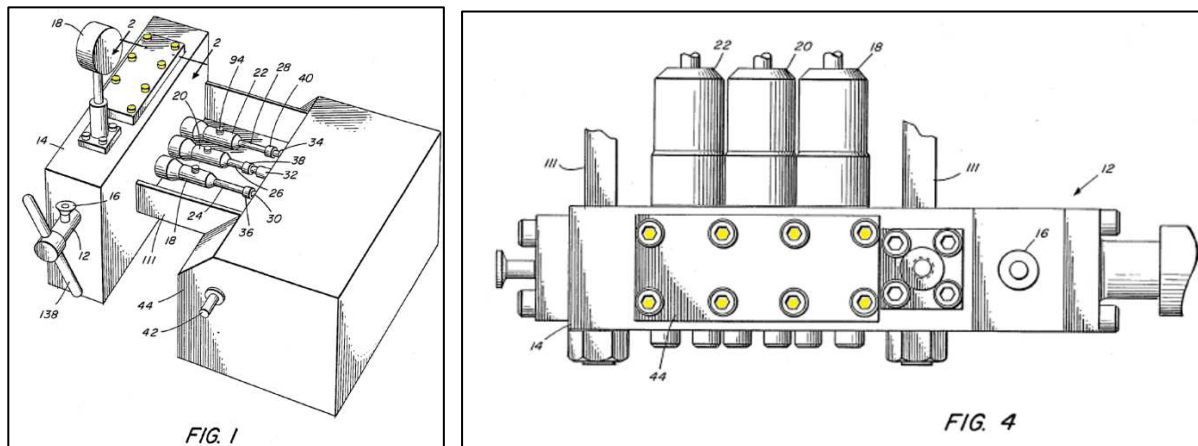
Wilkinson (EX1008), FIGs. 1 and 4 (annotated): Showing multiple threaded connections fastening down the top plate.

iv. Claim 4 “each of the plurality of fasteners is a threaded fastener”

317. Claim 4 of Foster recites “each of the plurality of fasteners is a threaded fastener.” While the fasteners in Wilkinson are not explicitly illustrated as being

threaded, threaded fasteners would have been obvious to the skilled artisan at the time of filing.

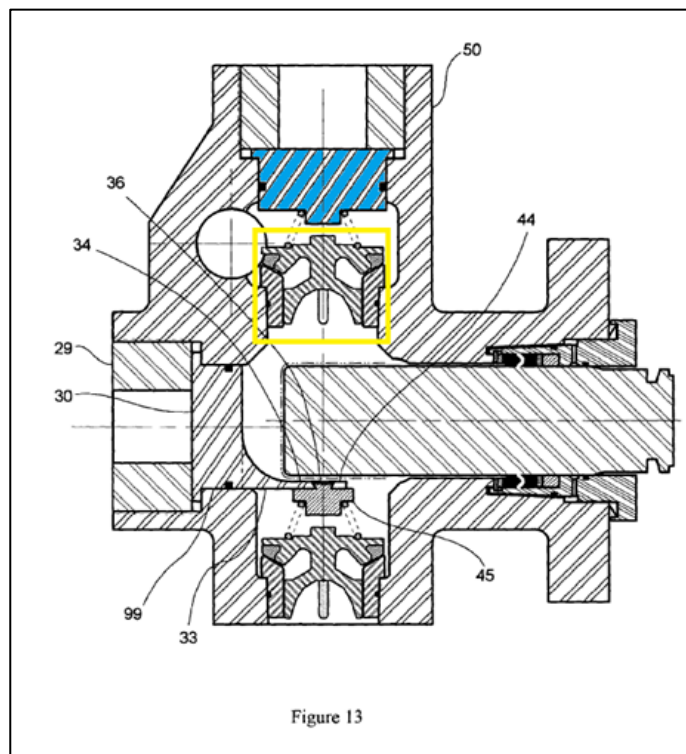
318. The annotated figures below are taken from Wilkinson. The figures illustrate hex-headed fasteners that secure the cover plates to the fluid end housing. The presence of threads (in the fastener and its opposing hole or “opening”) would have been obvious to the skilled artisan given the fasteners and are illustrated with a hex head. The skilled artisan would understand that a hex head is used to torque a threaded fastener with a threaded opening in order to secure the fastener within the opening. Accordingly, it would have been obvious to the skilled artisan that the openings formed in the fluid end housing would be threaded.



Wilkinson (EX1008), FIGs. 1 and 4 (annotated): Showing multiple threaded connections fastening down the top plate.

- v. **Claim 5 “a third plug installed within the first vertical bore and positioned between an external surface of the housing and one of the first pair of valves.”**

319. Claim 5 recites “a third plug installed within the first vertical bore and positioned between an external surface of the housing and one of the first pair of valves.” This claim is broad enough to cover a top vertical bore plug or a bottom vertical bore plug. A top vertical bore plug is shown in the figure below, from Blume, and is a conventional part of a plunger pump fluid end. These plugs provide a pressure retention seal, and in some fluid ends, retain the valves in the fluid end.



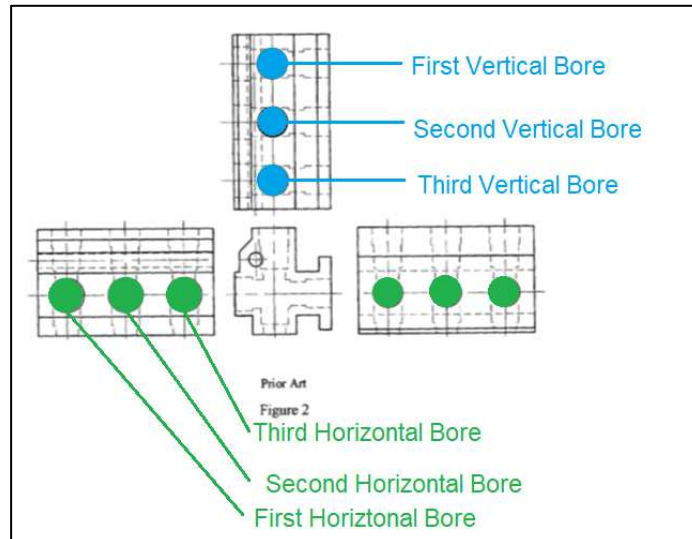
Blume (EX1006), FIG. 13 (annotated): Showing bore plug (highlighted in blue).

vi. Claim 6

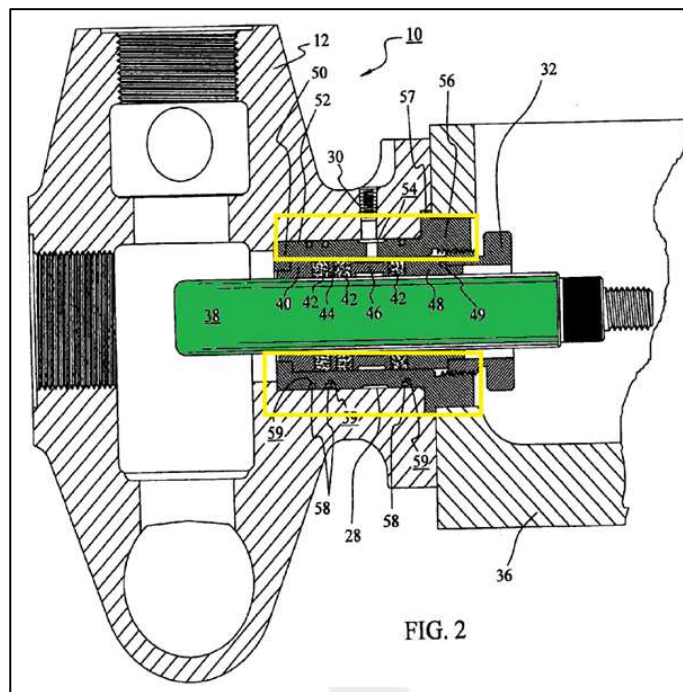
- a. 6.a “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore and at least a portion of the second reciprocating plunger installed within the central opening of the second component”**

320. Recitation 6.a of claim 6 recites “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore and at least a portion of the second reciprocating plunger installed within the central opening of the second component.” Where recitation 1.J of claim 1 recites the “first component” for a first plunger assembly, this recitation recites the corresponding “component” for a second plunger assembly of a multiplex pump. Accordingly, Blume as modified by Stanton provides a second component for the same reasons as the first component of recitation 1.J.

321. While Blume as modified by Stanton do not explicitly illustrate “first” and “second” components, it would have been obvious to the person of ordinary skill in the art that these features would be present in the references due their disclosures as triplex pumps. EX1008, 1:29-32, 6:66-67; EX1007, ¶[0009]. A triplex pump as disclosed in Blume modified to include the packing arrangement of Stanton would include three such packing arrangements – one for each plunger assembly.



Blume (EX1006), FIG. 2 (annotated).

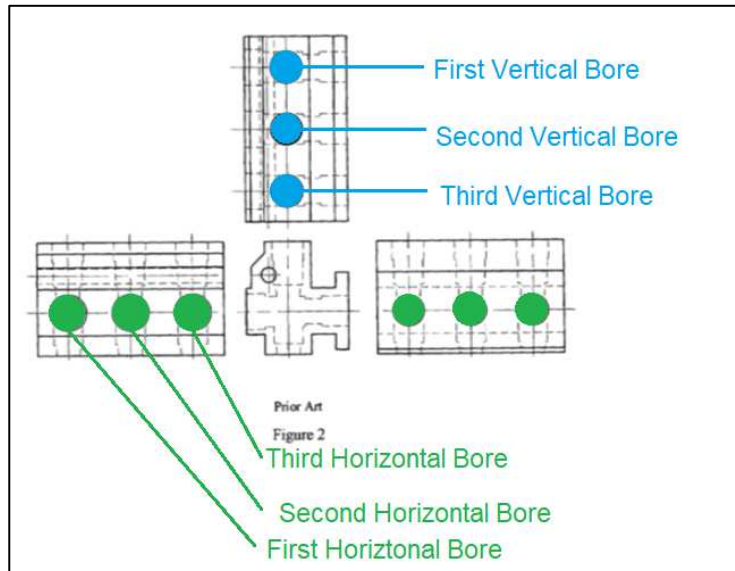


Stanton (EX1007), FIG. 2 annotated).

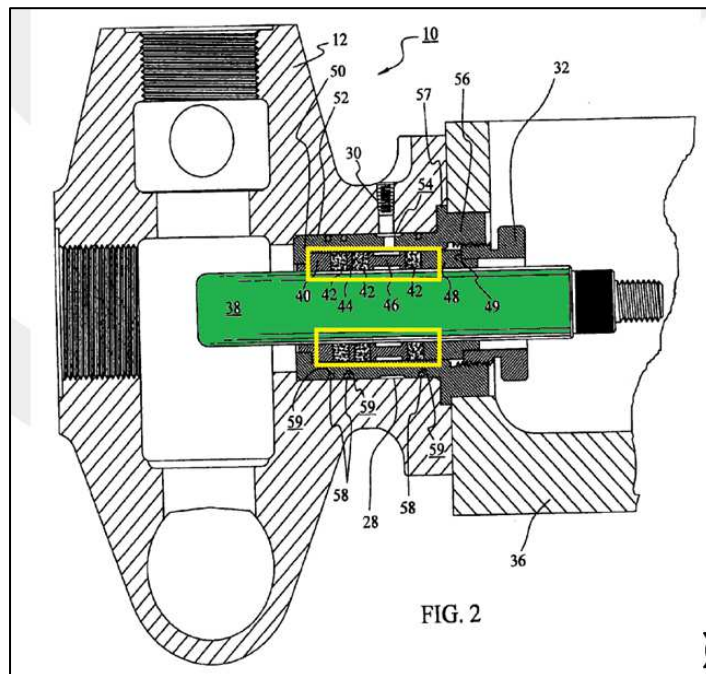
b. 6.b “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger”

322. Recitation 6.b of claim 6 recites “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger.” Where recitation 1.K of claim 1 recites the “first plurality of packing seals” for a first plunger assembly, this recitation recites the corresponding “second plurality of packing seals” for a second plunger assembly of a multiplex pump. Accordingly, Blume modified by Stanton provides a second plurality of packing seals for the same reasons as the first component of recitation 1.K.

323. While Blume and Stanton do not explicitly illustrate “first” and “second” plurality of packing seals, it would have been obvious to the person of ordinary skill in the art that these features would be present in the references due their disclosures as triplex pumps. EX1008, 1:29-32, 6:66-67; EX1007, ¶[0009]. A triplex pump as disclosed in Blume modified to include the packing arrangement of Stanton would include three such pluralities of packing seals – one for each plunger assembly.



Blume (EX1006), FIG. 2 (annotated).

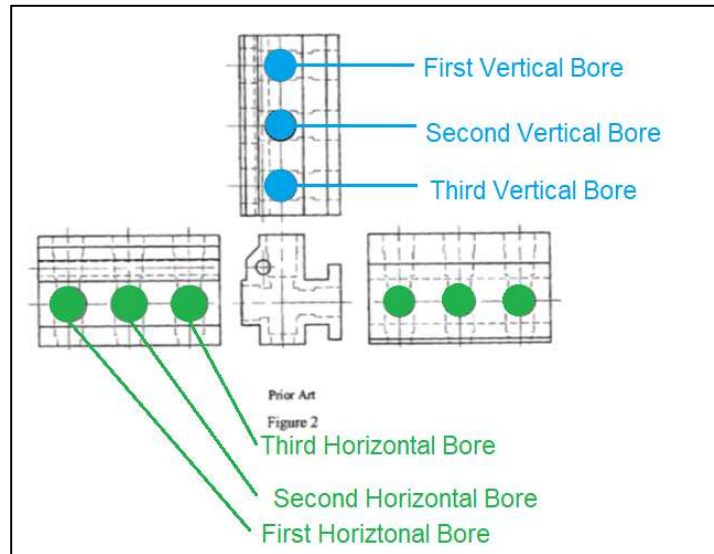


Stanton (EX1007), FIG. 2 annotated).

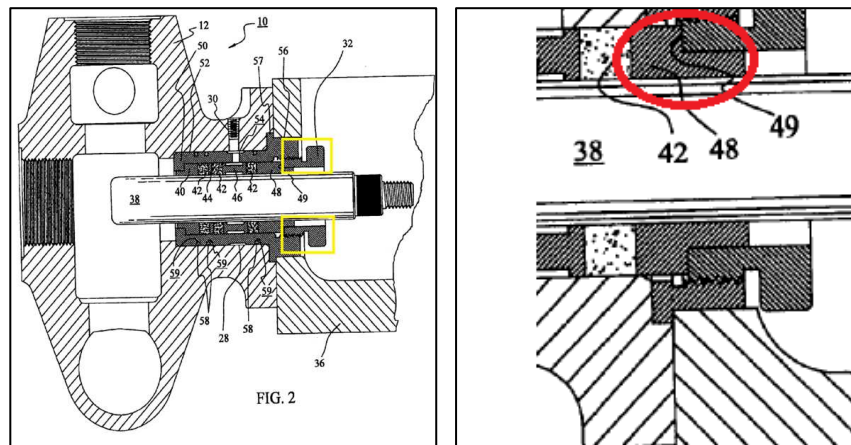
- c. 6.c “a second packing nut attached to the second component and holding the second plurality of packing seals within the second component.”**

324. Recitation 6.c of claim 6 recites “a second packing nut attached to the second component and holding the second plurality of packing seals within the second component.” Where recitation 1.L of claim 1 recites the “first packing nut” for a first plunger assembly, this recitation recites the corresponding “second packing nut” for a second plunger assembly of a multiplex pump. Accordingly, Blume modified by Stanton provides a second packing nut for the same reasons as the first component of recitation 1.L.

325. While Blume and Stanton do not explicitly illustrate “first” and “second” packing nuts, it would have been obvious to the person of ordinary skill in the art that these features would be present in the references due their disclosures as triplex pumps. EX1008, 1:29-32, 6:66-67; Stanton, ¶[0009]. A triplex pump as disclosed in Blume modified to include the packing arrangement of Stanton would include three such packing nuts – one for each plunger assembly.



Blume (EX1006), FIG. 2 annotated).



Stanton (EX1007), FIG. 2 annotated).

vii. **Claim 7**

a. **7.P “a fluid end assembly”**

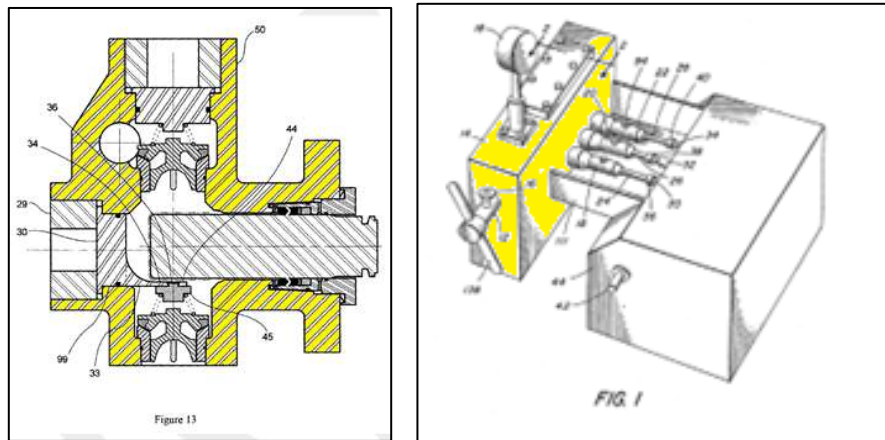
326. The preamble of claim 7 of Foster recites that the claims are directed to a “fluid end assembly.” While I understand that the preamble of a claim does not always recite patentably relevant subject matter, in this case I need not address that issue as Blume, Wilkinson and Stanton all include a “fluid end assembly.

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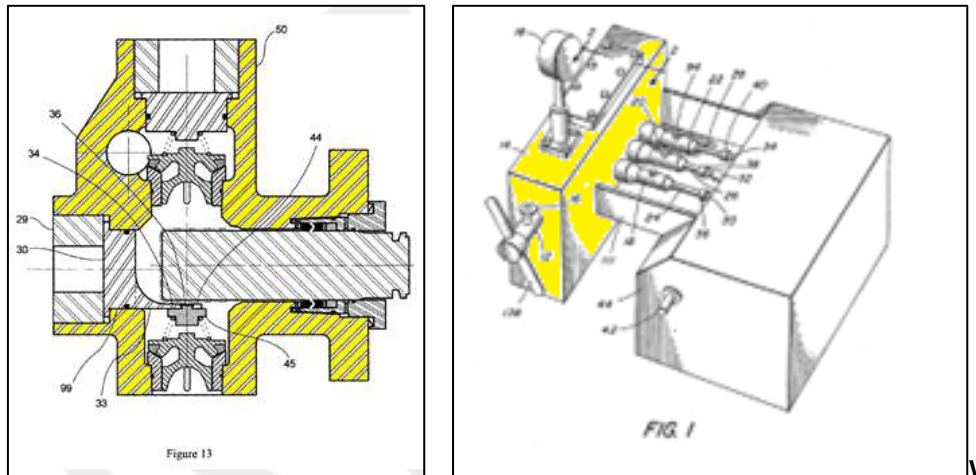
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Blume (EX1006), FIG. 13 (annotated) (left) and Wilkinson (EX1008), FIG. 1 (annotated) (right).

b. 7.a “a housing made of a single integrally formed piece”

327. Recitation 7.a. of claim 7 recites “a housing made of a single integrally formed piece.” The annotated figures below are from Blume, Wilkinson, and Stanton. Note that the fluid end of the respective pumps consists of a single piece, such that no breaks or seams are illustrated. This renders as obvious, and not novel, the recitation of “a housing made of a single integrally formed piece:” Indeed, a typical reciprocating power pump, because of the high pressure it develops and contains, would not split the pump liquid end frame or “casing”, but would machine it as a “monoblock”.

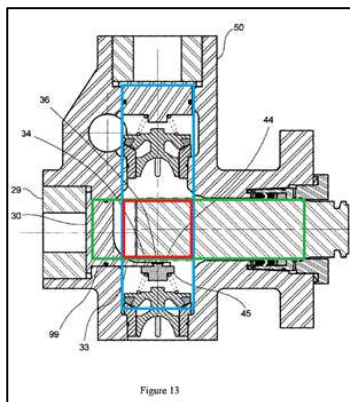


Blume (EX1006), FIG. 13 (annotated) (left) and Wilkinson (EX1008), FIG. 1 (annotated) (right).

- c. **7.b “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber”**

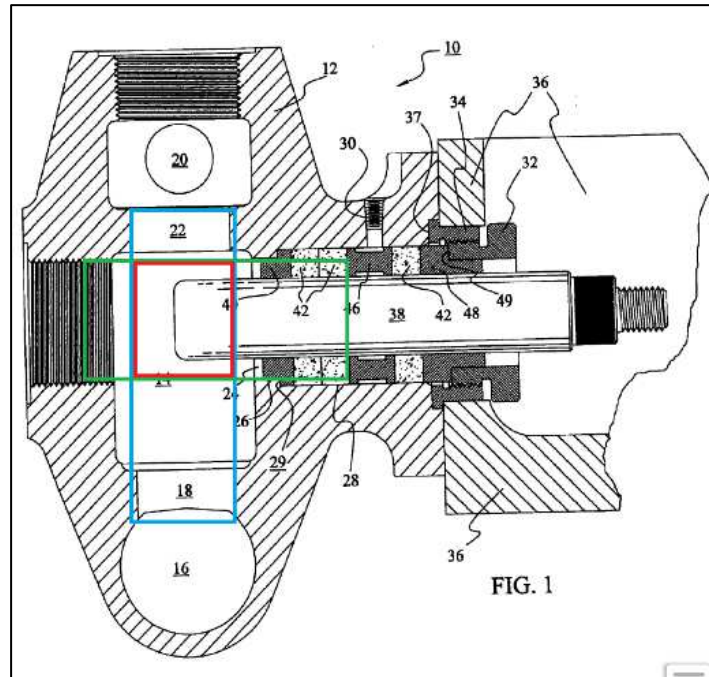
328. Recitation 7.b of claim 7 of Foster recites “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber.” Such an internal chamber is a conventional part of a fluid end, as illustrated in the discussion of the prior art I provide above. Furthermore, the figure from Blume that I have reproduced below clearly illustrates that the Blume fluid end includes such an internal chamber (annotated in red) formed by the intersection of a first vertical bore (annotated in blue) formed in the housing and a first horizontal bore (annotated in green) formed in the housing.

329. “First” as used here refers to the bores associated with one of the plungers of the triplex pump provided as an exemplar in Foster, shown in the figures below. The purpose of this internal chamber is to contain the plunger in the horizontal bore and the suction and discharge valves in the intersecting vertical bore. The resulting internal chamber provides a conduit for the suction fluid as the plunger moves backward, and a conduit for the discharge fluid as it is pressurized by the plunger and moves forward within the bore of the horizontal plunger bore and vertical discharge bore of the internal chamber. This is a conventional design for a reciprocating power pump. As such, this falsifies any novelty of Foster’s claim to “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber.” This is illustrated in the figure below:



Blume (EX1006), FIG. 13 (annotated): Cross-section demonstrating a very typical reciprocating power pump design. As shown in the above-side views in the lower 2/3 of the figure, power pumps typically are constructed with three, five, or seven cylinders and associated plungers, stuffing box assemblies, and valve pairs.

330. For completeness, I note that the fluid end of Stanton also includes “a first horizontal bore and a first vertical bore formed within the housing, the first vertical bore intersecting the first horizontal bore to form a first internal chamber,” as illustrated below.



Stanton (EX1007), FIG. 1 (annotated): Cross-section demonstrating a very typical reciprocating power pump design.

- d. 7.c “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber;”

331. Recitation 7.c of claim 1 of Foster recites that the “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.” The skilled artisan would understand that this feature of claim 7

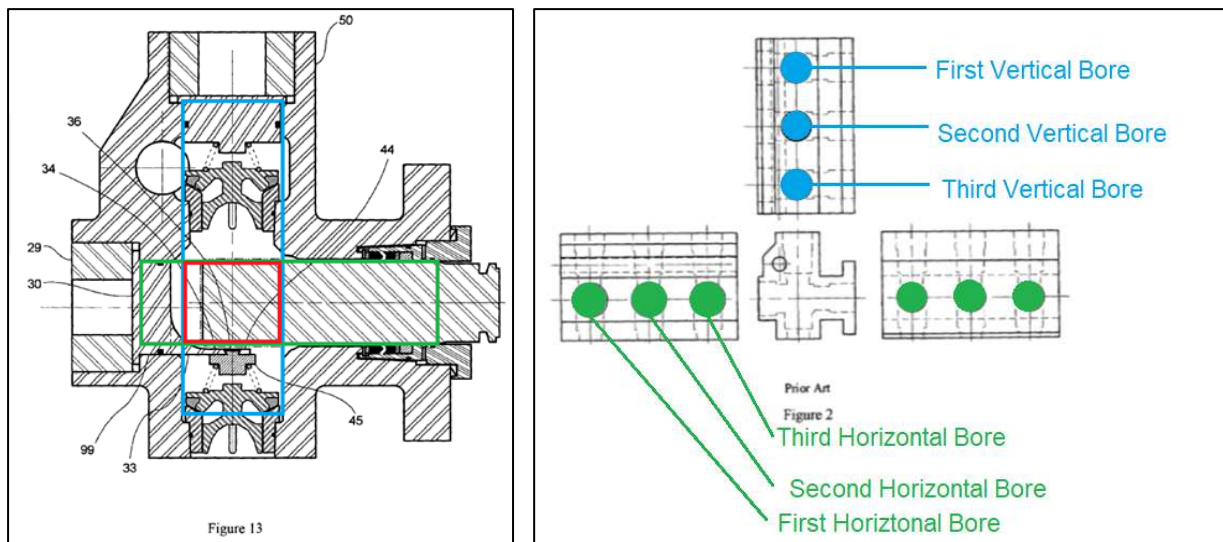
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EX1003

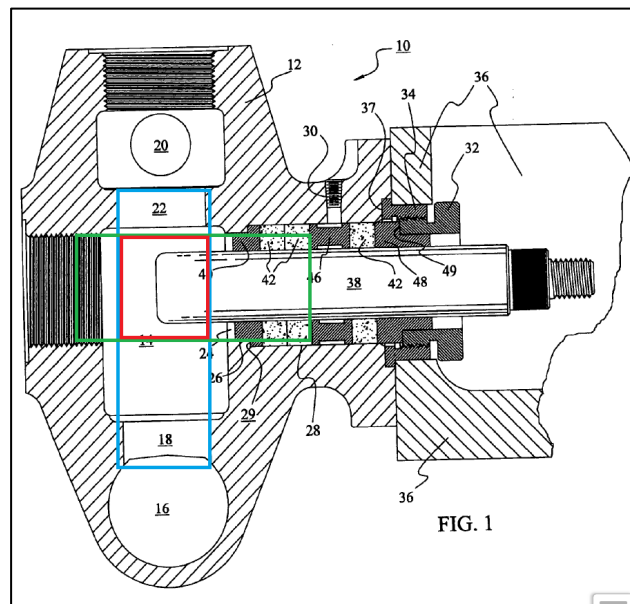
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is present in the fluid end of Blume as this fluid end is described as being the fluid end for a triplex pump. *E.g.*, EX1008, 1:39-32; 6:66-67. Specifically, “second” as used here refers to the bores associated with a second of the plungers of the example triplex pump. *See, e.g.*, EX1001, 8:13-23 (“each set of paired bores...” (emphasis added)). . Only one such plunger assembly is illustrated in the drawings (e.g. the figure above) because the POSITA would understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in this case, given the triplex pump being the example), each member of which has the same structure. While not explicitly illustrated, it would have been obvious to the person of ordinary skill in the art that the pump illustrated has these features, as would be typical of any reciprocating power pump.



Blume (EX1008), FIGs. 1 and 13 (annotated).

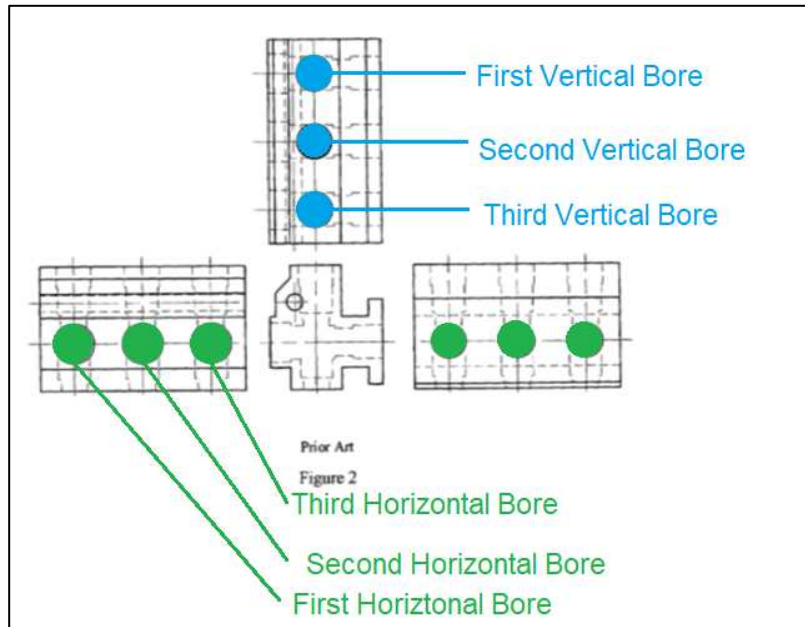
332. For completeness, I note that the fluid end of Stanton also includes “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber,” as illustrated below. Specifically, Stanton discloses that its fluid ends may be used in duplex and multiplex (e.g. triplex) pumps (Stanton, ¶[0009]), and therefore, it would have been obvious to the skilled artisan that the fluid end of Stanton would include “a second horizontal bore and a second vertical bore formed within the housing, the second vertical bore intersecting the second horizontal bore to form a second internal chamber.”



Stanton (EX1007), FIG. 1 (annotated): Cross-section from Stanton, demonstrating a very typical reciprocating power pump design.

- e. **7.d “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber;”**

333. Recitation 7.d of claim 7 of Foster recites that the “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.” The skilled artisan would understand that this feature of claim 1 is present in the fluid end of Blume because the fluid end of Blume is described as being suitable for a multiplex, duplex or triplex pump. EX1008, 1:29-32; 6:66-67. Furthermore, the drawing in the figure below from Blume shows side-by-side arrangement of the plugs covering the horizontal and vertical bores of the fluid end. Accordingly, the skilled artisan would understand that the fluid end of Blume includes “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.”

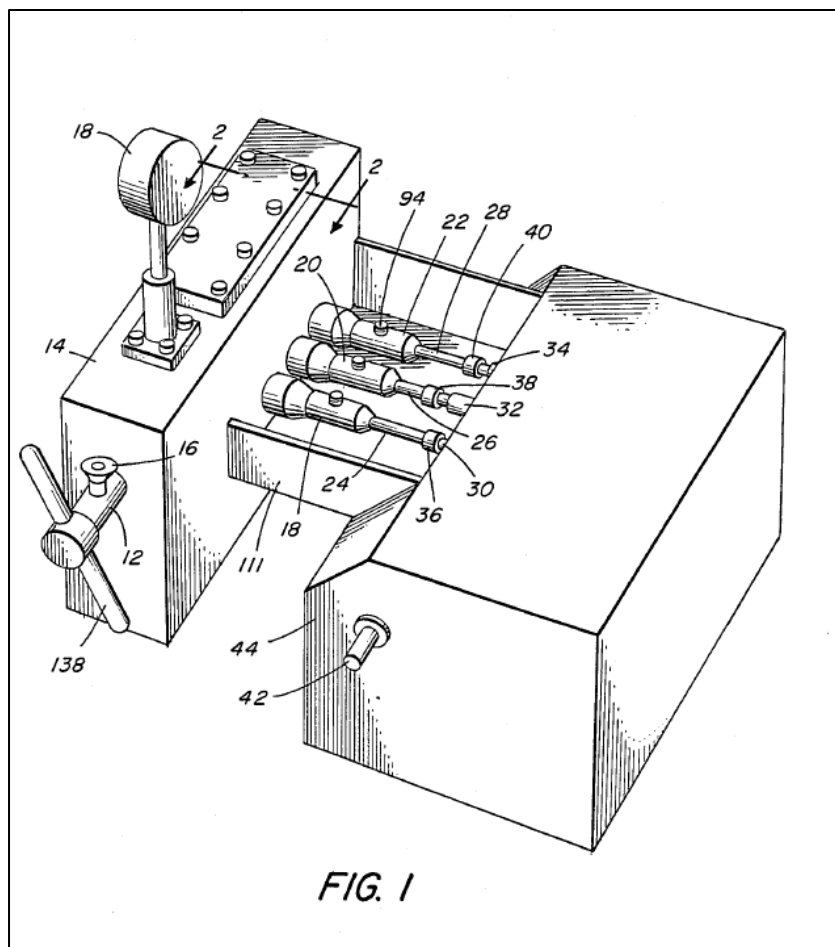


Blume (EX1006), FIG. 2 (annotated).

334. For completeness, I note that Stanton and Wilkinson also would have rendered obvious “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.”

335. Stanton discloses that its fluid ends may be used in duplex and multiplex (e.g. triplex pumps) (Stanton, ¶[0009]), and therefore, it would have been obvious to the skilled artisan that the fluid end of Stanton would include “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.”

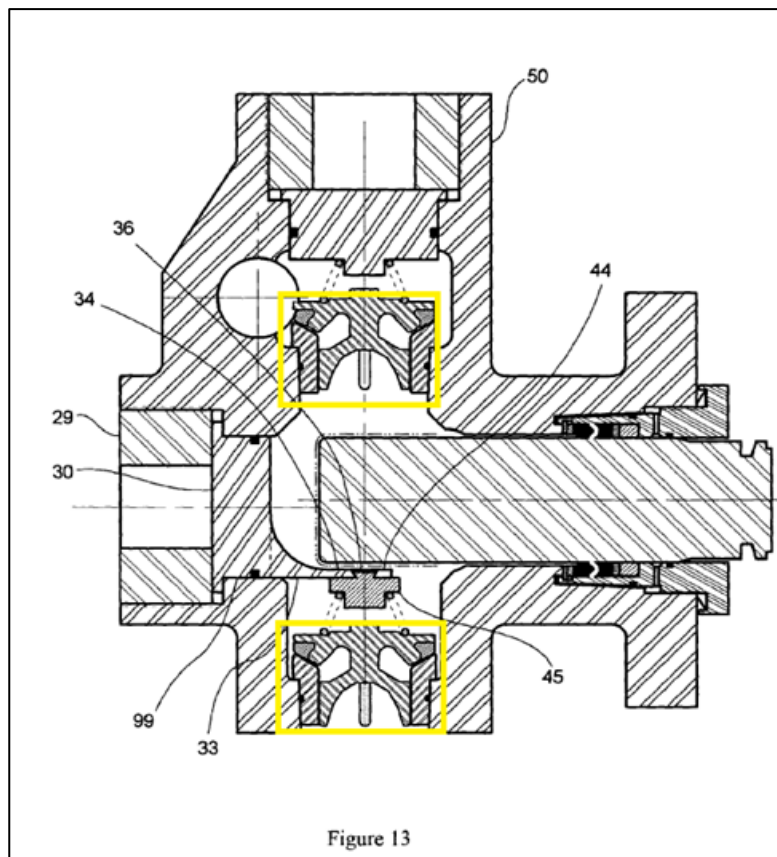
336. The figure below from Wilkinson shows side-by-side arrangement of the plunger assemblies of the fluid end. Accordingly, the skilled artisan would understand that the fluid end of Wilkinson includes “the second horizontal bore, the second vertical bore, and the second internal chamber are situated in a side-by-side relationship with the first horizontal bore, the first vertical bore, and the first internal chamber.”



Wilkinson (EX1008), FIG. 1.

- f. **7.e “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber”**

337. Recitation 7.e of claim 7 recites “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber.” As illustrated below, fluid end from Blume includes a pair of valves (a suction valve and a discharge valve) positioned on opposites side of the internal chamber.



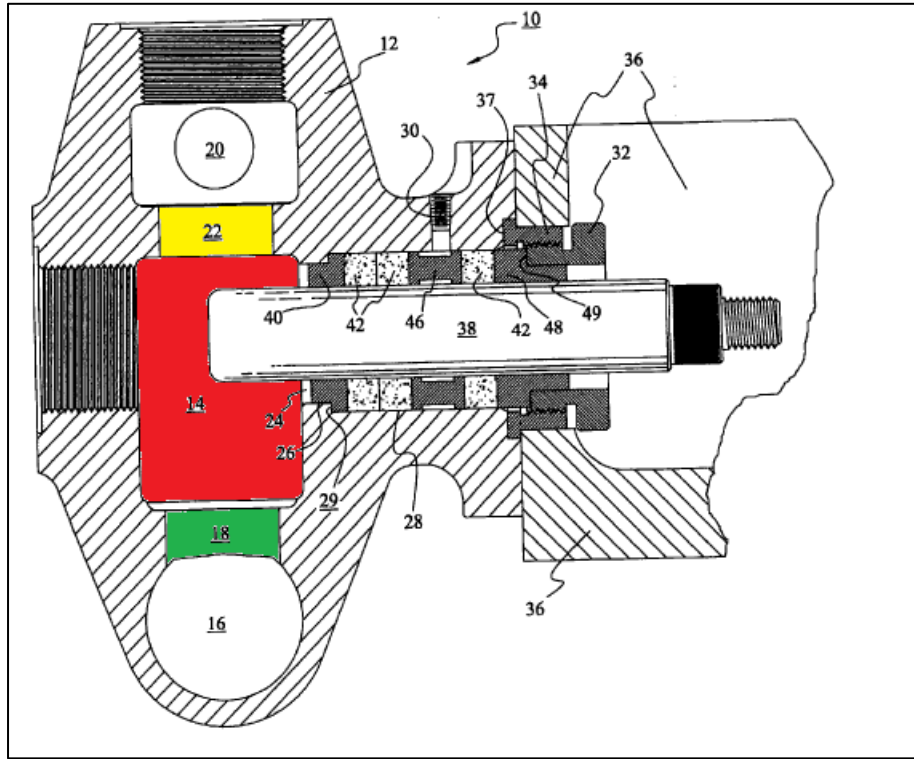
Blume (EX1006), FIG. 13 (annotated): Cross-section demonstrating a very typical reciprocating power pump design, including valve details.

338. For completeness I note that Stanton and Wilkinson also disclose “a first pair of valves, each valve installed within the first vertical bore and positioned on opposite sides of the first internal chamber.” Stanton discloses the following:

[0020]. **The suction valve** is usually a spring-loaded check valve for allowing the flow of fluid from the low-pressure side of the pump through the suction port **into the pumping chamber** while preventing the backflow of fluid through the suction port. **The discharge valve** is usually a spring-loaded check valve for allowing the flow of fluid from the liquid cylinder through the discharge port to the high-pressure side of the pump with preventing backflow of fluid through the discharge port. **Preferably, although not necessarily, the suction and discharge valves are vertically disposed in the pump, that is, the axis of each of the generally cylindrical valves is vertically oriented in the pump body. Furthermore, the vertical axes of the suction and discharge valves are preferably, although not necessarily, co-axially aligned.**

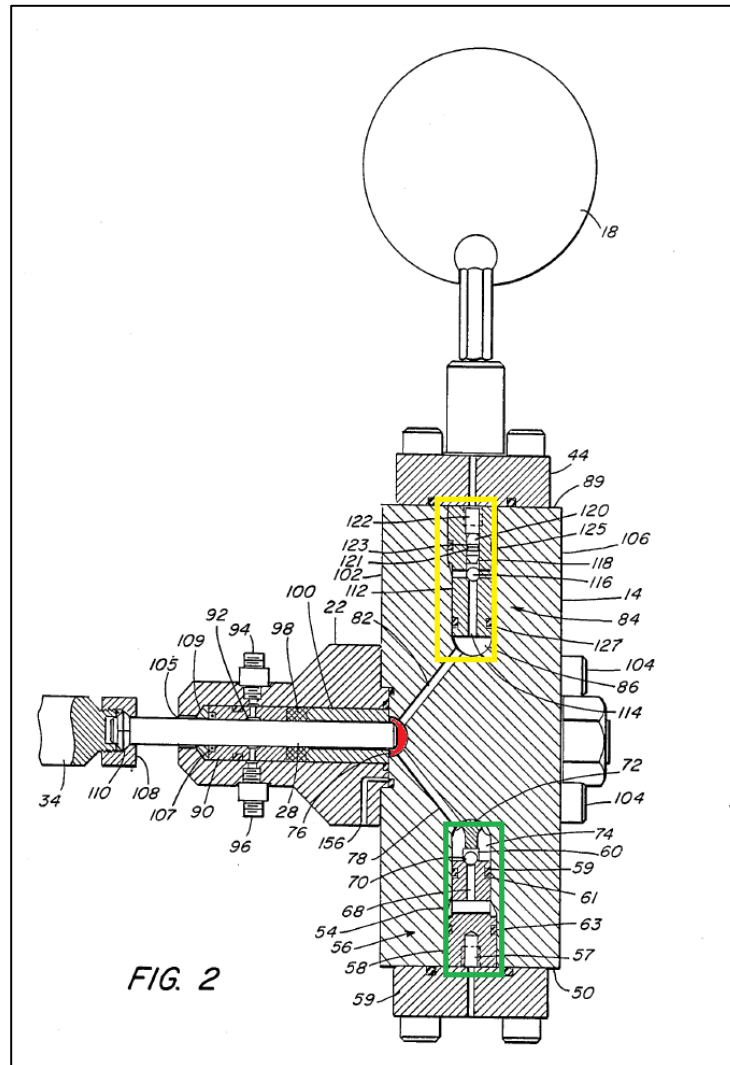
Stanton, ¶[0020] (emphasis supplied).

339. As illustrated in the annotated version of FIG. 1 from Stanton provided below, the suction valve “deck” 18 (where the suction valve is arranged, annotated in green) is positioned on the opposite side of the pumping chamber 14 (annotated in red) from the discharge valve “deck” 22 (where the discharge valve is arranged, annotated in yellow).



Stanton (EX1007), FIG. 1 (annotated).

340. As illustrated in the annotated version of FIG. 2 from Wilkinson provided below, the suction valve (annotated in green) is positioned on the opposite side of the pumping chamber 76 (annotated in red) from the discharge valve (annotated in yellow).

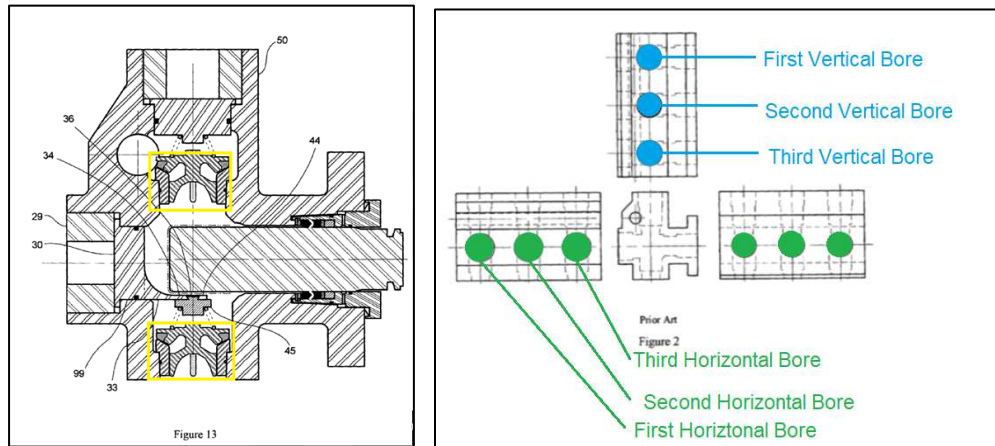


Wilkinson (EX1008), FIG. 2 (annotated).

- g. 7.f “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber”**

341. Recitation 7.f of the claim 7 recites “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber.” The POSITA would understand that each of the triplex

plunger arrangements of the fluid ends of Stanton would include the valves (suction and discharge) placed as illustrated in the figure below.



Blume (EX1006), FIGs. 2 and 13 (annotated).

342. As discussed above with respect to recitation 1.C, “second” as used in Foster refers to the additional plunger arrangements in a multiplex, duplex or triplex pump. *See, e.g.*, EX1001, 2:57-64. The POSITA would understand that the each of the plunger arrangements of the Blume fluid end would include substantially the same structure, including the valves illustrated above. Accordingly, “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal chamber” would have been obvious at the time of filing to the skilled artisan from the teachings of Blume.

343. Similarly, because Stanton and Wilkinson also disclose multiplex, duplex and triplex pumps, “a second pair of valves, each valve installed within the second vertical bore and positioned on opposite sides of the second internal

chamber” would have been obvious to the POSITA from these references as well. Specifically, as illustrated in the figures provided in the discussion above regarding recitation 1.E of claim 1, the POSITA would understand that each of the plunger assemblies of Stanton and Wilkinson fluid ends would include the valves highlighted in the above-annotated figures.

h. 7.g “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores”

344. Recitation 7.g of claim 7 of Foster recites “a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores.” Such a plate would have been obvious to the POSITA based on the combined teachings of Blume and Wilkinson.

345. First, the nature of the recited plate is conventional, and has been used for many years prior to the priority date for the ‘582 Application, including by Kerr themselves. EX1005; EX1009, 23. Such a plate also would have been obvious from the patent art at the time of filing of the ‘582 Application.

346. For example, as shown in the figure below, Wilkinson indicates using such a bolted-on plate to firmly secure the bore plugs against the casing. As described in column 3 line 25 of Wilkinson:

A set of three suction valves are accessed through the bottom of the block 14, and a set of three discharge valves are accessed through the top of the block by removal of a plate 44.

EX1008, 3:25.

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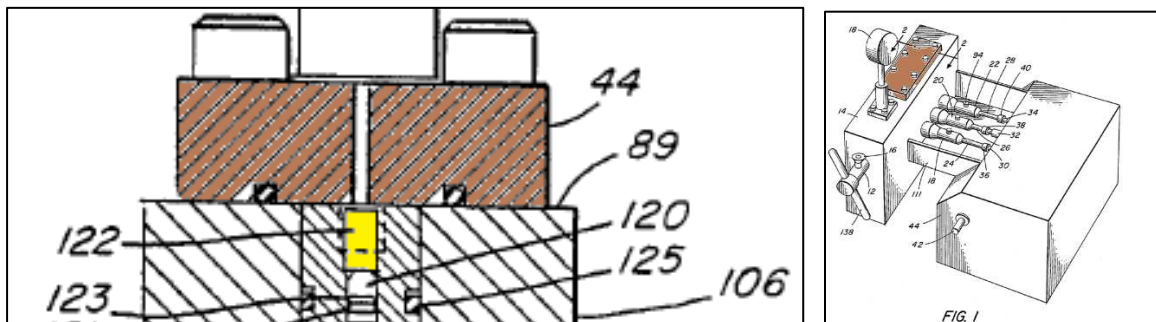
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347. As further explained in Wilkinson:

Each discharge valve assembly comprises a valve seat 112 having a center channel 114 in communication with the hemispherical termination of the valve bore. A ball 116 is guided within a bore 118 above the valve seat. A valve stop 120 is positioned in bore 118 of the valve seat and is retained by a removable plug 122.

EX1008, 4:55-60 (emphasis added).

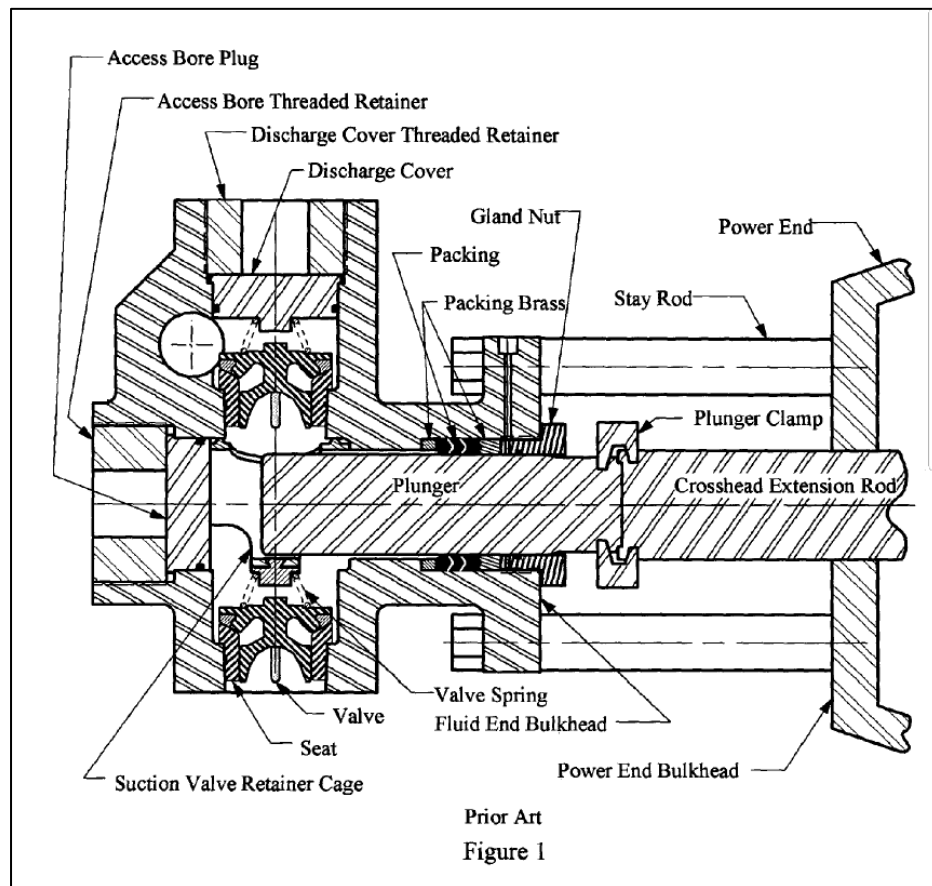
348. As indicated in the detail from FIG. 2 of Wilkinson provided below, plate 44 is fastened along the surface of the fluid end to retain the valve assembly, including plug 122. As illustrate in FIG. 1 from Wilkinson, plate 44 covers the three bores associated with the three plunger assemblies of the Wilkinson fluid end.



Wilkinson (EX1008), FIGs. 2 and 1 (annotated).

349. Claim 7 of Foster recites a plate that covers a horizontal bore, not a vertical bore. It would, however, have been obvious to the skilled artisan to use the plates from Wilkinson on the Blume fluid end. The POSITA would understand that there are numerous ways to secure a bore plug in a bore, such as the threaded plug of Blume or the cover place as illustrated in Wilkinson. While Wilkinson uses the plates 44 and 59 to secure the assemblies and plugs in the discharge bores and suction

bores, respectively, Blume shows that the same method of securing the plugs in the suction and discharge bores can be used to retain the plug in its access bore. More specifically, Blume uses the same retention technique to secure the plugs in both its horizontal and vertical bores. As illustrated below, an essentially identical threaded retainer is used to retain the discharge cover in the vertical bore as is used to retain the access bore plug in the horizontal bore. This would suggest to the POSITA that the same retention method, whichever one is selected, may be used to cover both the vertical and horizontal bores of a fluid end.



Blume (EX1006), FIG. 1.

350. Accordingly, it would have been obvious to the skilled artisan to use a plate, such as plate 44 or 59 of Wilkinson, to secure the plug in the access bore of the Blume fluid end. Specifically, the skilled artisan would understand that if a cover plate can be used to cover a vertical bore, then a structurally similar or identical plate could be used to cover a horizontal bore. Therefore, using a cover plate to cover the horizontal bore of Blume would be nothing more than replacing one method of securing a bore plug with another known method with predictable results.

351. The skilled artisan would also understand that the structural and functional requirements for a vertical bore cover in Wilkinson are the same as those for the horizontal bore cover of Blume. The skilled artisan would understand that the vertical bore pressure experienced by Blume and Wilkinson, would be equivalent to the pressure experienced by the horizontal bore. Therefore, the skilled artisan would understand that using the vertical bore cover plate from Wilkinson would be an obvious and viable alternative for the bore plug retainer 29 of Blume.²

² Furthermore, numerous other prior references, including those cited here (*e.g.*, Kerr (EX1004), Apex (EX1005), the Kerr website (EX1009, 23-24), the Kere Spec Sheet (EX1011), would have informed the POSITA's knowledge, reinforcing the obvious conclusion that the Wilkson vertical bore plate could be used to cover a horizontal bore of a fluid end like that in Blume.

352. For completeness, I note that the patentee of Foster argued that it would not be obvious to provide a plate as disclosed in Blume as a cover for a horizontal bore. EX1002, 49-50. This argument, however, was premised on Blume being applied to a modular bore block in which a separate structure is provided for each plunger assembly:

The Examiner claims it would be obvious to modify Orr to become a "housing made of a single, integrally-formed piece" with a "plate fastened to the housing". Action at 5. Applicant disagrees. As discussed above, **Orr distinctly teaches modular fluid blocks 52, each block having an individual ring 60 attached thereto - not a plate**. Even if an artisan were to combine two Orr fluid blocks into one, he or she would merely scale up Orr's own teaching, and use two locking rings. To combine multiple rings into one would not be advantageous, as an artisan would thereafter have to remove the entire combined ring from the surface during maintenance, as opposed to selective rings. It would therefore not be obvious to modify the plates 44/59 taught in Wilkinson along with the rings 60 taught in Orr to accomplish the features of claim 1.

EX1002, 49-50 (emphasis supplied).

353. In the present ground of rejection, the plate of Wilkinson is not being applied to a modular fluid end, but the monolithic fluid end of Blume. Accordingly, it is my opinion that this argument by the patentee in no way affects the strong obviousness rationale presented herein.

354. Elsewhere during prosecution, the patentee argued that it would not have been obvious to apply the cover plate from Wilkinson to a horizontal bore simply because Wilkinson only illustrates vertical bore covers, and therefore, the

skilled artisan would not think to use a cover plate on the horizontal bore. *See, e.g.*, EX1002, 49 (“the plates cover vertical discharge and suction valve openings on the top and bottom surfaces of the block.”). This seems disingenuous given the patentees repeated use of horizontal bore covers (EX1004, *passim*, EX1009, 23). Furthermore, Foster itself draws no distinctions between its horizontal bore covers and its vertical bore covers, giving them the same references number (“316”), illustrating them with identical structure, and describing them as having identical function. EX1001, 8:41-51. The skilled artisan would clearly understand that a cover plate sufficient to cover a vertical bore would similarly be suitable to cover a horizontal bore.

355. Finally, based on my reading of the Examiner’s reasons for allowance of the claims of Foster, I understand that the examiner misunderstood the scope of the claims under examination. As noted in the reasons for allowance:

While Wilkinson (US 4773833) teaches a single plate (44 or 59) and a single housing where the plate spans multiple fluid end bores, **the plate does not have openings that open to the bores.**

Ex1002 at 13 (emphasis added).

356. The feature of a bore cover with “openings that open to the bores” was cancelled from the claims in the amendment immediately preceding the notice of allowance:

a plate fastened to the housing along an exterior surface containing openings to the first and second horizontal bores; and having a first and a second opening formed therein, the first opening aligned with the first horizontal bore and the second opening aligned with the second horizontal bore, the first opening exposing the first plug and the second opening exposing the second plug;

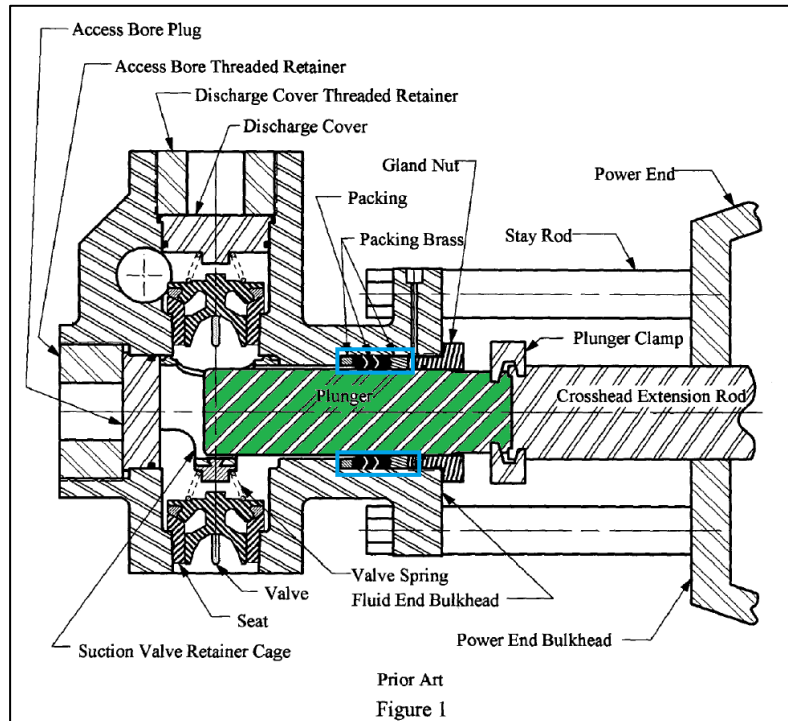
EX1002 at 43.

357. Accordingly, it is my opinion that the examiner was clearly mistaken in allowing the claims of Foster over the prior art and Wilkinson in particular.

- i. 7.h “a first component having a central opening formed therein, at least a portion of the first component installed within the first horizontal bore;”**

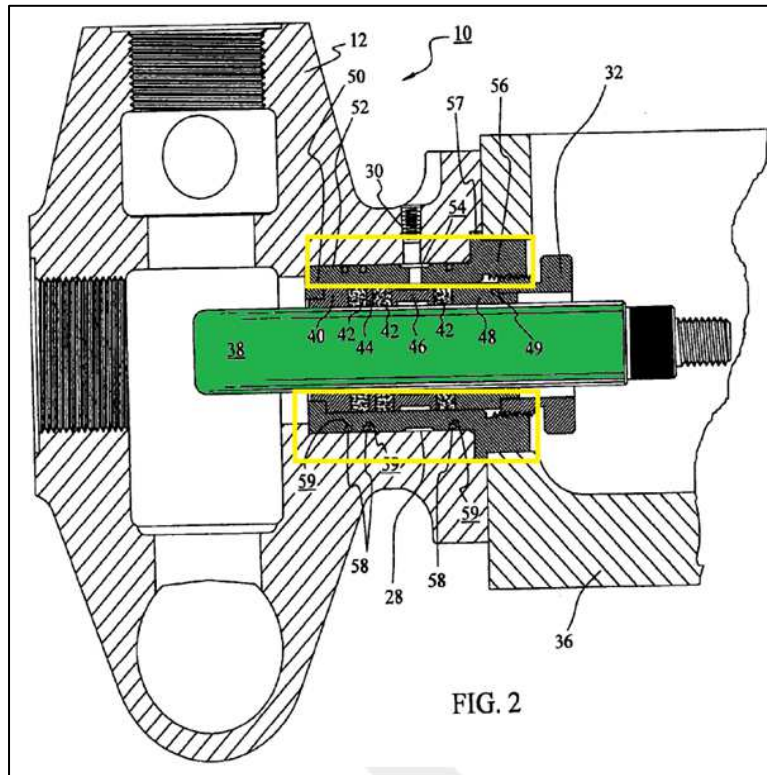
358. Recitation 7.h of claim 7 of Foster recites “a first component having a central opening formed therein, at least a portion of the first component installed within the first horizontal bore.” Such a component is included in the fluid end of Stanton.

359. This uses the broad term “component” that could correspond to almost any packing other than the later recited seals. I am therefore relying on a packing sleeve due to the teachings in Foster. *See, e.g.*, EX1001, 4:12-16, 6:63-67, 9:14-20, 10:66-11:7. The fluid end of Blume includes a packing assembly where the assembly is secured within the fluid end via a packing or gland nut, but this just one way of securing the packing.



Blume (EX1006), FIG. 1 (annotated).

360. Another way of securing that packing is illustrated in FIG. 2 of Stanton. In Stanton the packing is arranged within a stuffing box 50 that acts as a packing sleeve. A gland nut 32 secures the packing within the horizontal bore as illustrated in FIG. 2. The packing assembly of Stanton illustrates the stuffing box (annotated in yellow) with a portion that is in the horizontal bore and the plunger (annotated in green) partially within the stuffing box. It would have been obvious to the POSITA to replace the packing assembly of the Blume fluid end with the stuffing box 50 of Stanton as it is replacing one known method of providing packing to a plunger pump with another with predictable results.



Stanton (EX1007), FIG. 2 (annotated).

361. The skilled artisan would be motivated to use the Stanton packing assembly in place of that of Blume because the Stanton arrangement allows the packing nut to set the intended packing pressure by torquing the packing nut to a desired value. As indicated in the detail from FIG. 2 of Stanton, the packing nut 32 screws into the stuffing box sleeve 50. This arrangement allows the compression of the packing arranged within the stuffing box sleeve 50 to be set by torquing the packing nut 32 to a particular value. The arrangement of Blume would require a spring or other additional parts within the sleeve to set the pressure.

362. The packing nut 32 screwing directly into the stuffing box sleeve 50 also provides for easier repair in the event of damaged threads – the stuffing box

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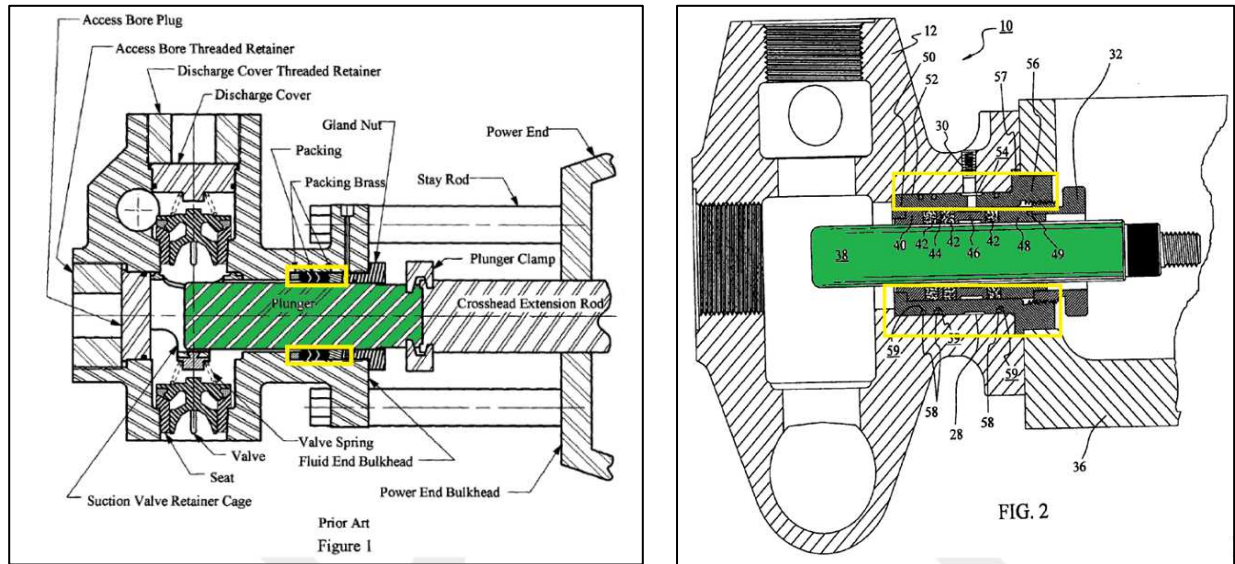
sleeve 50 may be replaced in the event of the damaged threads. In Blume design, the packing nut screws into the fluid end housing, making damaged threads much more difficult to replaced or repair, requiring repair or replacement of the fluid end housing.

363. Additionally, Blume packing would require sealing of the packing sleeve flange via a flexible o-ring or gasket, which can be damaged or over pressured. In Stanton design, the packing nut would serve to seal the back of the packing arrangement.

364. The above-described design choices provide additional reasons why the skilled artisan would have been motivated at the time of invention to modify the packing arrangement of Blume with that of Stanton.

j. 7.i “a first reciprocating plunger, at least a portion of the first reciprocating plunger installed within the central opening of the first component”

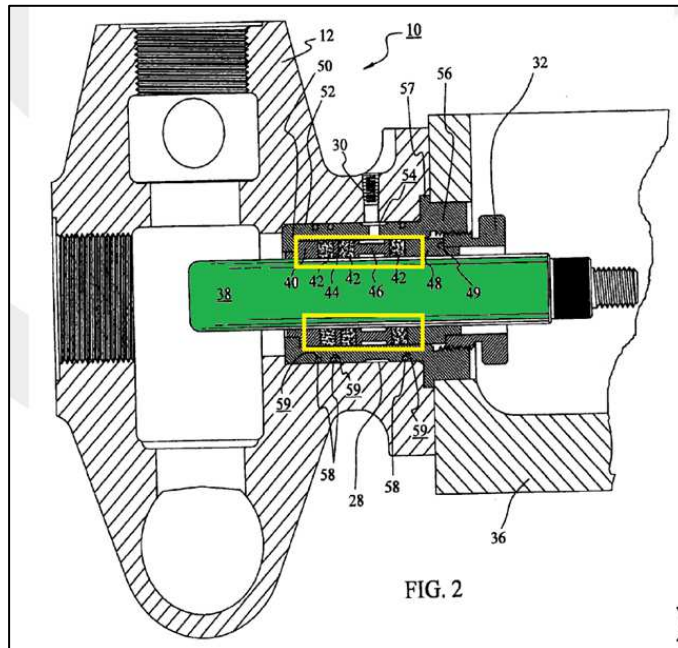
365. Recitation 7.i of the ‘534 Patent recites “a first reciprocating plunger, at least a portion of the first reciprocating plunger installed within the central opening of the first component.” The figures below, from Blume and Stanton, exhibits a typical fluid end arrangement for a reciprocating power pump. Note the green plunger partially within the yellow packing/stuffing, showing that such a configuration is not novel in Foster.



Blume (EX1006), FIG. 1 (annotated) (left) and Stanton (EX1007), FIG. 2 (annotated) (right): Demonstrating a very typical reciprocating power pump design.

k. 7.j “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger”

366. Recitation 7.j of claim 7 of Foster recites “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger.” This is a conventional feature of reciprocating plunger pumps that is included in the fluid ends of Blume and Stanton. Because this ground of rejection is relying on the packing sleeve from Stanton, it also relies on the seals from Stanton. The figures below illustrate “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger” in the Stanton fluid end, annotated in yellow. Accordingly, Stanton includes “a first plurality of packing seals installed within the first component and engaging the first reciprocating plunger.”



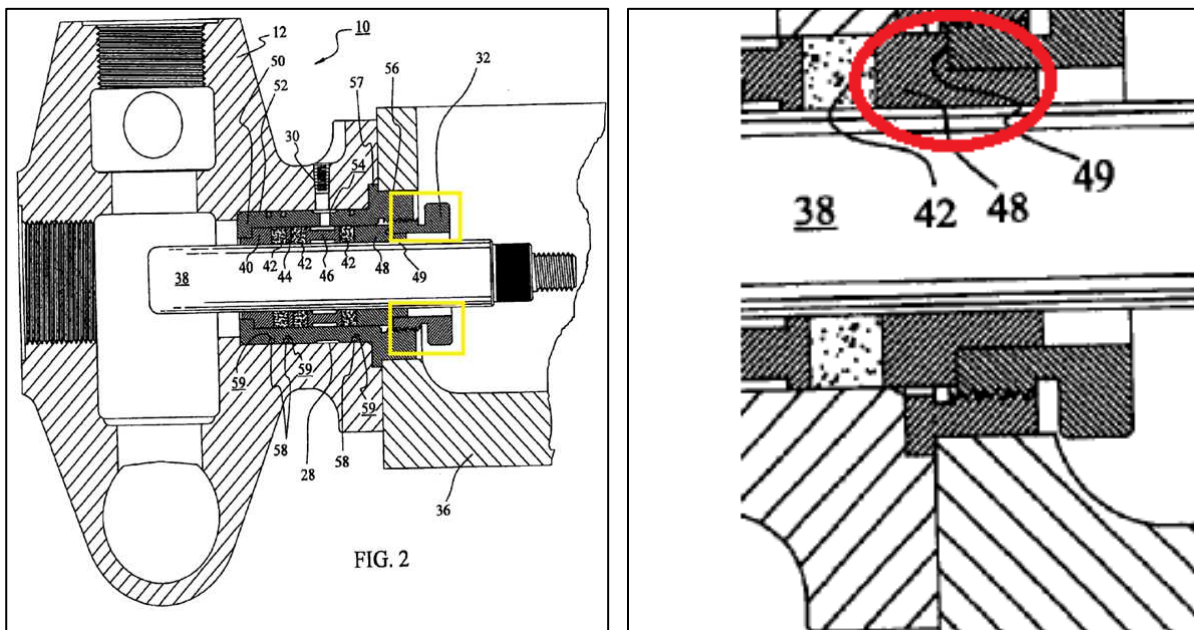
Stanton (EX1007), FIG. 2 (annotated).

- l. **7.k “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.”**

367. Recitation 7.K of claim 7 of Foster recites “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.” Because this ground of rejection is relying on the packing sleeve from Stanton, it also relies on the packing nut from Stanton. Such a packing nut is included in Stanton.

368. In the figures below, the packing nut (annotated in yellow) is attached to the sleeve with threading. This mimics how any packing nut “hold[s] the plurality of first packing seals within the first component” (EX1001, claim 7) due to the compression of the packing. If there is no nut, then all the packing loses its fit and

function, because the pressure ahead of the plunger would push the packing from the bore, and it could not seal around the plunger. This nut not only compresses the packing rings to squeeze out radial clearance around the plunger through which fluid could leak, but acts to hold the packing rings in the sleeve and as an additional fluid barrier at the rear of the packing box assembly, essentially acting as a detachable rear end of the packing sleeve, as circled in red in Fig. 66. Accordingly, Stanton includes “a first packing nut attached to the first component and holding the first plurality of packing seals within the first component.”



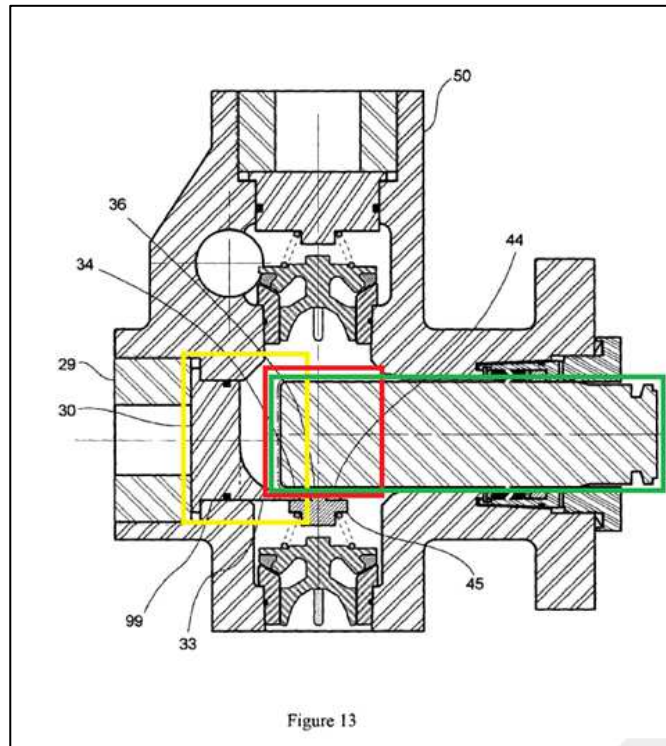
Stanton (EX1007), FIG. 2 (annotated): Illustrating the packing nut along with packing assembly.

viii. Claim 8

- a. 8.a “a first plug and the first reciprocating plunger installed within the first horizontal bore and positioned on opposite sides of the first internal chamber”**

369. Recitation 8.a of claim 8 recites “a first plug and the first reciprocating plunger installed within the first horizontal bore and positioned on opposite sides of the first internal chamber.” Such a “first plug and first reciprocating plunger” are disclosed in Blume.

370. The figure below, from Blume, exhibits a typical liquid end arrangement for a reciprocating power pump. In order to maintain a monoblock (single piece, non-segmented casing) concept, the horizontal bore, within which the plunger (annotated in green) moves and pressurizes the fluid during operation, is closed by a plug (annotated in yellow) rather than being retained as a closed end during the fabrication process. As illustrated, the plug is positioned on an opposite of the internal chamber (annotated in red) from the plunger. This approach allows free access of the boring tool when it is machining the horizontal bore.



Blume (EX1006), FIG. 13 (annotated): Cross-section demonstrating a very typical reciprocating power pump design, including valve and plug details (annotated).

b. 8.b “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber”

371. Recitation 8.b of claim 8 recites “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber.” Such a “second plug and second reciprocating plunger” would have been obvious from the disclosures of Blume. Blume does not explicitly illustrate “a second plug and a second reciprocating plunger installed within the second horizontal bore and positioned on opposite sides of the second internal chamber.” Such a “second plug” and “second plunger,”

however, would have been obvious to the POSITA because each plunger assembly

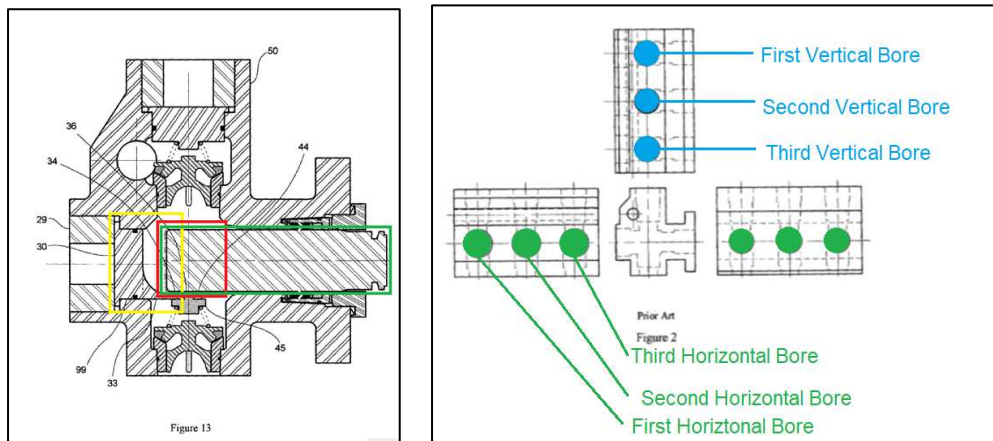
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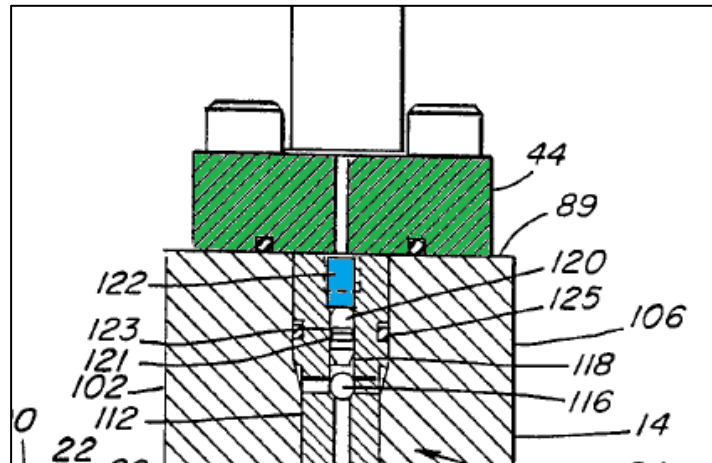
of Blume triplex pump would have the same structure as that illustrated in the figure below in which a plug (yellow) is installed within the horizontal bore on the opposite side of the internal chamber (red) from the plunger (green).



Blume (EX1006), FIGs. 13 and 2 (annotated)

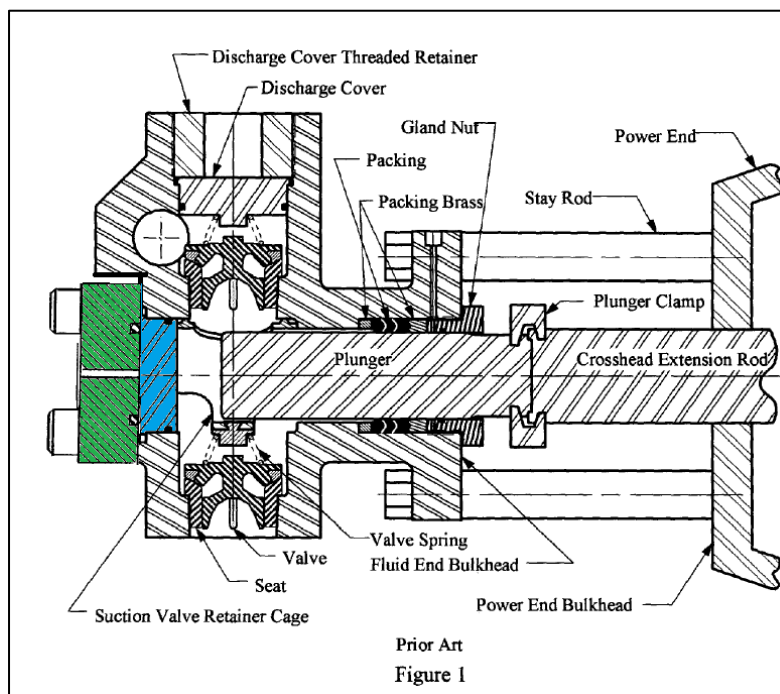
c. 8.c “in which the first plug is positioned adjacent the plate”

Recitation 8.c of claim 8 recites that “the first plug is positioned adjacent the plate.” Blume as modified by Stanton and Wilkinson would include a first plug “positioned adjacent the plate.” Specifically, the plate 44 of Wilkinson secures its valve in the bore via a plug 122. EX1008, 3:25-29; 4:59-60. The plate 44 (green) is positioned adjacent to plug 122 (blue) such that they are abutting, as illustrated in the annotated detail from FIG. 2 of Wilkinson.



Wilkinson (EX1008), FIG. 2 (annotated).

According, when the skilled artisan applies the plate of Wilkinson to cover the horizontal bore of Blume, the skilled artisan will position the plate adjacent to the “first plug” arranged within the horizontal bore, as illustrated in the combination of FIG. 1 of Blume with the plate of Wilkinson.

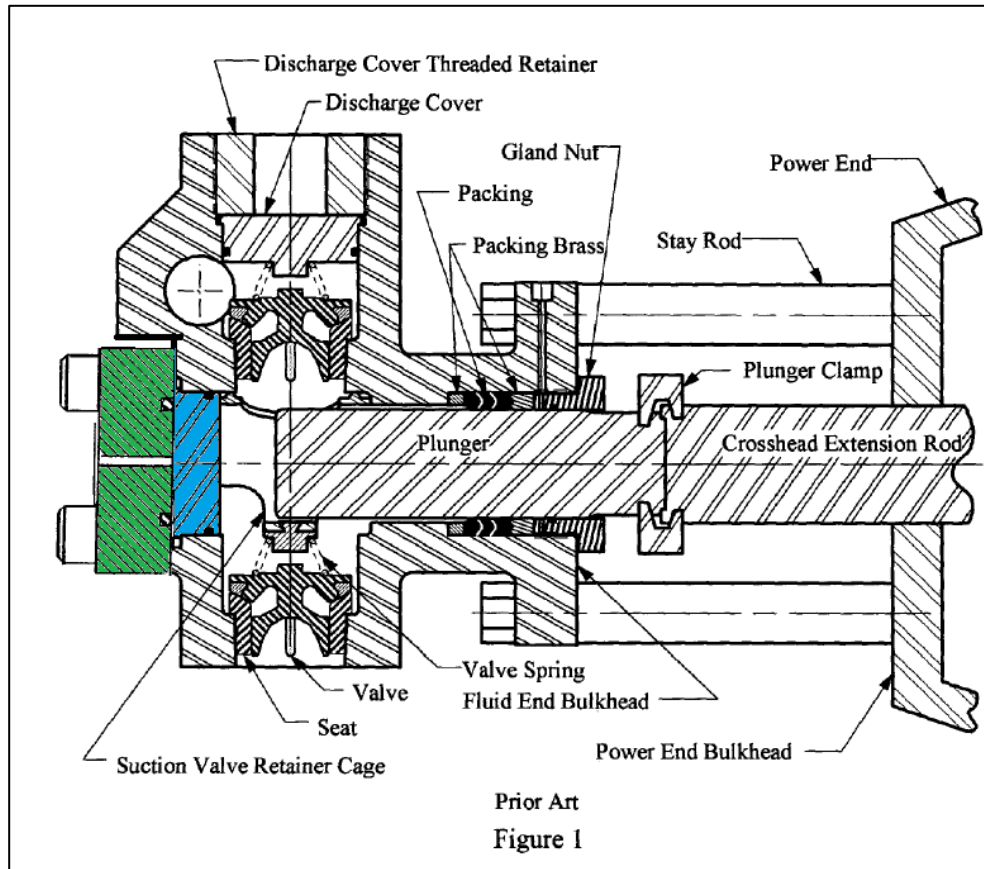


Blume (EX1006), FIG. 1, modified to include plate of Wilkinson (EX1008).

d. 8.d “in which the second plug is positioned adjacent the plate”

Recitation 8.d of claim 8 recites that “the second plug is positioned adjacent the plate.” Blume as modified by Stanton and Wilkinson would include a second plug “positioned adjacent the plate.” First, the “second plug” would have the same structure as the “first plug.” “Second” as used here refers to the plug associated with a second of the plunger arrangements of the example triplex pump of Blume. *See, e.g.,* EX1001, 8:24-33. The skilled artisan would understand from this being a triplex pump that each plunger assembly is one of a homologous series (of three in this case, given the triplex pump being the example), each member of which has the same structure. It would, therefore, have been obvious to the person of ordinary skill in the art that the “second plug” would be arranged relative to the “second reciprocating plunger” in the same way as the “first plug” and first reciprocating plunger.”

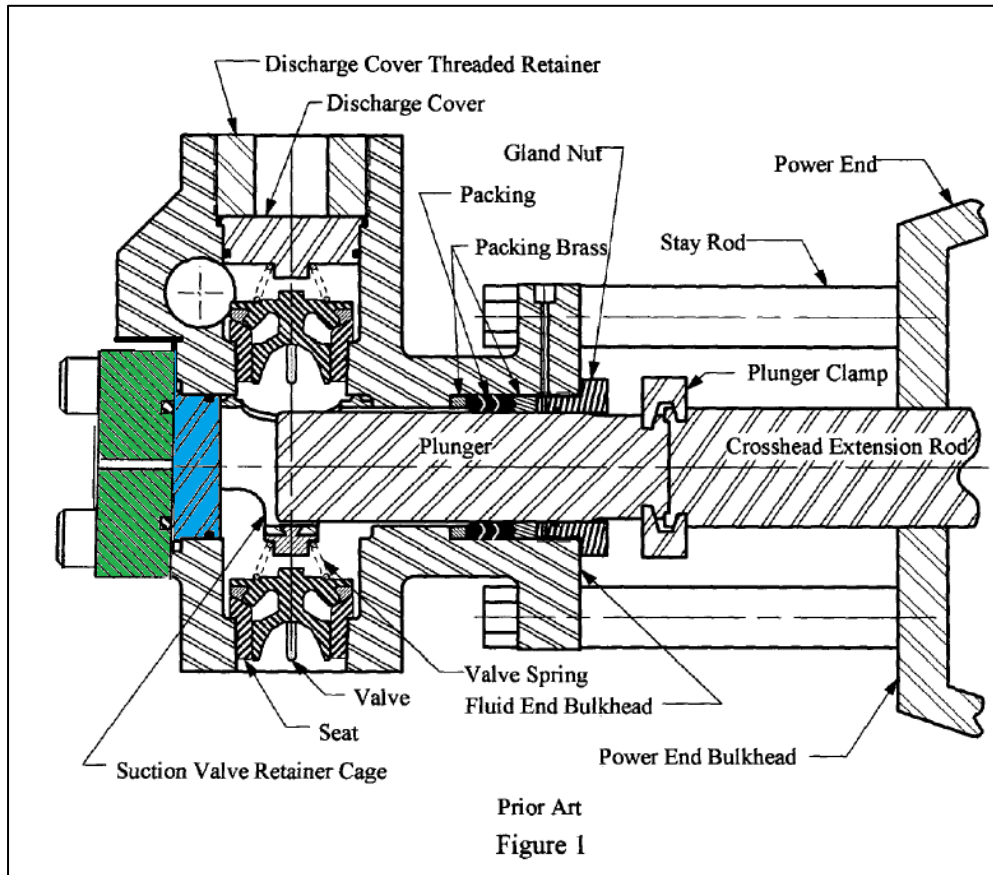
Furthermore, Wilkinson discloses that its plate 44 is configured to cover multiple bores. EX1008, 3:35:25-29. Accordingly, the “second plug” of Blume as modified by Stanton and Wilkinson would be “positioned adjacent the plate,” as illustrated in the annotated figure provided below. Specifically, the second plug (blue) is adjacent to the plate (green), and also abuts the plate.



Blume (EX1006), FIG. 1, modified to include plate of Wilkinson (EX1008).

ix. Claim 9 “which the plate abuts the first plug; and in which the plate abuts the second plug.”

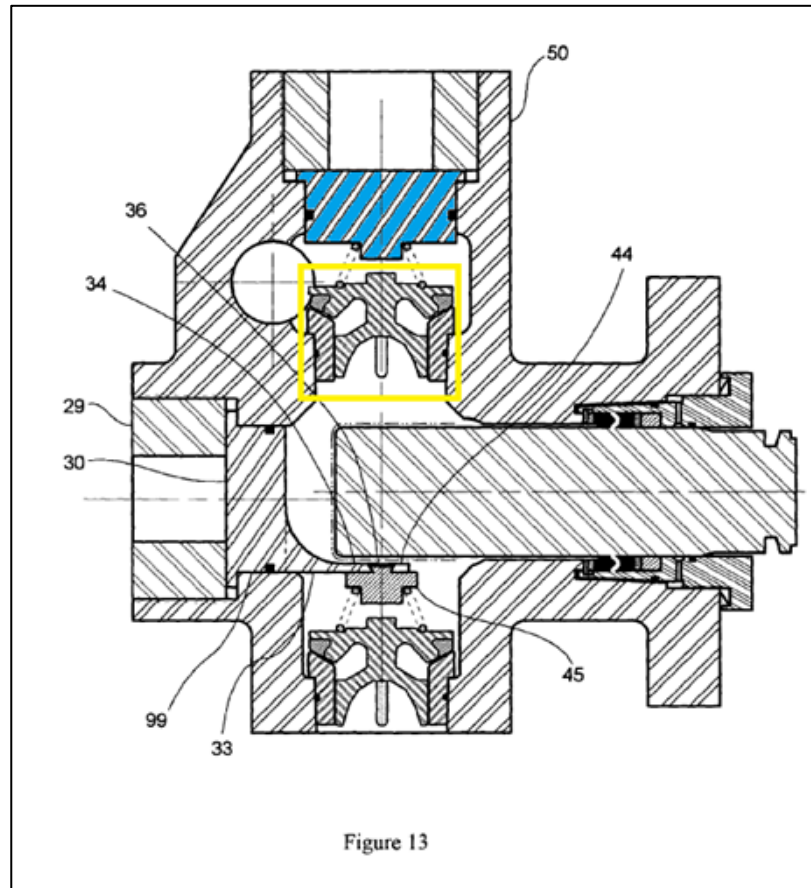
372. Claim 9 recites that “the plate abuts the first plug; and in which the plate abuts the second plug.” As explained above, modifying Blume to utilize the plate of Wilkinson would result in the “plate” abutting the “first plug” and the “second plug,” as illustrated in the annotated figure provided below. Specifically, the plate (green) abuts the first plug (blue). Similarly, the second plug would have the same relative arrangement to the plate. Therefore, the second plug would also abut the plate.



Blume (EX1006), FIG. 1, modified to include plate of Wilkinson (EX1008).

- x. **Claim 10 “a third plug installed within the first vertical bore and positioned between an external surface of the housing and one of the first pair of valves.”**

373. Claim 10 recites “a third plug installed within the first vertical bore and positioned between an external surface of the housing and one of the first pair of valves.” This claim is broad enough to cover a top vertical bore plug or a bottom vertical bore plug. A top vertical bore plug is shown in the figure below, from Blume, and is a conventional part of a plunger pump fluid end. These plugs provide a pressure retention seal, and in some fluid ends, retain the valves in the fluid end.



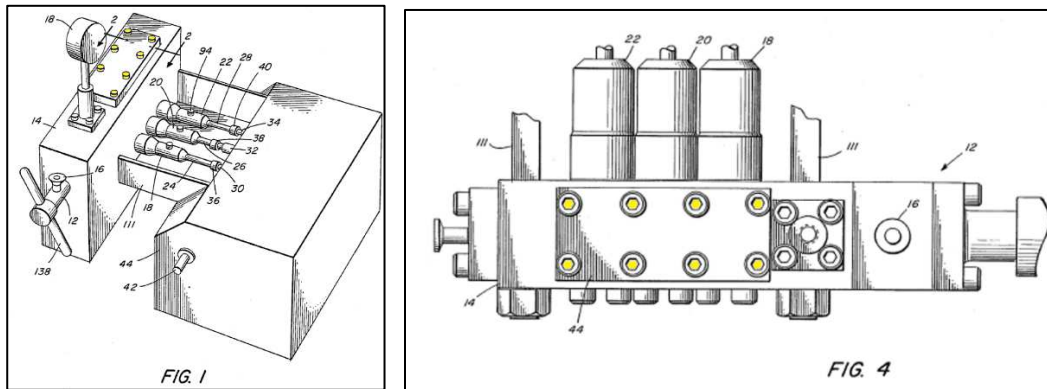
Blume (EX1006), FIG. 13 (annotated): Showing plug (highlighted in blue).

xi. Claim 11

- a. 11.a “which the plate comprises a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a one-to-one relationship”**

374. Recitation 11.a of claim 11 of Foster recites “a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a one-to-one relationship.” While these openings are not explicitly illustrated in Wilkinson, they would have been obvious to the skilled artisan at based on Blume as modified by Stanton and Wilkinson.

375. As discussed above, it would have been obvious to the skilled artisan to use the plate of Wilkinson to cover the horizontal bore of Blume. The annotated figures below are taken from Wilkinson. the figures illustrate hex-headed fasteners that secure the cover plates to the fluid end housing. The skilled artisan would understand that a hex head is used to torque a threaded fastener within a threaded opening in order to secure the fastener within the opening. The skilled artisan would understand that these hex-headed fasteners pass through fastener openings in the plate and engage with threaded openings formed in the housing in a one-to-one relationship to secure the plates to the fluid end housing. Specifically, the skilled artisan would understand that a hex head is used to torque a threaded fastener within a threaded opening in order to secure the fastener within the opening. The threaded openings are not shown in sufficient detail to illustrate the actual threads. The presence of threads (in the fastener and its opposing hole or “opening”), however, would have been obvious to the skilled artisan given the fasteners and are illustrated with a hex head. The skilled artisan would understand that a threaded fastener would need to engage with a threaded opening in order to secure the plate to the housing. Accordingly, it would have been obvious to the skilled artisan that the plate of Wilkinson applied to the fluid end of Blume would include “a plurality of fastener openings that align with a plurality of threaded openings formed in the housing in a one-to-one relationship.”

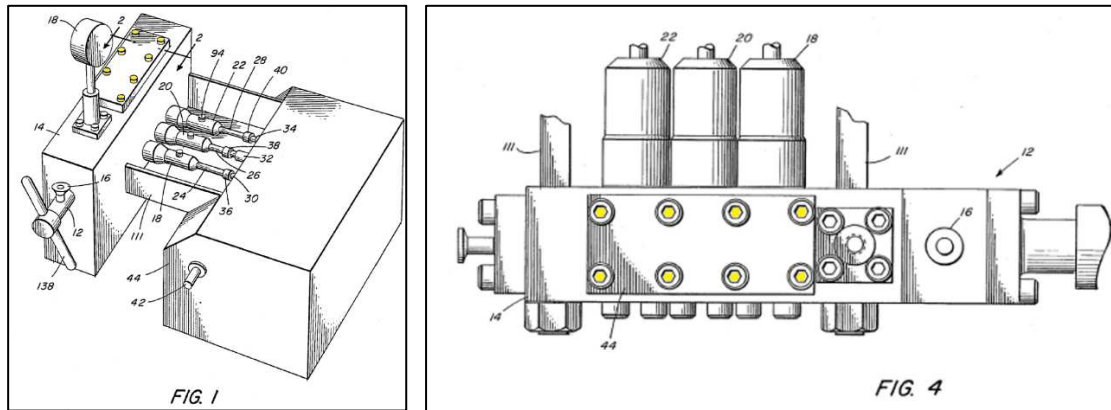


Wilkinson (EX1008), FIGs. 1 and 4 (annotated): Showing multiple threaded connections fastening down the top plate.

- b. 11.b “a plurality of fasteners, each of the plurality of fasteners installed within a corresponding one of the aligned fastener openings and threaded openings”

376. Recitation 11.b of claim 11 of Foster recites “a plurality of fasteners, each of the plurality of fasteners installed within a corresponding one of the aligned fastener openings and threaded openings.” Such fasteners would have been obvious to the skilled artisan based on the teachings of Blume in light of Stanton and Wilkinson.

377. The annotated figures below are taken from Wilkinson. Illustrated in the figures are hex head fasteners. The skilled artisan would understand that a hex head is used to torque a threaded fastener within a threaded opening in order to secure the fastener within the opening. The skilled artisan would understand that such a fastener is a threaded fastener that would install within the aligned fastener openings in the plate and the corresponding threaded openings in the housing.

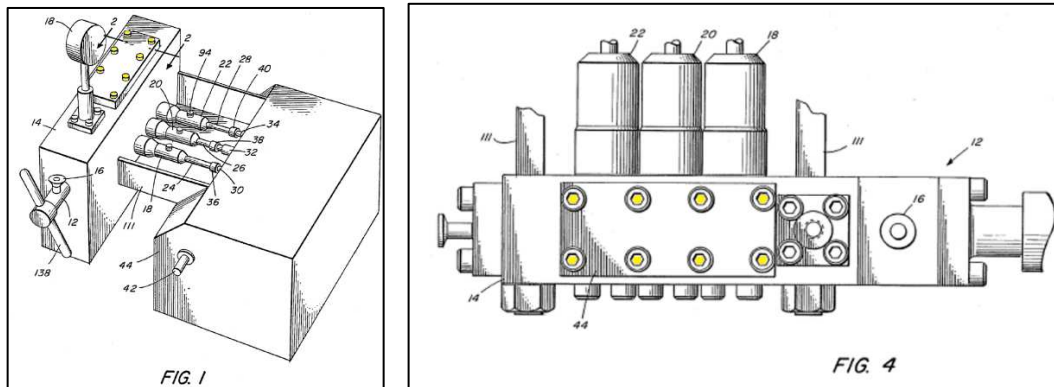


Wilkinson (EX1008), FIGs. 1 and 4 (annotated): Showing multiple threaded connections fastening down the top plate.

- xii. **Claim 12 “a plurality of fasteners, each of the plurality of fasteners extending through the plate and into the housing to fasten the plate to the housing.”**

378. Claim 12 of Foster recites “a plurality of fasteners, each of the plurality of fasteners extending through the plate and into the housing to fasten the plate to the housing.” Such fasteners are included in the fluid end of Wilkinson, the threaded fasteners discussed in section V.C.ii.a, *supra*.

379. The annotated figures below are taken from Wilkinson. Illustrated in the figures are hex head fasteners. The skilled artisan would understand that such fasteners extend through the plate and into the housing to fasten the plate to the housing.

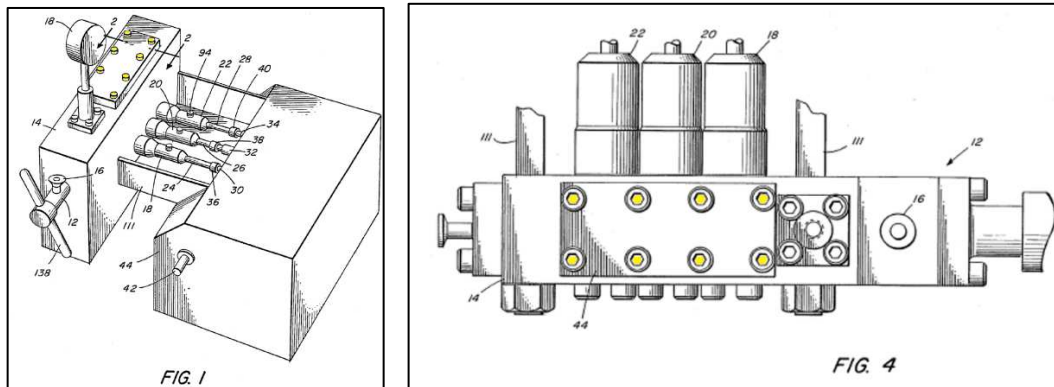


Wilkinson (EX1008), FIGs. 1 and 4 (annotated): Showing multiple threaded connections fastening down the top plate.

xiii. Claim 13 “each of the plurality of fasteners is a threaded fastener.”

380. Claim 13 of Foster recites “each of the plurality of fasteners is a threaded fastener.” While the fasteners in Wilkinson are not explicitly illustrated as being threaded, threaded fasteners would have been obvious to the skilled artisan at the time of filing.

381. The annotated figures below are taken from Wilkinson. The figures illustrate hex-headed fasteners that secure the cover plates to the fluid end housing. The presence of threads (in the fastener and its opposing hole or “opening”) would have been obvious to the skilled artisan given the fasteners and are illustrated with a hex head. The skilled artisan would understand that a hex head is used to torque a threaded fastener with a threaded opening in order to secure the fastener within the opening. Accordingly, it would have been obvious to the skilled artisan that the openings formed in the fluid end housing would be threaded.



Wilkinson (EX1008), FIGs. 1 and 4 (annotated): Showing multiple threaded connections fastening down the top plate.

xiv. Claim 14

- a. 14.a “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore”**

382. Recitation 14.a of claim 14 recites “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore.” Where recitation 7.J of claim 1 recites the “first component” for a first plunger assembly, this recitation recites the corresponding “component” for a second plunger assembly of a multiplex pump. Specifically, “second” as used in Foster refers to the additional plunger arrangements in a multiplex, duplex or triplex pump. *See, e.g.,* EX1001, 9:14-20. The skilled artisan would understand that the each of the plunger arrangements of the Blume fluid end, as modified by Stanton and Wilkinson, would include substantially the same structure, including a packing sleeve having a central opening (annotated in yellow) with a portion of the packing sleeve installed within the second horizontal bore, as

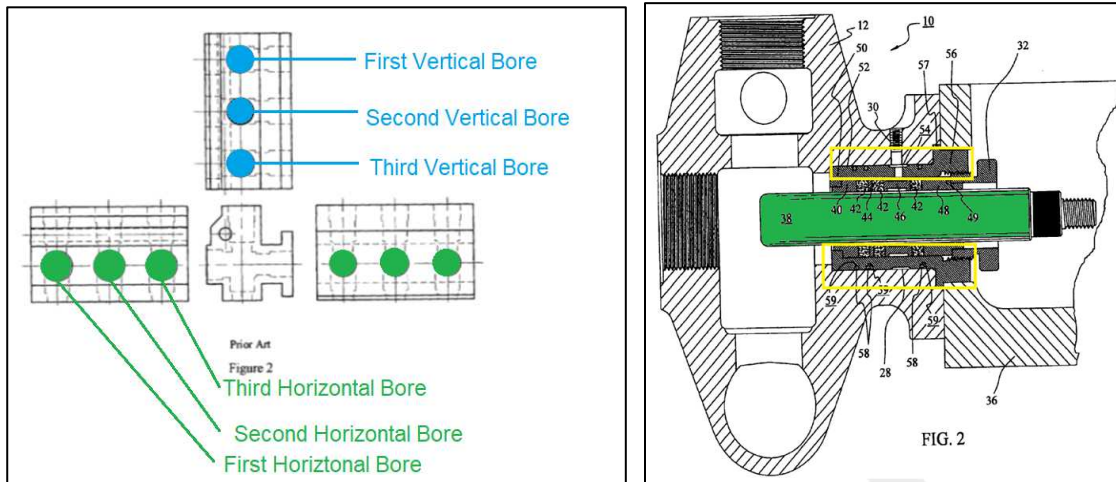
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illustrated in the figure below. Accordingly, “a second component having a central opening formed therein, at least a portion of the second component installed within the second horizontal bore” would have been obvious at the time of filing to the skilled artisan from the teachings of Blume in view of Stanton and Wilkinson.

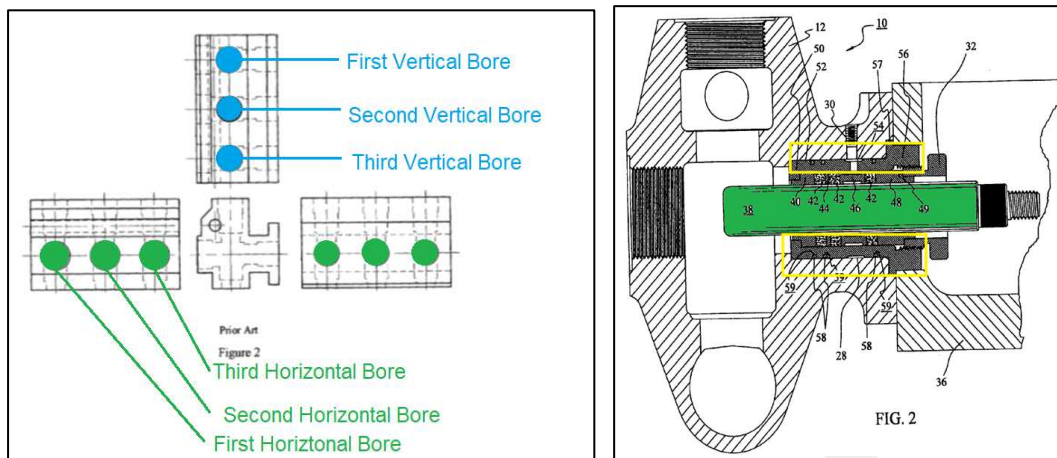


Blume (EX1006) FIG. 2 (annotated) and Stanton (EX1007), FIG. 2 (annotated).

- b. 14.b “a second reciprocating plunger, at least a portion of the second reciprocating plunger installed within the central opening of the second component;”**

383. Recitation 14.b of claim 14 recites “a second reciprocating plunger, at least a portion of the second reciprocating plunger installed within the central opening of the second component.” Such a “second reciprocating plunger” would have been obvious from the teachings of Blume in view of Stanton and Wilkinson. Specifically, “second” as used in Foster refers to the additional plunger arrangements in a multiplex, duplex or triplex pump. *See, e.g.*, EX1001, 9:55-65. The skilled artisan would understand that the each of the plunger arrangements of the Blume

fluid end, as modified by Stanton and Wilkinson, would include substantially the same structure, including a “second reciprocating plunger” (annotated in green), at least a portion of which is installed within the central opening of the second component (annotated in yellow), as illustrated in the figures below.

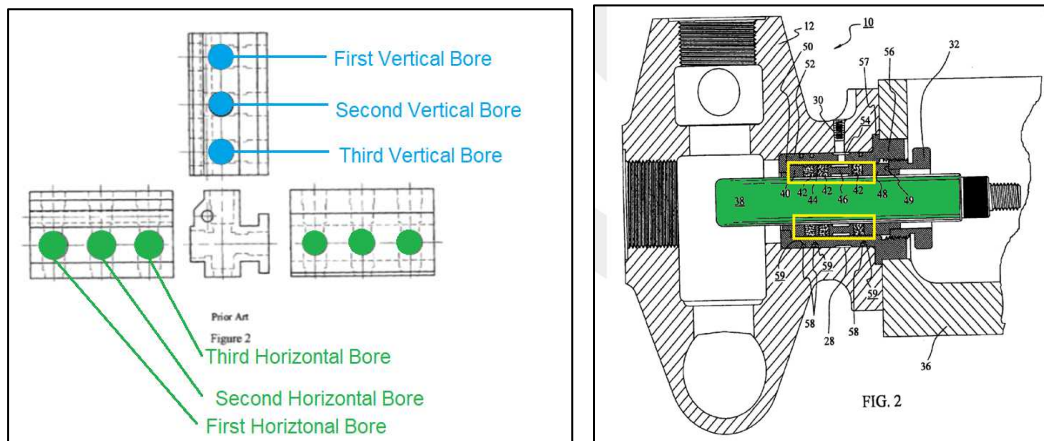


Blume (EX1006) FIG. 2 (annotated) and Stanton (EX1007), FIG. 2 (annotated).

c. 14.c “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger;”

384. Recitation 14.c of claim 14 recites “a second plurality of packing seals installed within the second component and engaging the second reciprocating plunger.” Such a “second plurality of packing seals” would have been obvious from the teachings of Blume in view of Stanton and Wilkinson. Specifically, “second” as used in Foster refers to the additional plunger arrangements in a multiplex, duplex or triplex pump. *See, e.g.*, EX1001, 9:55-65. The skilled artisan would understand that the each of the plunger arrangements of the Blume fluid end, as modified by

Stanton and Wilkinson, would include substantially the same structure, including a “second plurality of packing seals” (annotated in yellow) engaging the “second reciprocating plunger” (annotated in green), as illustrated in the figures below.

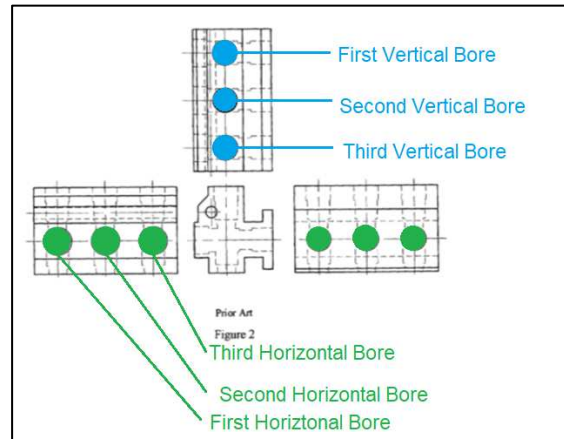


Blume (EX1006) FIG. 2 (annotated) and Stanton (EX1007), FIG. 2 (annotated).

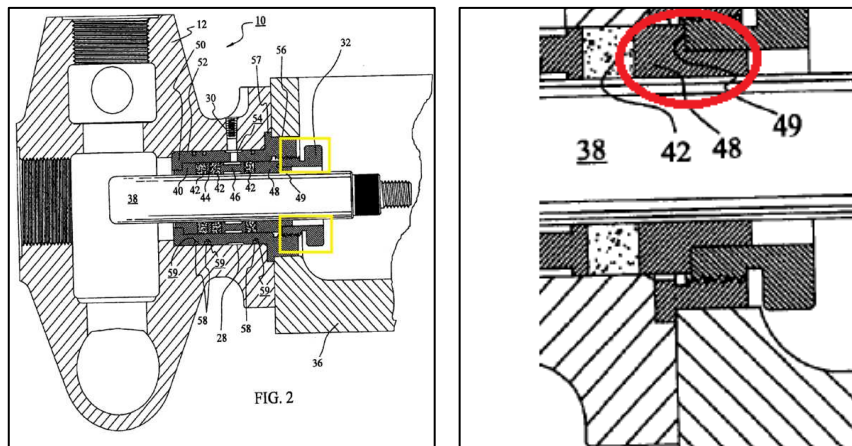
d. 14.d “a second packing nut holding the second plurality of packing seals within the second component”

385. Recitation 14.d of claim 14 recites “a second packing nut attached to the second component and holding the second plurality of packing seals within the second component.” Such a “second packing nut” would have been obvious from the teachings of Blume in view of Stanton and Wilkinson. Specifically, “second” as used in Foster refers to the additional plunger arrangements in a multiplex, duplex or triplex pump. *See, e.g.*, EX1001, 9:55-65. The skilled artisan would understand that the each of the plunger arrangements of the Blume fluid end, as modified by Stanton and Wilkinson, would include substantially the same structure, including a

“second packing nut” (annotated in yellow) holding the second plurality of packing seals within the second component, as illustrated in the figures below.



Blume (EX1006), FIG. 2 (annotated).



Stanton (EX1007), FIG. 2 (annotated).

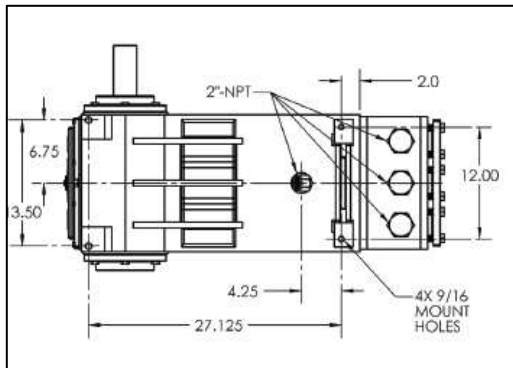
xv. Conclusion With Respect to the Third Ground

386. As illustrated through the discussion above, it is my opinion that every recitation of claims 1-14 of Foster would have been obvious at the time of filing.

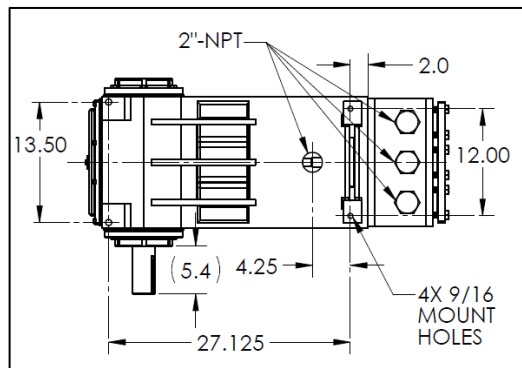
VI. Ground 4 – Claims 1-14 are invalid under 35 U.S.C. § 103 over the Offer for Sale of the Kerr Pump

387. It is my opinion that claims 1-14 of Foster are invalid as obvious over the offer for sale of the Kerr Pump. It is my understanding that the Kerr Pump was offered for sale by Kerr no later than December 28, 2014, and in doing so, Kerr Pumps provided the Kerr Spec Sheet (EX1011) as being indicative of the pump being offered. Petition at section IX.d.

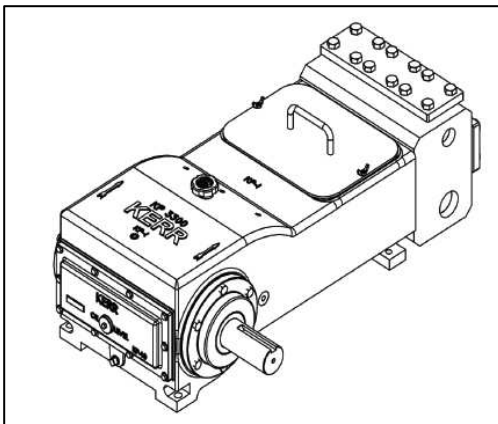
388. Based on my review of Kerr (i.e., the Kerr Pump manual relied upon in Ground 1 above) and the Kerr Spec Sheet (EX1011), it is my opinion that Kerr is representative of the Kerr Pump that was offered for sale. Reproduced below are figures from the Kerr Spec Sheet and Kerr. As illustrated, the figures between the two documents are identical:



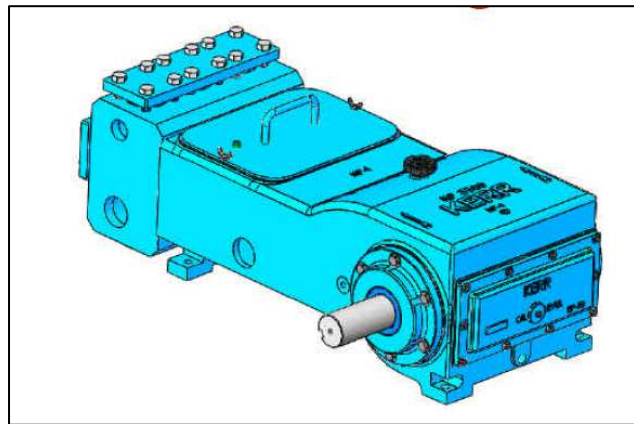
Kerr Spec Sheet (EX1011).



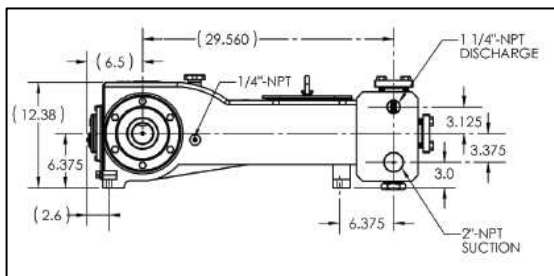
Kerr (EX1004), p. 25.



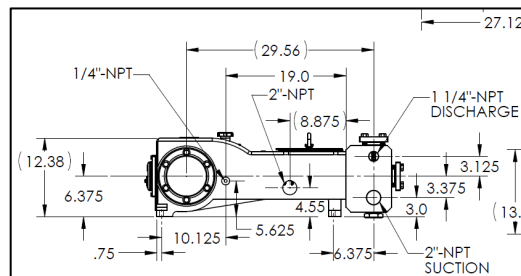
Kerr Spec Sheet (EX1011).



Kerr (EX1004), p. 24.



Kerr Spec Sheet (EX1011).



Kerr (EX1004), p. 25.

389. Accordingly, it is my opinion that Kerr is representative of the Kerr Pump as it was offered for sale on or before December 28, 2014. Therefore, claims 1-14 of Foster are invalid over the Kerr Pump for the same reasons as those presented in section V.A based on Kerr.

GD ENERGY PRODUCTS LLC

Petitioner

EX1003

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VII. Ground 5 – Claim 15 of Foster is Invalid under 35 U.S.C. § 112

390. Based on my review of Foster, it is my opinion that claim 15 is unpatentable under 35 U.S.C. § 112 as, for example, being indefinite for failing to particularly point out and distinctly claim the subject matter regarded as the invention. Claim 15 recites:

15. The fluid end assembly of claim 7, further comprising: a retainer attached to the first component using the plurality of fasteners; in which at least a portion of the first packing nut is installed within the retainer.

(Emphasis added).

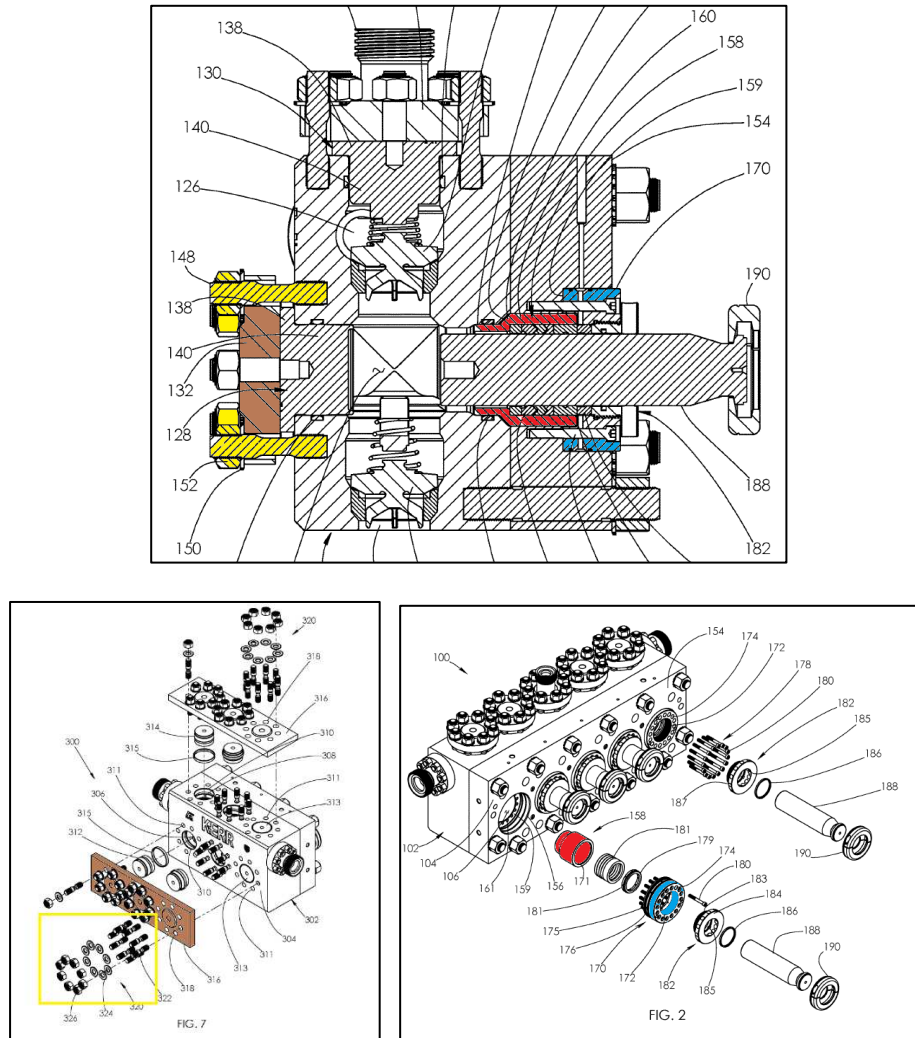
391. First, the “plurality of fasteners” lacks antecedent basis. Claim 7, from which claim 15 depends, does not recite “a plurality of fasteners,” nor does claim 15 introduce “a plurality of fasteners.” Therefore, claim 7 is indefinite for at least this reason.

392. Second, even assuming for the sake of argument that claim 15 was intended to depend from claim 12 which introduces “a plurality of fasteners,” it is my opinion that the claim would still be indefinite because it is not clear to the skilled artisan how “a plurality of fasteners ... extending through the plate and into the housing to fasten the plate to the housing” could also attach a retainer to the first component arranged at least partially within the recited horizontal bore.

393. Third, even if it is assumed for the sake of argument that the skilled artisan would understand how “a plurality of fasteners extending through the plate

and into the housing to fasten the plate to the housing” could also attach a retainer to the first component arranged at least partially within the recited horizontal bore, the claim would be unpatentable as failing the written description requirement of 35 U.S.C. § 112(a). I have reviewed Foster in detail and it provides no disclosure of a plurality of fasteners that serve both of these functions. EX1001, *passim*.

394. For example, in all of the figures reproduced below, the plurality of fasteners (annotated in yellow) that attached the plate (annotated in brown) to the fluid end housing (each of which is required to “extend[] through the plate and into the housing to fasten the plate to the housing” (*see* claim 12)) do not also attached a retainer (annotated in blue) to the first component (annotated in red).



EX1001, FIGs. 3, 7, 2 (annotated)

VI. Conclusion

395. Based on my review of the cited art, and Foster, and for the reasons stated herein, it is my opinion that cited art, whether considered alone or in combination, anticipates or renders obvious claims 1-14 of Foster to one of skill in the art. Also based on my review of Foster, claim 15 is invalid as indefinite or as failing to comply with the written description requirements for valid patents.

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct.

Executed this 31 day of January 2025.

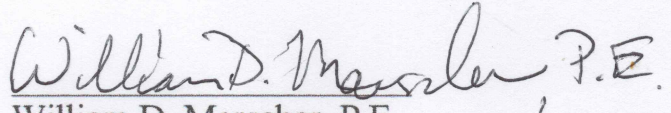

William D. Marscher, P.E.

EXHIBIT A

William Donnelly Marscher, P.E.
Mechanical Solutions Inc.
CEO & Senior Consultant

William D. Marscher is employed as CEO and Senior Consultant of the machinery consulting and independent rotating machinery company Mechanical Solutions, Inc. (MSI), performing engineering work in the field of fluid systems and their rotating and reciprocating machinery, particularly pumps, compressors, and turbines. His typical work responsibilities include backing up MSI's technical team in design, analysis, and testing of all types of plant machinery, as well as other types of fluid and mechanical systems. Mr. Marscher has background in all types of pumps, including centrifugal as well as positive displacement (e.g. reciprocating, gear, rotary, diaphragm, and screw) pumps.

For 21 years, Mr. Marscher has been one of the U.S. voting representatives on the ISO (International Standards Organization) TC108 committee concerning, among other issues, pump dynamic behavior and acceptance standards. He is past president of the Society of Tribologists & Lubrication Engineers (STLE), the primary technical society worldwide for the study of bearings, sealing, wear, and erosion issues in machinery. For the past 40 years he has been a voting member of the ASTM Fatigue Standards Committee, as well as the ASTM Wear & Erosion Standards Committee. He is also the past Board of Directors Chairman for the Machinery Failure Prevention Technology Society (MFPT) of the Vibration Institute. Mr. Marscher is an 18 year member of the Texas A&M Pump Users Symposium Advisory Committee (essentially the Board of Directors for the Symposium). For ASME, Mr. Marscher was Chair of the Predictive Maintenance committee, and was Organizing and Presiding Chair of the 1993 RoCon Rotating Machinery Conference and the 1995 Tribology Conference.

Mr. Marscher has written eight handbook chapters for various major engineering handbooks, which have focused on pump and turbomachinery mechanical issues, including dynamics and vibration. In previous employ, he was a senior engineer for the Bendix Fuel Pump and EFI Division (maker of automotive electric motor driven plunger/piston pumps and fuel injection systems, now a Honeywell division), a senior engineer for Pratt & Whitney Aircraft Engines, Director of Mechanics (Mechanical Engineering) for Worthington Pump HQ, and Manager of Engineering Mechanics for Dresser Worthington Pump Division after their acquisition of Worthington. Later, he was VP of the independent pump and turbomachinery developer Concepts NREC, from which 25 years ago he spun off Mechanical Solutions, Inc. as an independent pump and turbomachinery technology company. He has since become a charter Standards Partner for the Hydraulic Institute (HI), the trade association for the pump industry, became Vice Chair of the pump vibration technical committee for HI, and was HI Standards Partner of the Year for 2018, based on playing a significant role in the 9.6.4 and new 9.6.8 standards. He also won the Vibration Institute MFPT Fraey Award for Diagnostics Excellence.

Education: B.S.M.E. Cornell University, 1970
Master Eng. (Mech. Des.) Cornell University, 1972
M.Sc. Applied Mechanics, Rensselaer Polytechnic Institute, 1976

Experience:

Bendix Corp., MI (now Honeywell), 1970- 1973, Engineer, advanced concepts development and system modeling, and advanced sensor development for pumps and fuel injection systems
Pratt & Whitney Aircraft, CT, 1973-1980, Senior Engineer, aircraft engine compressor and turbine section mechanical development, analysis, and testing
Dresser Worthington Pump Div., Dresser Industries, NJ, 1980-1992, Manager and Director, Mechanical Engineering, in charge of mechanical design oversight for centrifugal & PD pumps
Concepts NREC, Inc., Norwich VT, 1992-1996, Vice President and Chief Mechanical Engineer
Mechanical Solutions, Inc., 1996- Present, Founder, CEO, and Senior Consultant

Honors:

NASA Fellow, Cornell University, 1971-1972, original Mars Rover Design project
1983 ASLE Best Technical Paper Award
1986 \$5000 Dresser Pump Creativity Award for Vibration Evaluation Methodology
Fellow & Past President, Society of Tribologists and Lubrication Engineers (STLE)
Fellow & Past President/ Board Chairman MFPT Engineering Society
Associate Editor for 18 years, STLE *Tribology Transactions* magazine
Chapters for 8 Technical Handbooks
Author of 6 U.S. Patents & 1 European Patent
Charter Standards Partner for the Hydraulic Institute, past V. Chairman Vibration Committee
2018 ANSI/HI Standards Partner of the Year
2019 Jack L. Frarey Machinery Diagnostics Achievement Award of the Vibration Institute/MFPT
Registered and Licensed Professional Engineer, State of New Jersey Lic. No. 40626

Publications and Short Courses

Mr. Marscher's eight machinery handbook chapters include the 2nd and 3rd Edition of the Sanks Pumping Station Design Handbook, the structural engineering chapter for Sawyer's Gas Turbine Handbook, the Lubrication and Bearings section of The Modern Marine Engineer's Manual 3rd Edition, and the vibration test and predictive maintenance chapters for the CRC Lubrication & Tribology Handbooks, as well as the handbook pump and turbomachinery tribology chapter. He authored the pump mechanical behavior section of the McGraw-Hill Pump Handbook, 4th Edition, and the pump erosion and wear chapter for the ASM Materials Handbook. He has given short courses and tutorials on pump vibration and rotating machinery mechanical evaluation and troubleshooting twelve times at the Texas A&M Pump Symposium, and also at the U. of Virginia, the von Karman Institute in Belgium, the Sumy Institute Ukraine, IMechE in London, STLE, and the Vibration Institute and MFPT. He has published a large number of refereed technical papers, and was co-author the book Centrifugal Pump Design & Application, published by Oxford University Press (Oxford, England).

Additional Selected Publications:

Marscher, W.D., “*A Phenomenological Model of Abradable Seal Wear in High Performance Machinery*”, Wear Magazine, v. 59, 1980 pp. 191-211

Marscher, W.D., “*A Critical Evaluation of the Flash Temperature Concept*”, ASLE Hodson Best Paper Award Winner, ASLE Annual Meeting, Preprint No. 81-AM-1D-3, May 1981

Marscher, W.D., “*Thermal vs. Mechanical Effects in High Speed Sliding*”, Wear Magazine, v. 79, pp 129-143, 1982

Marscher, W. D., “*Test Simulation of Turbomachinery Rotor/ Stator Interactions at Seals,*” ASLE Annual Meeting, May 1982, featured article in Lubrication Engineering magazine, v. 39, no. 9, pp 577-583, September 1983.

Marscher, W.D., “*Structural Design and Analysis of Modern Turbomachinery Systems*”, Chap. 7, Sawyer's Gas Turbine Engineering Handbook, 3rd Ed., v. I, Turbomachinery Publications, Norwalk CT, c. 1985

Marscher, W.D., “*The Effect of Fluid Forces at Various Operation Conditions on the Vibrations of Pumps*”, Proc. IMechE, Radial Loads and Axial Thrusts, Feb 5 1986

Marscher, W.D., “*Determination of Pump Rotor Critical Speeds During Operation through Use of Modal Analysis*”, Proc ASME 1986 WAM Symposium on Troubleshooting Methods and Technology, Anaheim Cal, Dec 1986

Marscher, W.D., “*The Relationship Between Pump Rotor System Tribology and Appropriate Vibration Specifications*”, Proc IMechE 3rd European Congress on Fluid Machinery for the Oil and Petrochemical Industries, The Hague, Netherlands, May 1987

Marscher, W.D., “*Subsynchronous Vibration in Boiler Feed Pumps Due to Stable Response to Hydraulic Forces at Part Load*”, Proc IMechE Conf on Part Load Pumping Control and Behavior, Edinburgh Scotland, Sept. 1988

Marscher, W. D., “*Analysis and Test of Multistage Pump ‘Wet’ Critical Speeds,*” ASME/STLE Joint Lubrication Conference, 1989, Preprint 89-GT-6E-1, October 1989.

Marscher, W.D., “*The Effect of Variable Frequency Drives on Vibration Problems in Vertical Pumps*”, Proc. Water & Wastewater Conference, Barcelona, Spain, April 1990

Marscher, W.D., “*Vibration Test and Analysis of a Barrel Boiler Feed Pump Exhibiting Non-Synchronous Vibration*”, Proc IMechE Seminar on Vibrations in Pumps, London, Dec. 1990

Marscher, W.D., “*The Use of Impact Testing to Solve Vibration Problems in Power Plant Pumps,*” EPRI Reliability Symposium, Tampa, FL, June 1991.

Marscher, W.D., “*Advanced Vibration Analysis and Test Technology for Pumps,*” Conf. on Vibration and Sealing in Centrifugal Machinery, Sumy Technical Institute, Ukraine, Sept. 1991

Marscher, W.D., “*Make Vibration Monitoring Live Up to Its Potential*”, Power magazine, pp 54-57, July 1994

Marscher, W.D., “*Wear and Erosion of Pumps*” Chapter of the ASM Handbook, vol. 18, pp 65-1 to 65-9, c. 1995

Marscher, W.D., “*Vibration*” Chapter and “*Predictive Maintenance*” Chapters, STLE/CRC Tribology & Lubrication Handbook, STLE Park Ridge IL, 1994 & 1997

Marscher, W.D., “*Bearing Application and Lubrication*” Chapter, Modern Marine Engineer’s Manual 3rd Edition, Cornell Maritime Press Centreville MD, 1999

Marscher, W.D., “*Electric Current Modal Impulses to Detect Motor-Driven Pump Rotor Condition*”, Proc. 17th Int’l Modal Analysis Conf., Kissimmee FL, Feb. 1999

Marscher, W.D., “*The Determination of Rotor Critical Speeds While Pump Remains Operating, through Use of Impact Testing*”, IMAC Conf. Orlando FL, SEM, Feb. 1999

Marscher, W.D., “*Avoiding Failures in Pumps*”, Tutorial in Proc. TAMU International Pump Symposium, Houston TX, Feb. 2002

Marscher, W.D., “*The Relationship of Vibration to Problems in Pumps*”, Cover Story in Chemical Engineering magazine, pp 38-44, May 2004

Marscher, W.D., & Hogg, Stephen, “*Use of Non-Contact Acoustic Signals as Metrics for Machinery Diagnostics*”, Proc. 2006 MFPT Annual Meeting, Virginia Beach VA, May 2006

Marscher, W.D., “*An End-User’s Guide to Pump Rotordynamics*”, Proc. Texas A&M 23rd International Pump Symposium, Houston TX, March 2007, and presented annually since then up through Sept. 2020.

Marscher, W.D., and Kelly, W.J., “*Machinery Prognosis Based on Finite Element, Tribological, and Fatigue Analysis Calibrated by Test*”, Proc. 2009 MFPT Annual Meeting, Dayton OH, May 2009

Marscher, W.D., & Kelly, W.J., “*Advanced Diagnostics & Prognostics of Plant Machinery*”, Proc. 2010 MFPT Annual Meeting, Huntsville AL, April 2010

Marscher, W.D., “*Turbomachinery Tribology*” Chapter, STLE/CRC Tribology & Lubrication Handbook Vol.3, STLE Park Ridge IL, 2011

Marscher, W.D., “*Vibration Detection Using Motion Magnification Video*”, Vibration Institute Annual Meeting, New Orleans LA, 2018

Marscher, W.D., “*Effects of Operating Pumps at Off-Design Flows and Speeds*”, Hydraulic Institute Annual Meeting, Florida, 2018.

Marscher, W.D., Onari, M.M., Boyadjis, P.A., Olson, E.J., Lerche, A., “*Vibration of Pumps and Turbomachinery*”, Short Course Texas A&M International Pump Symposium, Houston TX, March 2002, and presented annually since then up through Sept. 2020

Prior Legal Cases Last 8 Years:

1. Expert opinion, declaration, and deposition regarding validity of reciprocating pump valve patent No. 7,121,812.
Attorney: Jessica E. Zilberberg, Carlson Gaskey & Olds, P.C., Birmingham Michigan
Tel. (248) 988-8360, jzilberberg@cgalaw.com
2. Expert opinion and deposition concerning Sulzer submersible pump failures due to problems in the pump specification requirements versus actual needs (the wrong flow rate was

specified for the pump) and problems with the sump design. I supported Sulzer over a year's time in their successful defense. I was their primary technical witness.

Attorney: Michael Hanahan, Schiff Hardin LLP, Chicago IL, Tel: 312-258-5701.

3. Expert opinion and written declaration concerning failure of a Viking positive displacement pump for the making of peanut butter cup candy, which resulted in gross contamination resulting in a great deal of lost product and an extended period of lost production, as well as clean-up and repair costs. The liability amounted to 16 million dollars. The system should have been outfitted with sensors and controls, and should have had a provision for venting of discharge overpressure to avoid such catastrophes. After two years of mediation, the claim was able to be settled for only one percent of the original claim. My testimony composed the primary argument for our ultimately successful case.
Attorney: Timothy Mattson, Frith Anderson & Peake, Roanoke VA, Tel. 540-725-3380.
4. Expert engineering guidance in a case involving a large skyscraper, advising concerning a valve that was part of a system that flooded the building because of improper system design.
Attorney: Len Lesser, Simon-Lesser PC, New York, NY, Tel: 212-599-5455.
5. Expert engineering guidance in a case involving a leakage in a cooling assembly and piping in another large skyscraper, advising concerning a pipe joint breakage that flooded the building because of disconnected alarms. Attorney: Len Lesser, Simon-Lesser PC, New York, NY, Tel: 212-599-5455
6. Expert testimony (2-day deposition as well as testify in court, and provide expert guidance) concerning a Moyno pump/ gear/ motor set that was not properly sized in accordance with specifications, leading to chronic trips. Testified at trial, 2014, Attorney: David Romyn, Castle Law Associates, Los Angeles CA.
7. Expert testimony, including Declaration, on behalf of Siemens in their "Longview" case concerning a large steam turbine generator enduring hydrogen seal failures. Case was in 2014, attorneys were Robert Wolinsky, and David Michaeli, of Hogan Lovells in Washington DC.
8. Expert testimony, including Declaration, as well as detailed engineering calculations concerning a fire in an Aluminum plant in Qatar, which the Norwegian/British insurance company was refusing to pay the insurance money due because of relatively high prior vibration in a large fan assembly. The insurance company (which was the opposition) settled out of court for nearly the full amount due. Case was throughout most of 2013. Attorneys Vasilis Pappas and John Craig of Bennett-Jones of Calgary Alberta Canada.

9. Patent Declaration Concerning GIW Patent (Addie et al), DIVERTER FOR REDUCING WEAR IN A SLURRY PUMP, Filed: August 6, 2002, Examiner: Richard A. Edgar, Atty. Scott Sudderth of Womble Carlyle Sandridge & Rice, PLLC, Winston-Salem NC. Case was litigated in 2011/2012. W. Marscher provided expert testimony by declaration.
10. Evaluation of John Crane Mechanical Seal Failures in Sharpe Mixers, Preg O'Donnell & Gillette PLLC, Seattle WA, Atty. John Butler , 2010/2011. W. Marscher provided mechanical seal damage deposition and expert opinion/ declaration.

Prior Legal Cases Before 2010:

HARTLINE, DACUS, BARGER, DREYER, & KERN, LLP
6688 North Central Expressway, Suite 1000
Dallas, Texas 75230

Tel: 214-346-3723

Atty – Edward Davis

Dresser-Rand vs. Equistar Chemical Company. W. Marscher provided expert consulting and compressor design and impeller stresses, and was prepped for trial (settled before testimony).

GRAHAM CURTIN, P.A.
4 Headquarters Plaza
Morristown, NJ 07962

Atty. – Tom Curtin- 973-401-7159

Case was about pulsating/ vibrating system including a positive displacement screw compressor that BASF claimed was a faulty design, 2005, W. Marscher provided expert consulting for Dover legal team. Case was Dover/A-C Compressor vs. BASF, Excessive Acoustic Pulsation/ Vibration of Screw Compressor System.

GROTEFELD & DENENBERG, L.L.C.
105 West Adams Street
Suite 2300
Chicago, IL 60603

Atty. - Shantel Woods – 312-601-2374
Case was NJ Building vs. the Sloan Flusher Valve Co., 2003,
W. Marscher provided expert consulting for NJ Building legal team, and performed
deposition.

HOLCOMB & MAYTS, P.A.
Attorneys & Counselors at Law
106 S. Tampania Ave., Ste. 200
Tampa, FL 33609

Atty – Andrew Mayts - 813-874-8800
Case was Engine Systems, Inc. vs. Ingersoll-Dresser Pump Company, about 2002,
W. Marscher provided expert consulting for IDP legal team

ROETZEL & ANDRESS Law Firm
1 Seagate, Suite 999
Toledo, OH 43604-4504

Atty – Thomas Zaremba - 419-242-7985
Case was Nuclear Operating Co. v. Johnston Pump, about 2001,
MSI provided expert consulting for NOC legal team on Johnston Pump impeller failures
at First Energy Perry Nuclear Plant

FAEGRE & BENSON LLP, Minneapolis MN

Atty. - Jerry Snider
Helicopter Engine Dynamometer, W. Marscher provided at-trial witness testimony in
federal court for the Kahn Industries legal team, 1996

McNeer LLP, Clarksburg WV

Atty. - James Riley
Ionics RO Water Systems, T & T vertical pump and water-filled motor thrust bearing
failures, W. Marscher provided at-trial witness testimony in state court for the Ionics legal
team, 1996/1997