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(54) **LINEAR DRIVE ASSEMBLY**

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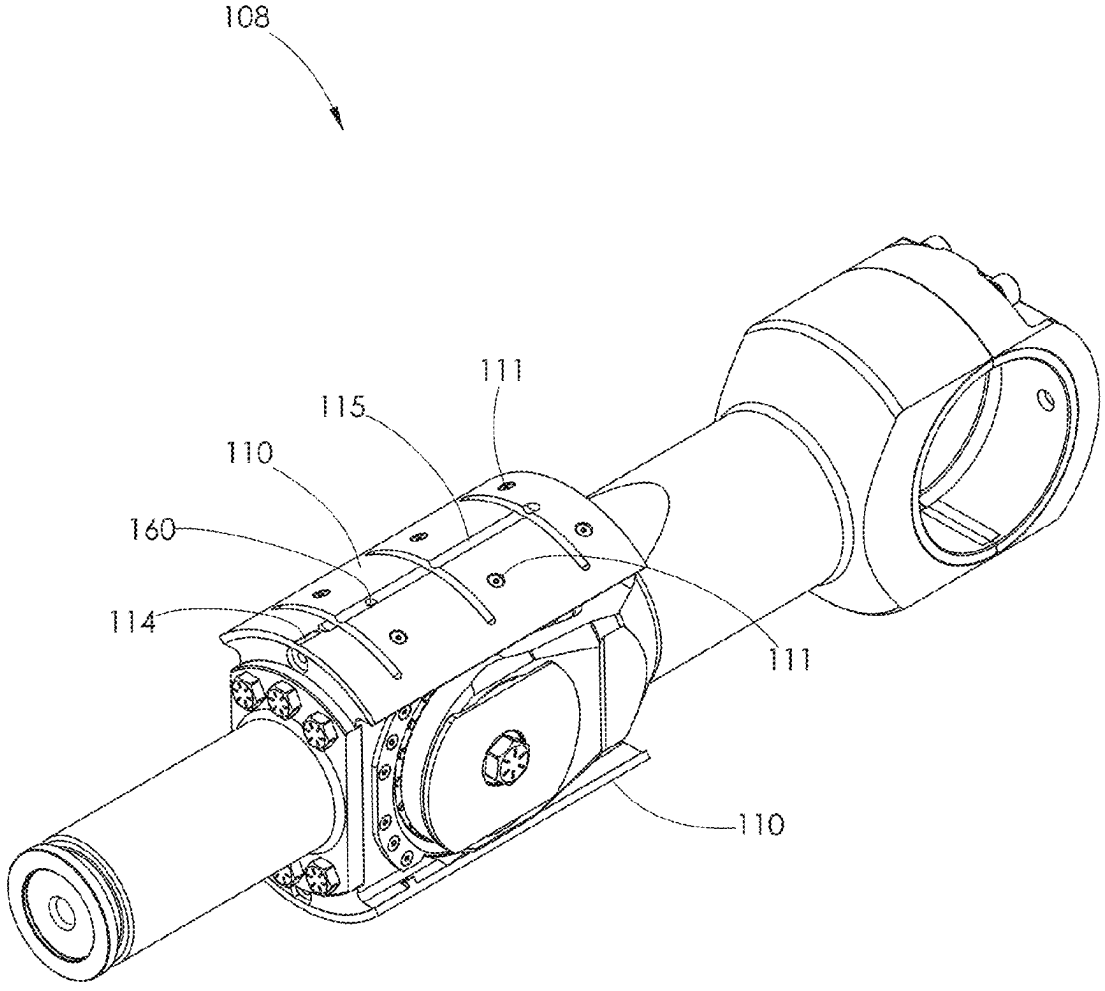
F16H 57/04	(2010.01)

(52) **U.S. Cl.**

CPC ***F16H 21/28*** (2013.01); ***F04B 53/146*** (2013.01); ***F16C 5/00*** (2013.01); ***F16C 33/1055*** (2013.01); ***F16C 33/1065*** (2013.01); ***F16C 33/108*** (2013.01); ***F16H 57/01*** (2013.01); ***F16H 57/042*** (2013.01)

(57) **ABSTRACT**

A pair of wear grooves for a linear drive assembly. One wear groove is disposed on a wear plate attached to a crosshead. This wear groove is on a front edge of the wear plate, and does not intersect any lubrication groove. Another wear groove is disposed circumferentially about an inner wall of a crosshead guide. Each of the wear grooves is observable to an operator without fully disassembling the crosshead and the crosshead guide, and each is observable from a single side of the crosshead guide. Should the wear groove not be observable, the associated component should be replaced. Should the wear groove be observable, the remaining life of the component can be determined from the groove's depth.



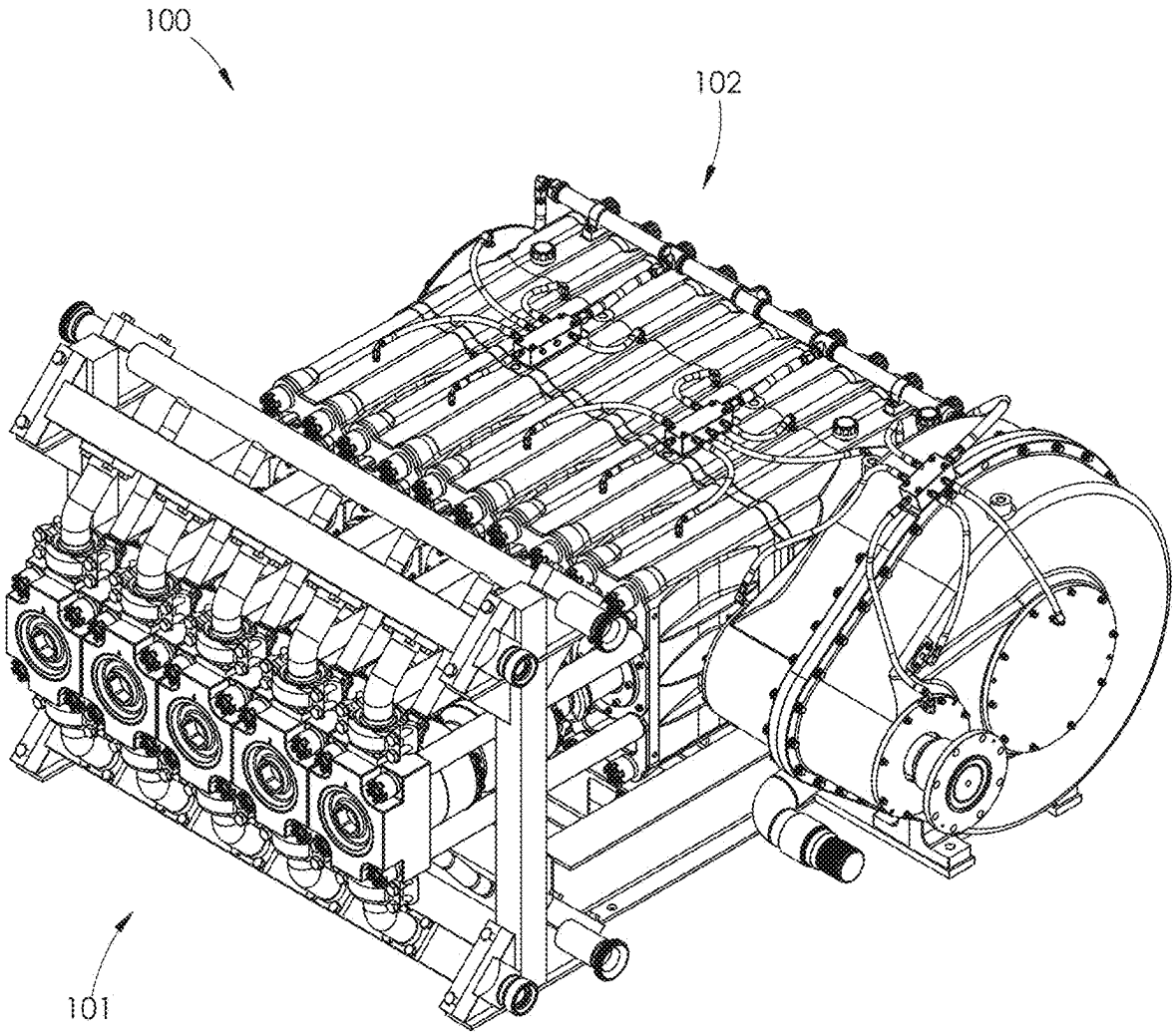


FIG. 1

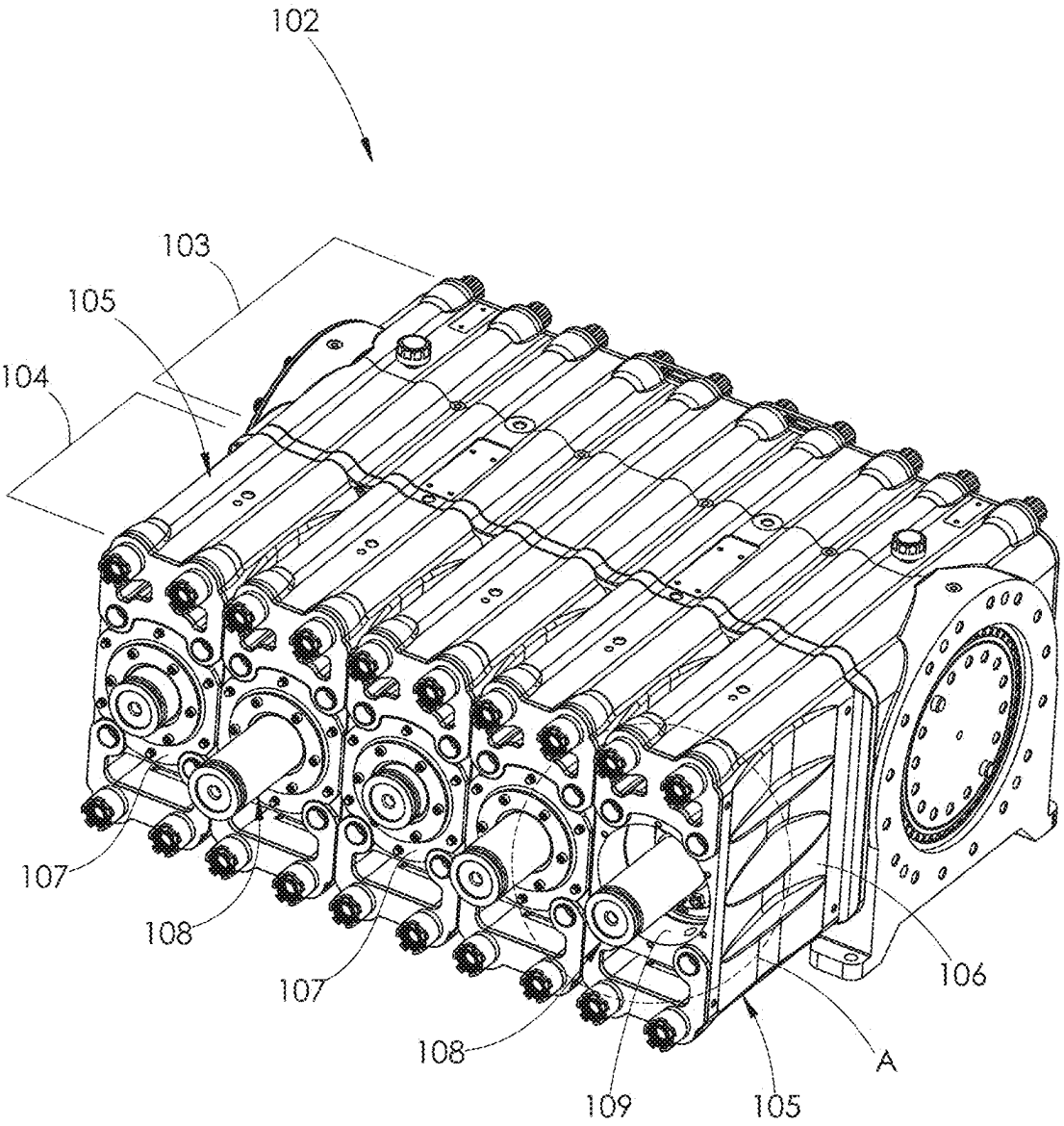


FIG. 2

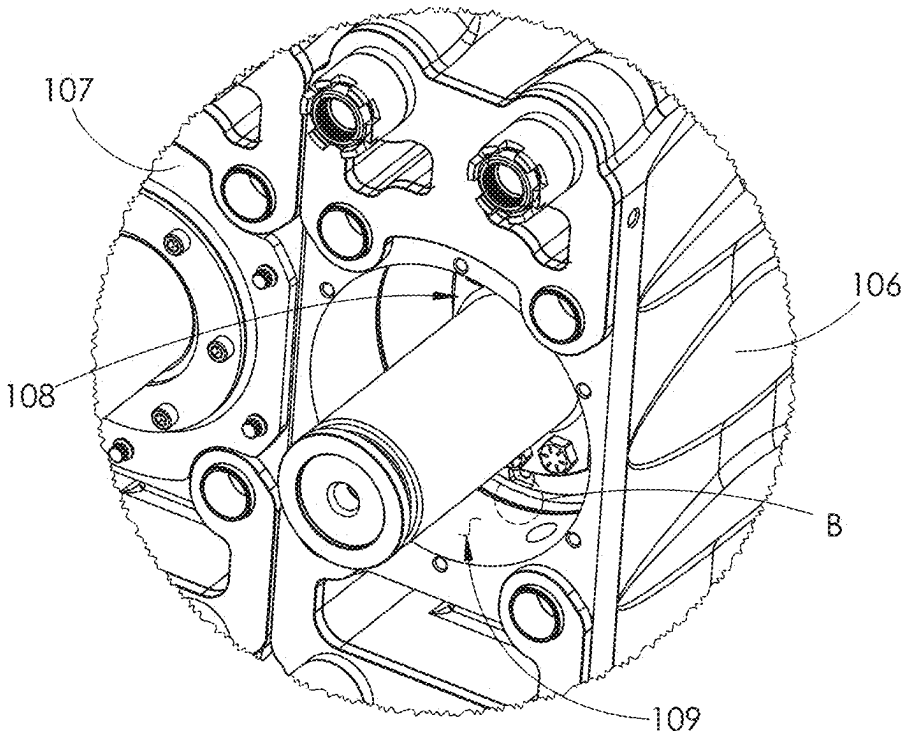


FIG. 3

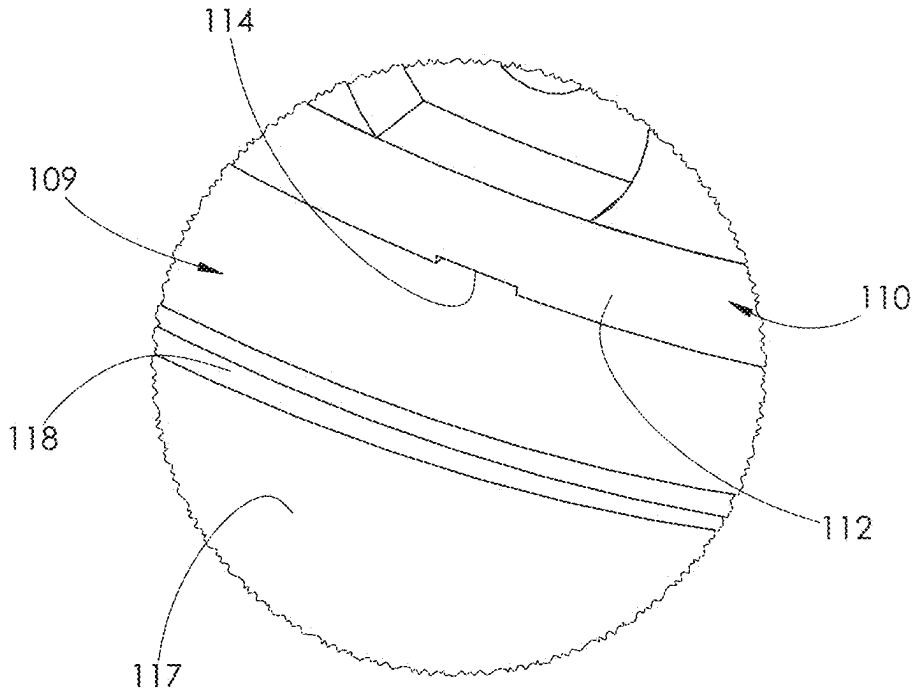


FIG. 4

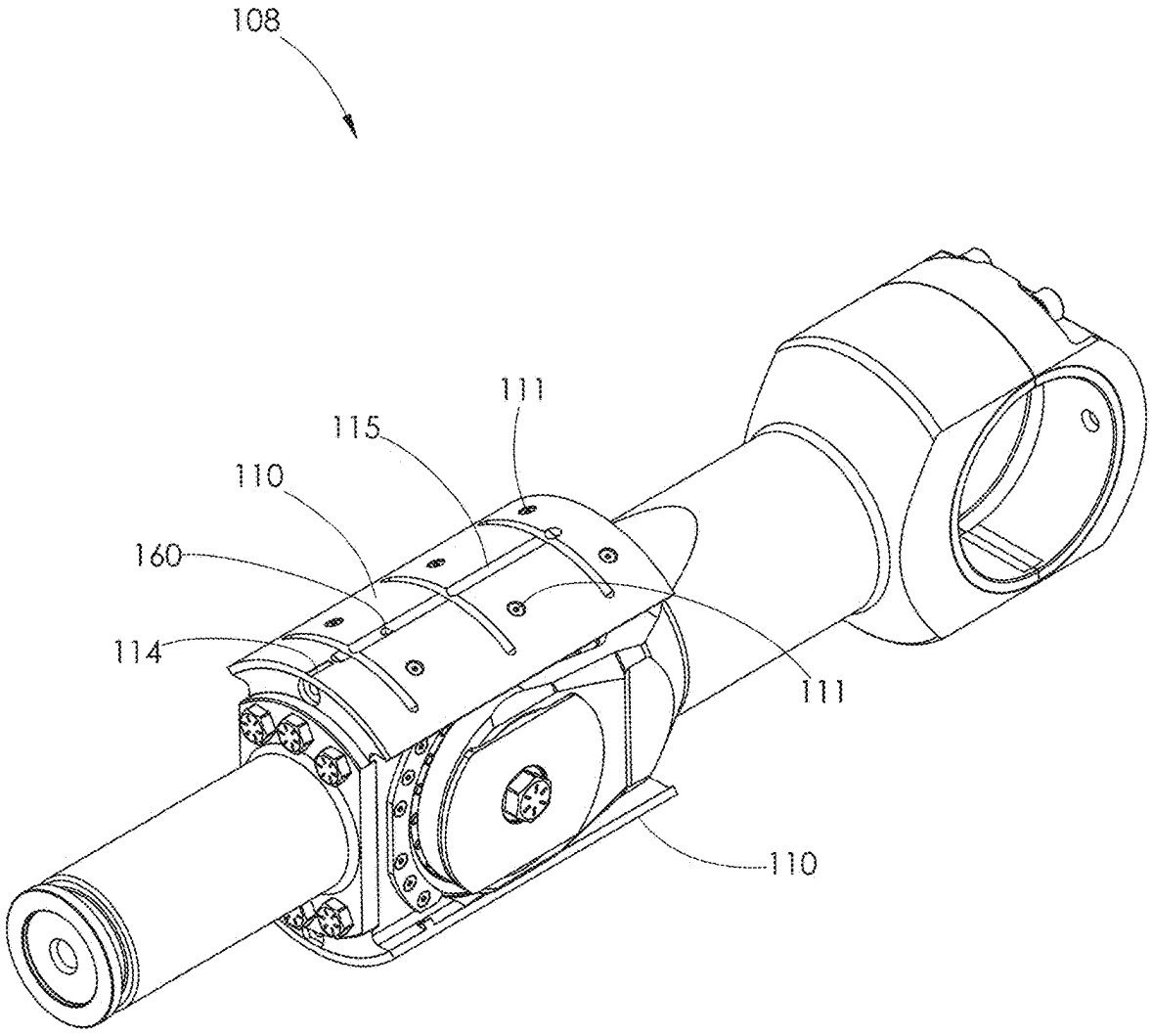


FIG. 5

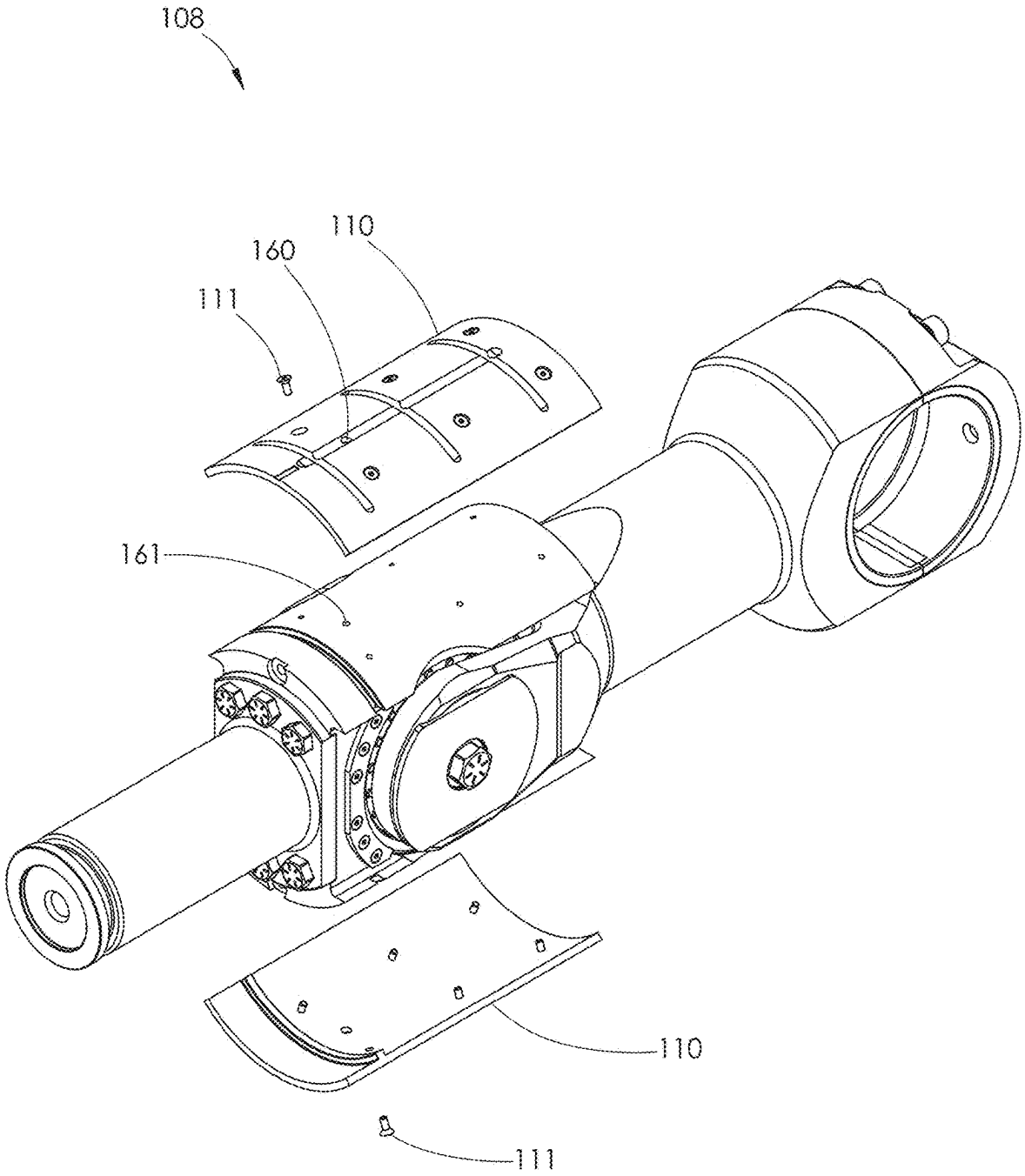


FIG. 6

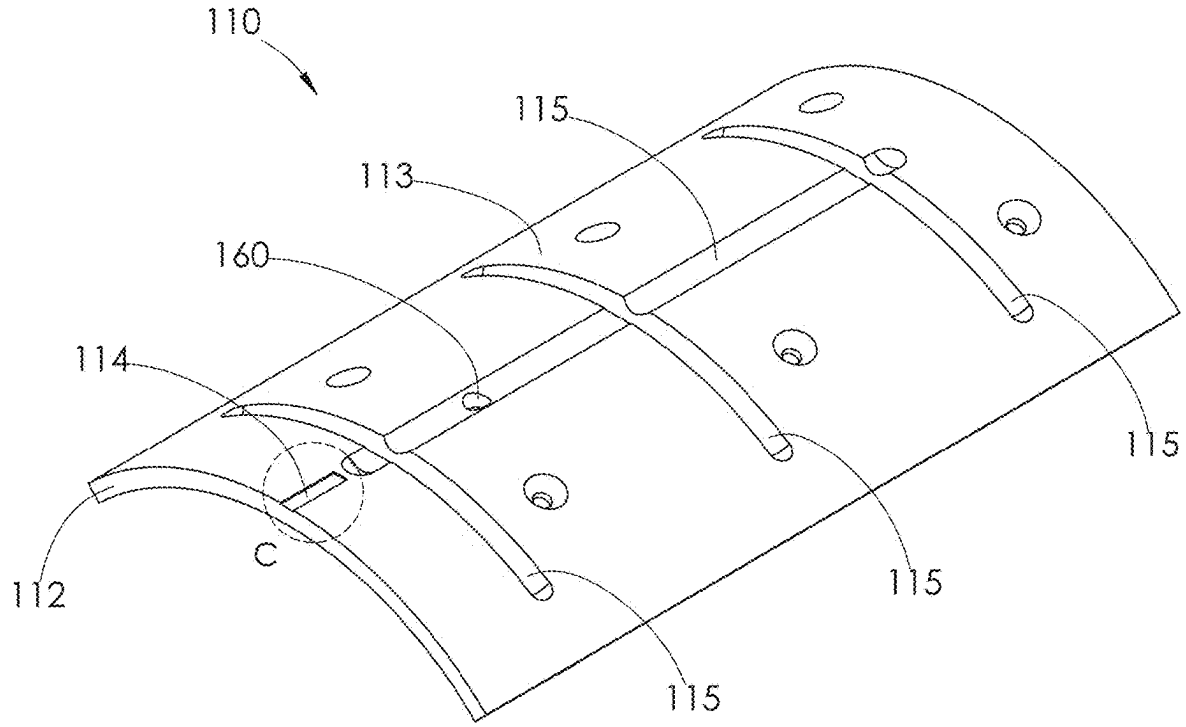


FIG. 7

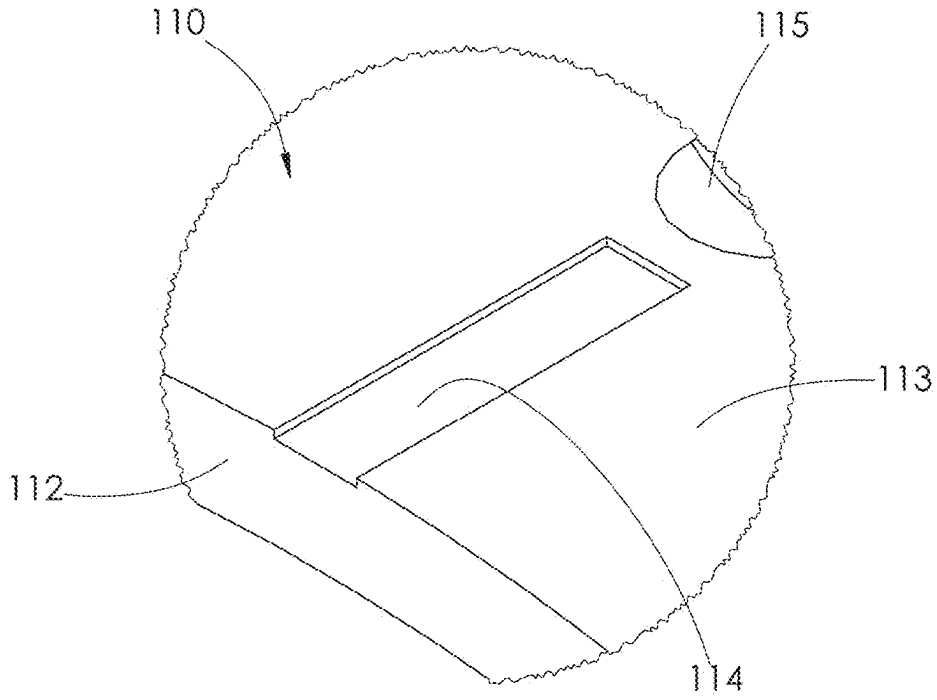


FIG. 8

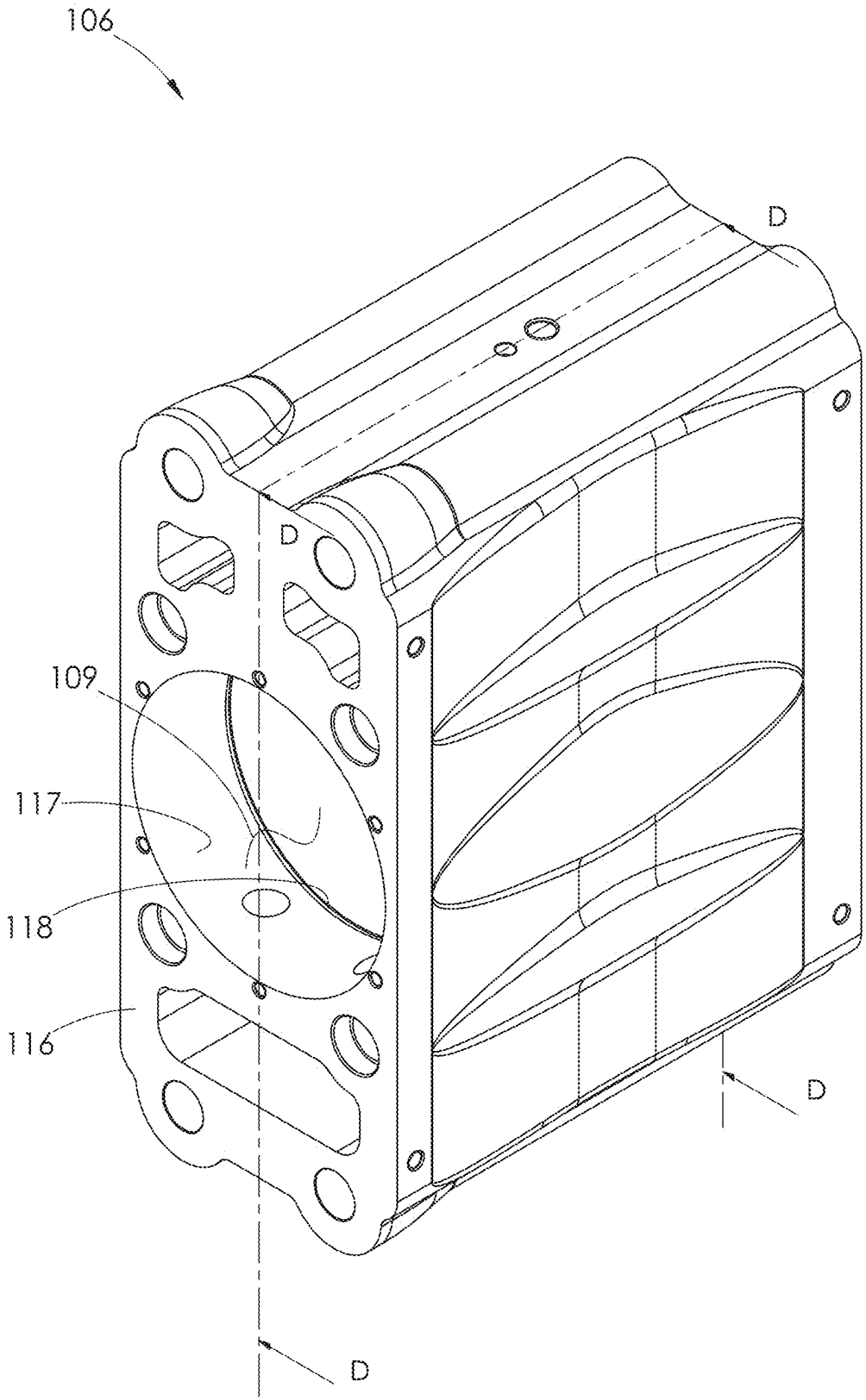


FIG. 9

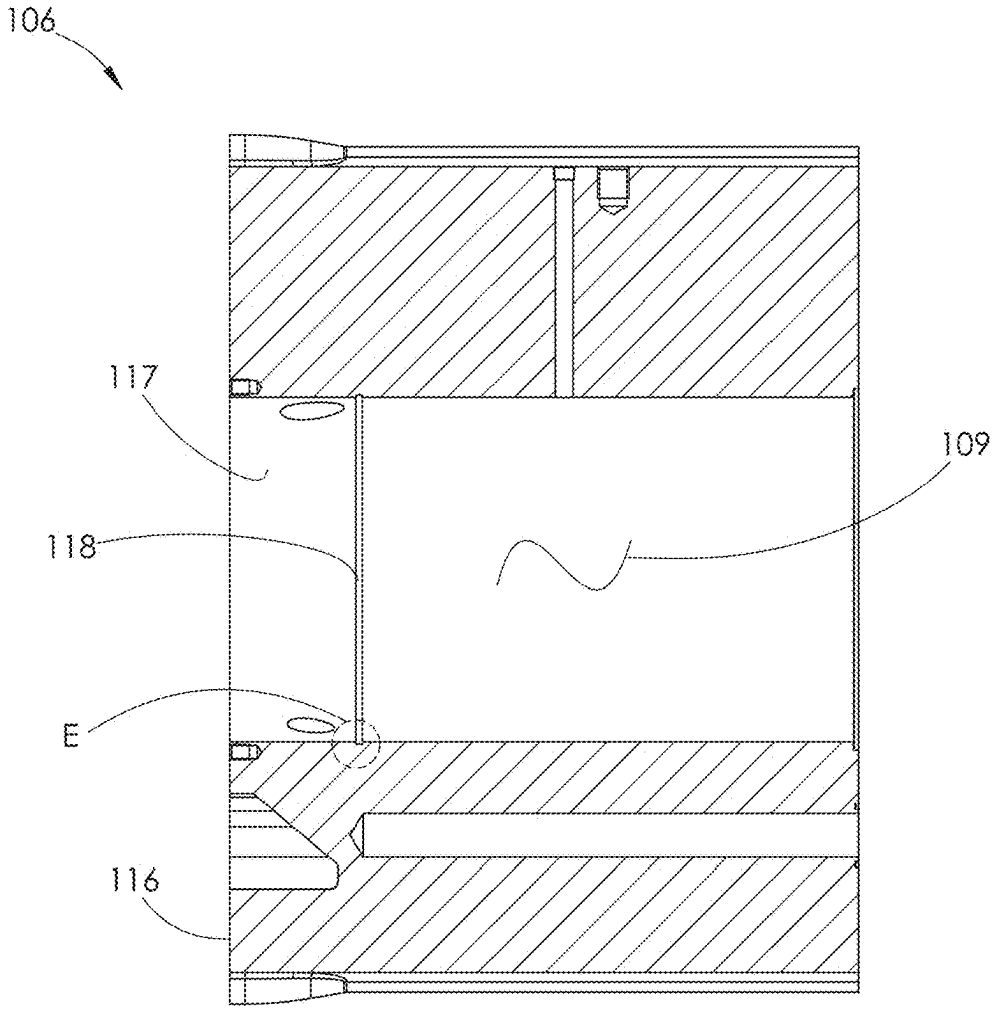


FIG. 10

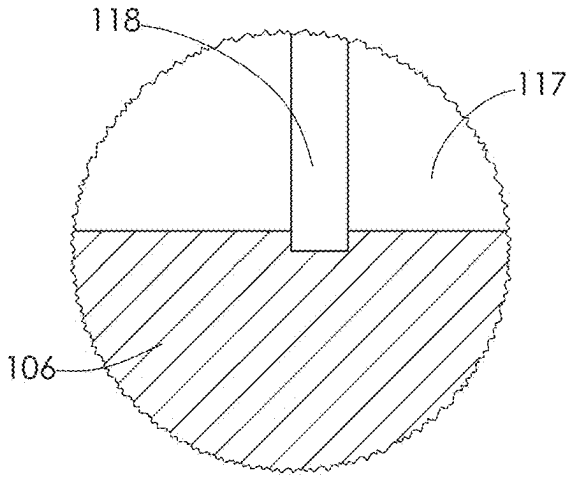


FIG. 11

LINEAR DRIVE ASSEMBLY

SUMMARY

[0001] The present invention is directed to a linear drive assembly. The linear drive assembly comprises a crosshead and a pair of wear plates. The crosshead is configured to be installed within a crosshead guide and comprises upper and lower surfaces. The pair of wear plates are removably attached to a corresponding one of the upper and lower surface of the crosshead. Each wear plate has an outer surface and a front edge. Each plate has at least one lubricant groove and at least one plate wear groove. The at least one lubricant groove is formed in the outer surface of the wear plate and is in fluid communication with lubricant ports formed in the crosshead. The at least one plate wear groove is formed in the outer surface of the wear plate and is distinct from the at least one lubricant groove. The at least one wear plate groove is not in fluid communication with any lubricant port formed in the crosshead. The at least one wear plate groove opens on the front edge of the wear plate.

[0002] In another aspect, the invention is directed to a kit. The kit comprises a crosshead guide, a linear drive assembly, and a first wear plate. The crosshead guide has a longitudinal bore formed therein. The linear drive assembly is configured to be installed within the longitudinal bore of the crosshead guide. The linear drive assembly comprises upper and lower surfaces and defines a lubricant channel in the upper surface and the lower surface.

[0003] The first wear plate is configured for removable attachment to the upper surface of the linear drive assembly. The first wear plate is defined by an inner surface conforming to the upper surface of the linear drive assembly, an outer surface, and a front edge. At least one lubricant groove is formed within the outer surface of the first wear plate. A lubricant port interconnects the inner surface to the outer surface and intersects the at least one lubricant groove. The at least one wear groove is formed in the outer surface of the first wear plate and is distinct from the at least one lubricant groove.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. **1** is a front perspective view of one embodiment of a high-pressure pump.

[0005] FIG. **2** is a front perspective view of the power end assembly shown in FIG. **1**.

[0006] FIG. **3** is an enlarged view of area A, shown in FIG. **2**.

[0007] FIG. **4** is an enlarged view of area B, shown in FIG. **3**.

[0008] FIG. **5** is a front perspective view of one embodiment of a linear drive assembly disclosed herein.

[0009] FIG. **6** is a front perspective view of the linear drive assembly shown in FIG. **5** with the wear plate and wear plate fasteners shown exploded from the assembly.

[0010] FIG. **7** is a top perspective view of one of the wear plates shown in FIG. **6**.

[0011] FIG. **8** is an enlarged view of area C, shown in FIG. **7**.

[0012] FIG. **9** is a front perspective view of one of the crosshead guides used within the power end assembly shown in FIG. **2**.

[0013] FIG. **10** is a cross-sectional view of the crosshead guide shown in FIG. **9**, taken along line D-D.

[0014] FIG. **11** is an enlarged view of area E, shown in FIG. **10**.

DETAILED DESCRIPTION

[0015] Turning now to FIGS. **1-11**, one embodiment of a high-pressure pump **100** is shown. The high-pressure pump **100** comprises a fluid end assembly **101** attached to a power end assembly **102** as shown in FIG. **1**. The power end assembly **102**, shown in FIG. **2**, comprises a crank section **103** joined to a crosshead section **104**. Continuing with FIG. **2**, the crosshead section **104** comprises a plurality of crosshead guide assemblies **105** situated in a side-by-side relationship. Each crosshead guide assembly **105** comprises a crosshead guide **106**, a pony rod cover **107**, and a linear drive assembly **108**. A crosshead bore **109** is formed within each crosshead guide **106**, as shown in FIGS. **9-10**, and each crosshead bore **109** is sized to receive a portion of a linear drive assembly **108** which includes a crosshead, as shown in FIGS. **2-3**. Continuing with FIGS. **5-8**, the linear drive assembly **108** comprises a plurality of wear plates **110** and a plurality of wear plate fasteners **111**.

[0016] One such high-pressure pump **100** is disclosed in U.S. Pat. No. 11,953,000, issued to Foster et al., the entire contents of which are incorporated herein by reference.

[0017] Each crosshead bore **109** and linear drive assembly **108** are configured to allow the operator to easily determine the amount of wear on the crosshead bore **109** and wear plates **110**. Knowing the amount of wear on the crosshead bore **109** and/or the wear plates **110** eliminates the need to further disassemble the power end assembly **102** during maintenance to measure the amount of wear on the components thus saving time.

[0018] Referring now to FIGS. **7-8**, a wear plate **110** is shown. The wear plate **110** comprises a front surface **112** and an outer surface **113**. The outer surface **113** comprises a wear indicator groove **114** and a plurality of lubrication channels **115**. The lubrication channels **115** are formed in the outer surface **113** and have a lubrication port **160** disposed through the wear plate **110**. The lubrication port **160** is in fluid communication with a lubrication passage **161** (FIG. **6**) formed in the crosshead of the linear drive assembly **108**. In this way, lubricant may be distributed from within the linear drive assembly **108** to the lubrication channel **115** of each wear plate **110**. As shown, the lubrication channel **115** comprises a longitudinal passage and intersecting radial passages. Thus, the intersecting radial passage may be characterized as "substantially perpendicular" to the longitudinal passage, as it extends substantially at a ninety degree angle relative to the longitudinal passage on the wear plate **110**. However, the wear plate **110** may have a curvature, along which the radial path extends.

[0019] The wear indicator groove **114** is separate and distinct from the lubrication channels **115**. Specifically, the wear indicator groove **114** is not in fluid communication with the lubrication channels **115**. The wear indicator groove **114** intersects the front surface **112** so that when the wear plate **110** is viewed from the front the wear indicator groove **114** appears as a notch in the outside radius of the front surface **112**, which can be seen in FIG. **4**. As shown in this embodiment, the wear indicator groove **114** is located approximately centered on the circumference of the outer surface **113**. However, the wear indicator groove **114** may be located anywhere along the circumference of the outer surface **113**. Also, the wear indicator groove **114** is shown

extending longitudinally perpendicular to the front surface **112**. The longitudinal distance is only constrained by the necessity to not intersect any lubrication channel **115**. Additionally, the only restriction on circumferential width of the wear indicator groove **114** is that it must be less than the total circumferential length of the outer surface **113** allowing for a visual comparison to determine wear on the wear plate **110**. The depth of the wear indicator groove **114** is 0.050 to 0.075 inches but may be larger or smaller.

[0020] Referring now to FIGS. **9-11**, a crosshead guide **106** is shown. The crosshead guide **106** comprises a front surface **116** and a crosshead bore **109**. The crosshead bore **109** comprises a bore wall **117** and a wear indicator groove **118**. The wear indicator groove **118** is formed around the entire circumference of the bore wall **117**. The longitudinal position of the wear indicator groove **118** is anywhere between the front surface **116** of the crosshead guide **106** and the location of the front surface **112** of the wear plate **110** when the linear drive assembly **108** is fully retracted. The depth of the wear indicator groove **118** is 0.050 to 0.075 inches but may be larger or smaller.

[0021] The wear indicator groove **118** of the crosshead bore **109** may be formed in only a portion of the circumference of the bore wall **117** or there may be a plurality of wear indicator grooves **118** formed in portions of the circumference of the bore wall **117**. If a plurality of partially circumferential wear indicator grooves **118** is used they may be spaced longitudinally. There may also be a plurality of fully circumferential wear indicator grooves **118** formed in the bore wall **117** which would be longitudinally spaced. It is also contemplated that one or more wear indicator grooves **118** may be formed in the bore wall **117** parallel to, or at an angle to, the longitudinal axis.

[0022] Referring now to FIGS. **2-4**, during maintenance operations in which the pony rod cover **107** is removed the operator may visually determine the amount of wear on both the crosshead bore **109** and the wear plates **110**. To determine the amount of wear on the wear plates **110** the operator observes the wear indicator groove **114** as shown in FIG. **4**. If the wear indicator groove **114** is still observable then the wear plate **110** still has usable life and need not be replaced. If no wear indicator groove **114** can be seen, the wear plate **110** should be replaced or the linear drive assembly **108** flipped. Since it is expected that the operator knows the depth of the wear indicator groove **114** in a new wear plate **110** the depth of the observed wear indicator groove **114** will provide the operator an indication of the approximate remaining life of the wear plate **110**. For instance, if the operator observes the depth of the wear indicator groove **114** to be approximately half that of a new one after fifty hours of operation, the operator can assume that the wear plate **110** will provide another fifty hours of operational life and re-check the wear plates **110** at that time.

[0023] Continuing with FIGS. **2-4**, the amount of wear on the crosshead bore **109** may be determined by operator observation when the pony rod cover **107** is removed. If the operator can still see the wear indicator groove **118** in the crosshead bore **109** then the crosshead guide **106** need not be replaced. As with the wear plate **110** an estimate of remaining life may be made by comparing the observed depth of the wear indicator groove **118** to that of a new one and assuming a linear, or other known, rate of wear.

[0024] The various features and alternative details of construction of the apparatuses described herein for the practice of the present technology will readily occur to the skilled artisan in view of the foregoing discussion. It is to be understood that even though numerous characteristics and advantages of various embodiments of the present technology have been set forth in the foregoing description, together with details of the structure and function of various embodiments of the technology, this detailed description is illustrative only, and changes may be made in detail. Changes may especially be made in matters of structure and arrangements of parts within the principles of the present technology to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

1. A power end assembly, comprising:
- a crosshead guide, comprising:
  - a bore formed therein; and
  - an inwardly facing wall;
- a linear drive assembly configured to be installed within the bore, the linear drive assembly comprising:
  - a crosshead comprising opposed first and second surfaces;
  - a pair of wear plates, each wear plate removably attached to a corresponding one of the first and second surfaces of the crosshead, each wear plate having an outer surface and a front edge and comprising:
    - at least one lubricant groove formed in the outer surface, the at least one lubricant groove in fluid communication with lubricant ports formed in the crosshead; and
    - at least one wear plate groove formed in the outer surface, the at least one wear plate groove not in fluid communication with any lubricant port formed in the crosshead or with the at least one lubricant groove;
    - in which the at least one wear plate groove opens on the front edge of the wear plate;
  - in which each wear plate is configured to engage both the crosshead and the inwardly facing wall of the crosshead guide.

2. The power end assembly of claim **1**, in which the crosshead guide further comprises:
- a wear indicator groove formed in the inwardly facing wall.

3. The power end assembly of claim **2**, in which the wear indicator groove is observable when the linear drive assembly is installed within the bore.

4. The power end assembly of claim **1**, in which the at least one wear plate groove is observable when the linear drive assembly is installed within the bore.

5. The power end assembly of claim **1**, in which the at least one wear plate groove has a depth of between 0.050 to 0.075 inches.

6. A power end assembly, comprising:
- a crosshead guide, comprising:
  - a bore formed therein, the bore defining a bore wall;
- a crosshead configured to be situated within the bore; and
- a wear plate removably attached to the crosshead, the wear plate comprising:
  - an outer surface, comprising:
    - a plurality of lubrication channels formed therein; and
    - a wear indicator groove formed separate from the plurality of lubrication channels;

an inner surface configured to engage an external surface of the crosshead; and

a plurality of openings formed therein, the plurality of openings extending through the inner surface and the outer surface and configured to receive a plurality of wear plate fasteners;

in which the outer surface of the wear plate is configured to engage the bore wall.

7. The power end assembly of claim **6**, in which the wear plate further comprises a front surface; in which the wear indicator groove intersects the front surface.

8. The power end assembly of claim **6**, in which the wear indicator groove is visible when the crosshead is situated within the bore.

9. The power end assembly of claim **6**, in which the bore wall comprises a second wear groove formed therein.

10. The power end assembly of claim **9**, in which the second wear groove is circumferential.

11. The power end assembly of claim **6**, in which the wear plate further comprises a lubrication port disposed through the wear plate.

12. The power end assembly of claim **11**, in which the lubrication port is in fluid communication with the plurality of lubrication channels, but not with the wear indicator groove.

13. The power end assembly of claim **6**, in which the crosshead comprises a lubrication passage formed therein; in which the lubrication passage is in fluid communication with the plurality of lubrication channels.

14. A power end assembly, comprising:

a crosshead guide, comprising:

a bore formed therein, the bore comprising a bore wall having a wear groove formed therein;

a crosshead configured to be situated within the bore; and

a wear plate removably attached to the crosshead, the wear plate comprising:

an outer surface comprising a plurality of lubrication channels formed therein;

an inner surface configured to engage an external surface of the crosshead; and

a plurality of openings formed therein, the plurality of openings extending through the inner surface and the outer surface and configured to receive a plurality of wear plate fasteners;

in which the outer surface of the wear plate is configured to engage the bore wall;

in which the wear groove is observable when the crosshead is situated within the bore.

15. The power end assembly of claim **14**, in which the wear groove is a first wear groove, in which the wear plate further comprises:

a second wear groove formed in the outer surface;

in which the second wear groove is not in fluid communication with the plurality of lubrication channels.

16. The power end assembly of claim **15**, in which the second wear groove is observable when the crosshead is situated within the bore.

17. The power end assembly of claim **14**, further comprising:

a pony rod cover removably attached to the crosshead guide;

in which the wear groove is not observable when the pony rod cover is attached to the crosshead guide.

18. The power end assembly of claim **14**, in which the wear groove is circumferential.

19. The power end assembly of claim **14**, in which the wear groove has a depth of between 0.050 and 0.075 inches.

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