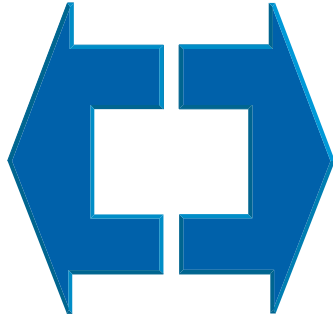




American National Standard for

Reciprocating Power Pumps

for Nomenclature, Definitions,
Application, and Operation

ANSI/HI 6.1-6.5-2015



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Approved March 5, 2015
American National Standards Institute, Inc.

American National Standard

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Foreword (Not part of Standard)

Purpose and aims of the Hydraulic Institute

The purpose and aims of the Institute are to promote the continued growth and well-being of pump manufacturers and further the interests of the public in such matters as are involved in manufacturing, engineering, distribution, safety, transportation and other problems of the industry, and to this end, among other things:

- a) To develop and publish standards for pumps;
- b) To collect and disseminate information of value to its members and to the public;
- c) To appear for its members before governmental departments and agencies and other bodies in regard to matters affecting the industry;
- d) To increase the amount and to improve the quality of pump service to the public;
- e) To support educational and research activities;
- f) To promote the business interests of its members but not to engage in business of the kind ordinarily carried on for profit or to perform particular services for its members or individual persons as distinguished from activities to improve the business conditions and lawful interests of all of its members.

Purpose of Standards

- 1) Hydraulic Institute Standards are adopted in the public interest and are designed to help eliminate misunderstandings between the manufacturer, the purchaser and/or the user and to assist the purchaser in selecting and obtaining the proper product for a particular need.
- 2) Use of Hydraulic Institute Standards is completely voluntary. Existence of Hydraulic Institute Standards does not in any respect preclude a member from manufacturing or selling products not conforming to the Standards.

Definition of a Standard of the Hydraulic Institute

Quoting from Article XV, Standards, of the By-Laws of the Institute, Section B:

“An Institute Standard defines the product, material, process or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, quality, rating, testing and service for which designed.”

Comments from users

Comments from users of this standard will be appreciated to help the Hydraulic Institute prepare even more useful future editions. Questions arising from the content of this standard may be sent to the Technical Director of the Hydraulic Institute. The inquiry will then be directed to the appropriate technical committee for provision of a suitable answer.

If a dispute arises regarding the content of an Institute Standard or an answer provided by the Institute to a question such as indicated above, the point in question shall be sent in writing to the Technical Director of the Hydraulic Institute, who shall initiate the appeals process.

Revisions

The Standards of the Hydraulic Institute are subject to constant review, and revisions are undertaken whenever it is found necessary because of new developments and progress in the art. If no revisions are made for five years, the standards are reaffirmed using the ANSI canvass procedure.

Units of measurement

Metric units of measurement are used; corresponding US customary units appear in parentheses. Charts, graphs, and sample calculations are also shown in both metric and US customary units.

Since values given in metric units are not exact equivalents to values given in US customary units, it is important that the selected units of measure to be applied be stated in reference to this standard. If no such statement is provided, metric units shall govern.

Consensus for this standard was achieved by use of the canvass method

The following organizations, recognized as having an interest in the standardization of reciprocating pumps, were contacted prior to the approval of this revision of the standard. Inclusion in this list does not necessarily imply that the organization concurred with the submittal of the proposed standard to ANSI.

A.W. Chesterton Company

Kemet Inc.

Leistritz Advanced Technologies Corp.

LVVWD - Las Vegas Valley Water District

Weir Floway, Inc.

Weir Group

6 Reciprocating power pumps

6.0 Scope

This standard applies to reciprocating power pumps. It includes types and nomenclature; definitions; design and application; and installation, operation, and maintenance.

6.1 Types and nomenclature

A reciprocating power pump is one driven by power from an outside source applied to the crankshaft of the pump. It consists of a liquid end and a power end. There are several variations and types of reciprocating power pumps, which are provided in horizontal and vertical configurations (see Figure 6.1).

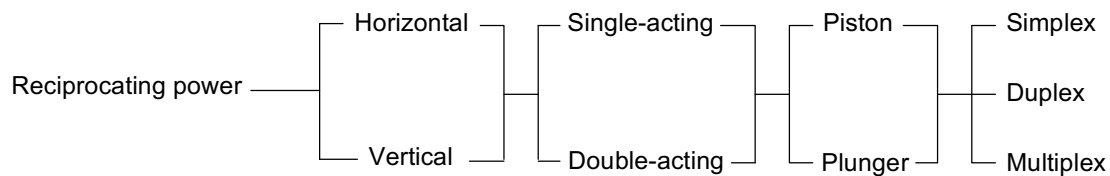


Figure 6.1 — Types of reciprocating power pumps

6.1.1 Horizontal pump

The axial centerline of the cylinder is horizontal (see Figure 6.1.1).

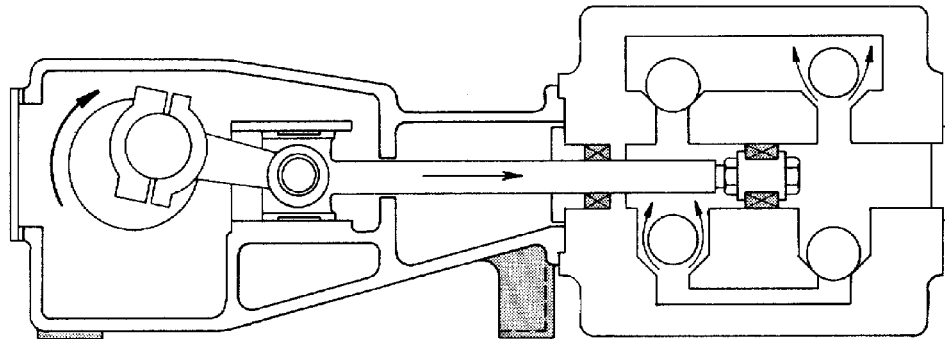


Figure 6.1.1 — Horizontal double-acting piston power pump

6.1.2 Vertical pump

The axial centerline of the cylinder is vertical (see Figure 6.1.2).

6.1.3 Piston pump

The liquid end contains pistons (see Figure 6.1.1).

6.1.4 Plunger pump

The liquid end contains plungers (see Figures 6.1.2, 6.1.4a, and 6.1.4b).

6.1.5 Single-acting pump

Liquid is discharged only during the forward stroke of the plunger or piston, that is, during one half of the revolution of the crankshaft (see Figures 6.1.2 and 6.1.4a).

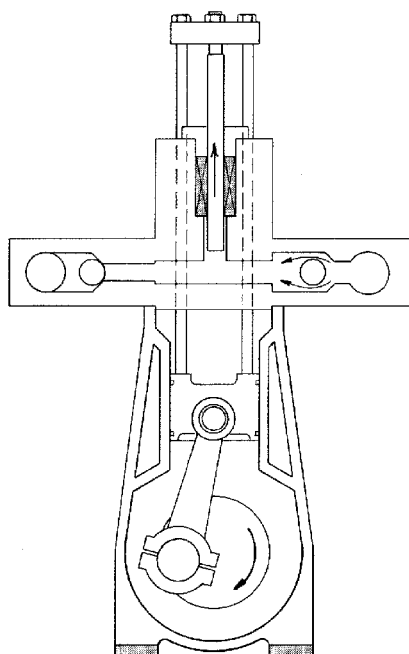


Figure 6.1.2 — Vertical single-acting plunger power pump

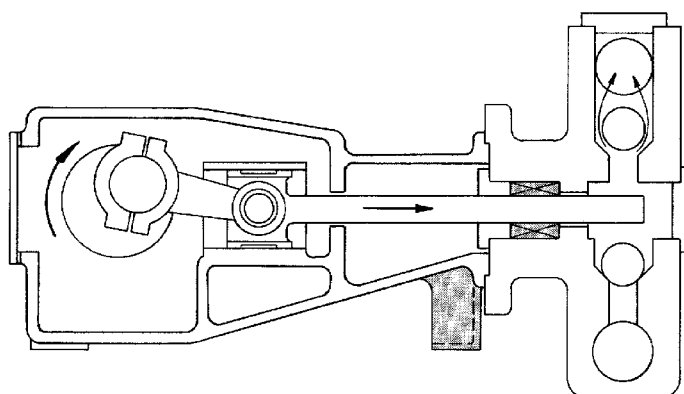


Figure 6.1.4a — Horizontal single-acting plunger power pump

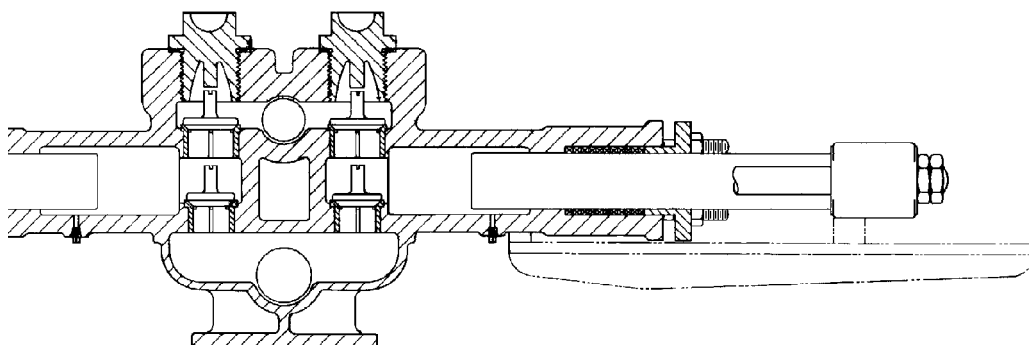


Figure 6.1.4b — Horizontal double-acting plunger power pump

6.1.6 Double-acting pump

Liquid is discharged during both the forward and return strokes of the piston or pair of opposed plungers. That is, discharge takes place during the entire revolution of the crankshaft (see Figures 6.1.1 and 6.1.4b).

6.1.7 Simplex pump

Contains one piston or one plunger or a pair of opposed plungers driven by one connecting rod (see Figures 6.1.1 and 6.1.4b).

6.1.8 Duplex pump

Contains two pistons or two plungers or two pairs of opposed plungers driven by two connecting rods.

6.1.9 Multiplex pump

Contains more than two pistons or two single-acting or opposed plungers.

Number of power crossheads	Type pump
1	Simplex
2	Duplex
3	Triplex
5	Quintuplex
7	Septuplex
9	Nonuplex

6.1.10 Description of components

The nomenclature and definitions in these standards were prepared to provide a means for identifying the various pump components included in the standards and to serve as a common language for all who deal with this type of equipment.

The following definitions and drawings illustrate typical construction of reciprocating power pump components but do not necessarily represent recommended designs. Variations in design may exist without violating the intent of these standards.

6.1.10.1 Right- and left-hand shaft extension of power pumps

“Right hand” or “left hand” designates the side of the power end (see Section 6.1.11) from which the crankshaft or pinion shaft extends. (It does not designate in which direction the shaft rotates.)

Horizontal power pumps are termed *right hand* or *left hand* as viewed when standing behind the power end with the liquid end being the most distant part. A left-hand pump has the shaft extending out of the left side of the power end. A right-hand pump has the shaft extending out of the right side of the power end (see Figure 6.1.10.1a).

Vertical power pumps are termed right-hand or left-hand pumps as viewed when standing at and facing the suction manifold of the pump. A left-hand pump has the shaft extending out of the left side of the power end. A right-hand pump has the shaft extending out of the right side of the power end (see Figure 6.1.10.1b).

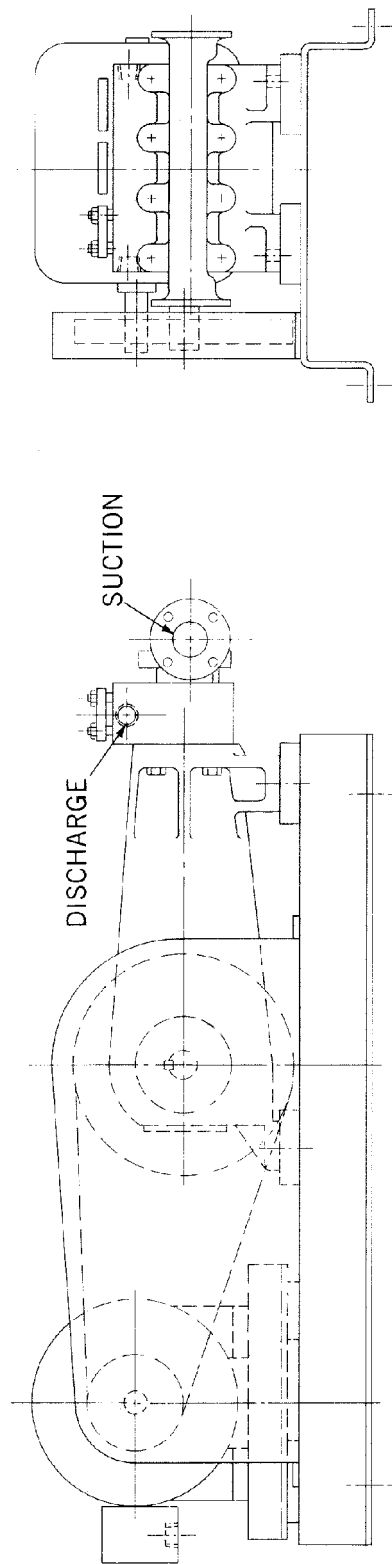


Figure 6.1.10.1a — Horizontal triplex plunger pump, on base, belt drive

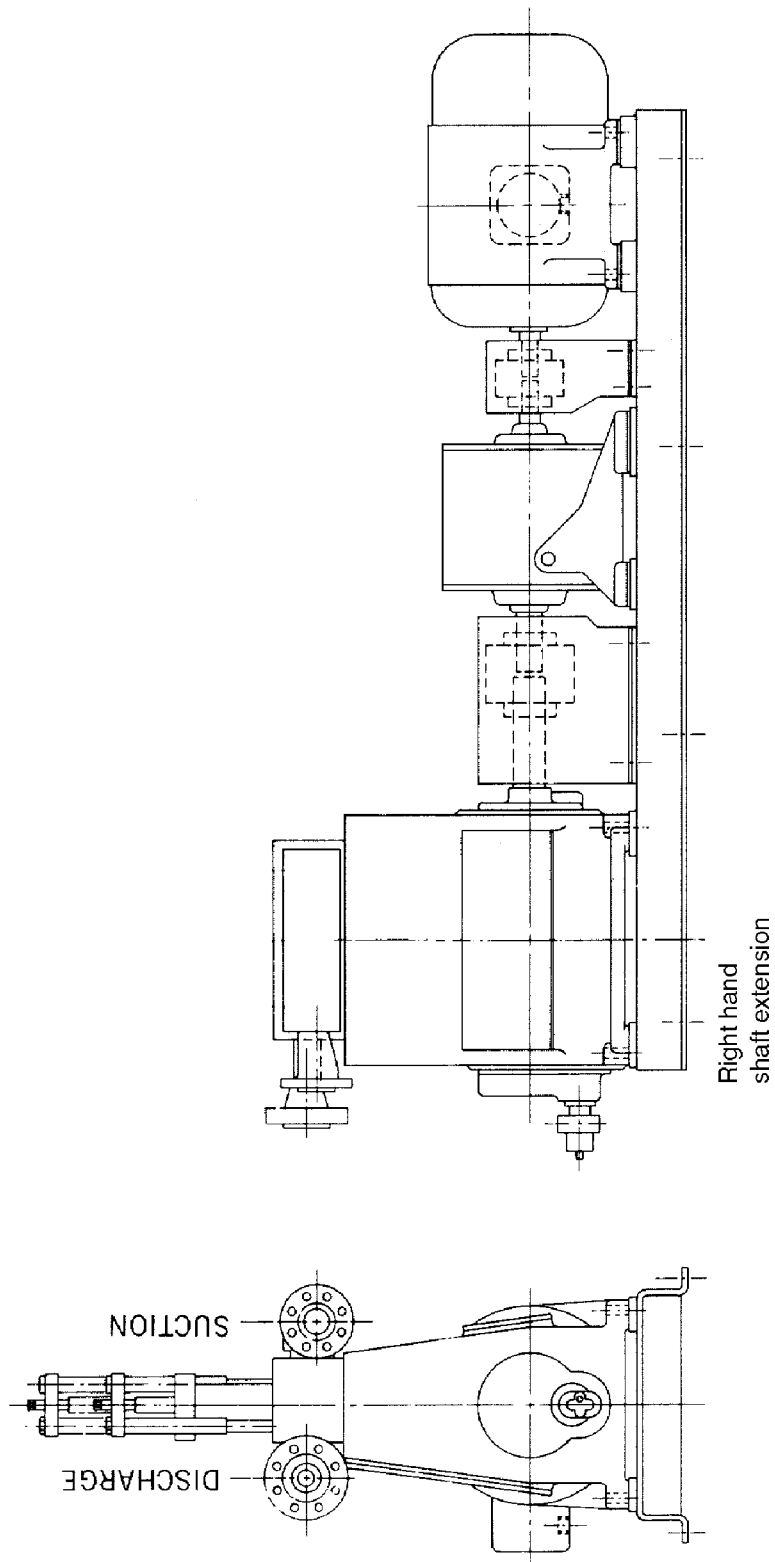


Figure 6.1.10.1b — Vertical triplex plunger pump, on base, gear reduction

6.1.11 Liquid end

That portion of the pump that handles the liquid. It consists of a liquid cylinder, valves, and other components. It includes all of the components, e.g., stuffing box, plungers, packing, valve covers, and separate suction and discharge manifolds if part of the design.

6.1.11.1 Liquid end parts

The following sections describe major liquid end components, which are shown in Figures 6.1.11.1a through d. A listing by part name is shown in Table 6.1.11.1, which also shows the standard abbreviation.

6.1.11.2 Liquid cylinder

A chamber(s) in that the motion of the plunger(s) or piston(s) is imparted to the liquid. The cylinder can be made integral with a suction and discharge manifold or can be made with separate manifolds (see Figure 6.1.11.2).

6.1.11.3 Cylinder liner

A replaceable liner that is placed in the cylinder of a piston pump. The piston reciprocates within the liner (see Figures 6.1.11.1d and 6.1.11.3).

6.1.11.4 Manifolds

A suction manifold is a chamber that accepts liquid from the suction port(s) and distributes it to the suction valves (see Figure 6.1.11.4).

A discharge manifold is a chamber that accepts liquid from the individual discharge valves and directs it to the discharge port(s) (see Figure 6.1.11.4).

6.1.11.5 Valve chest cover

A cover for the valves within the cylinder (see Figure 6.1.11.3).

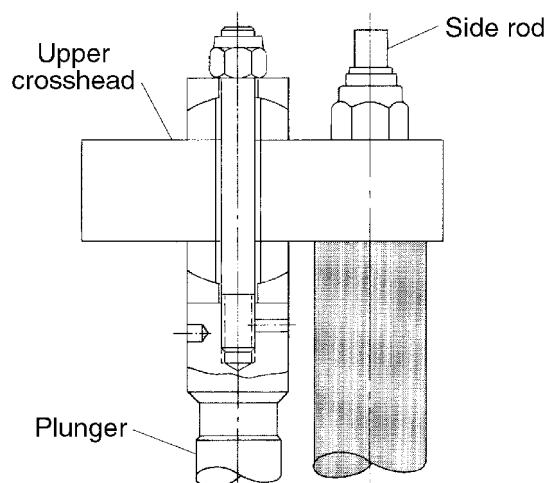
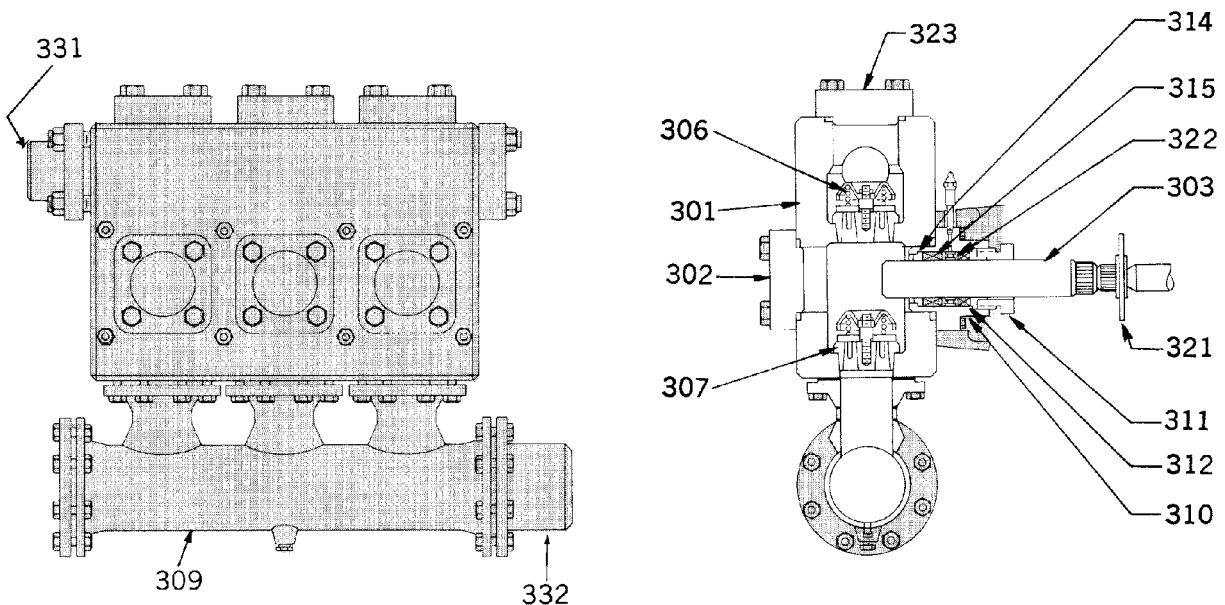
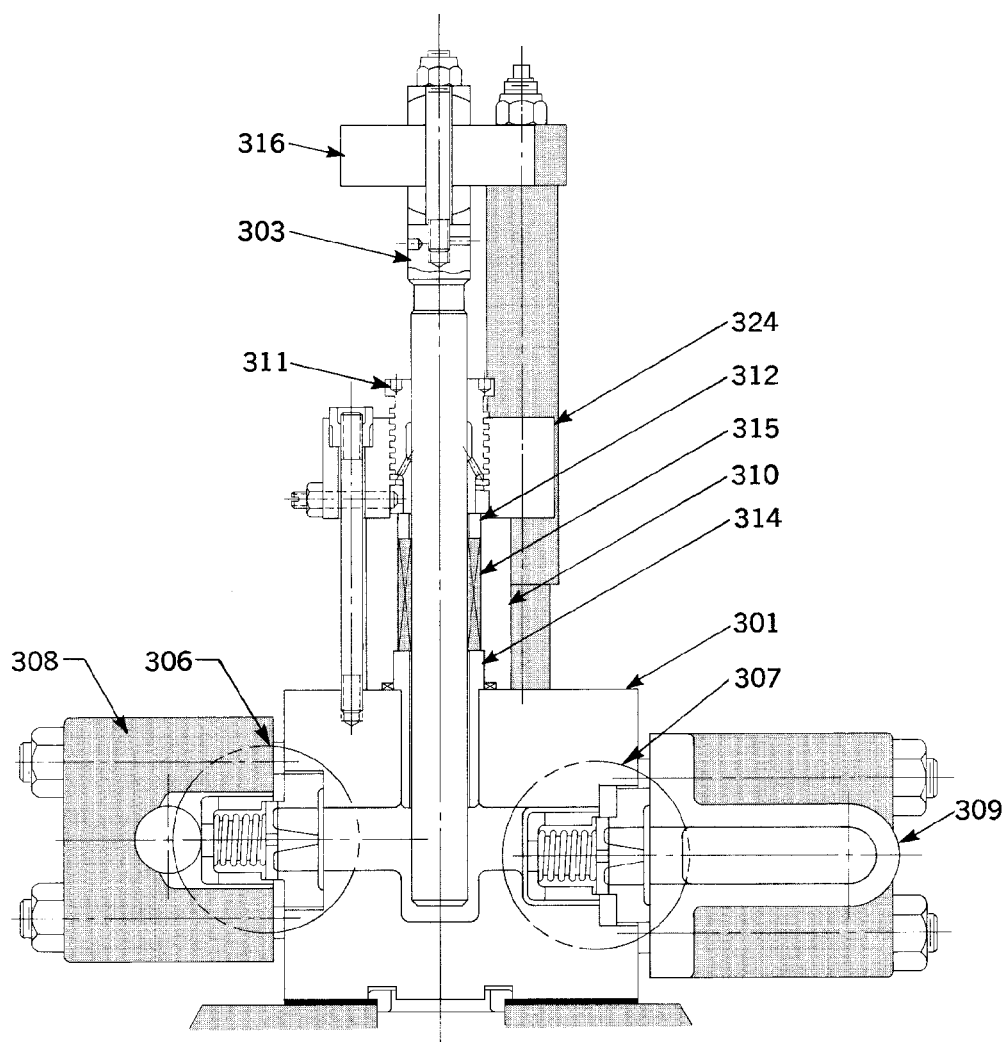


Figure 6.1.11.1a — Upper crosshead



301	Cylinder, liquid	310	Box, liquid stuffing	322	Ring, lantern
302	Head, liquid cylinder	311	Gland, liquid stuffing box	323	Cover, valve
303	Plunger	312	Ring, follower	331	Flange, discharge companion
306	Valve assembly, discharge	314	Bushing, throat	332	Flange, suction companion
307	Valve assembly, suction	315	Packing		
309	Manifold, suction	321	Deflector		

Figure 6.1.11.1b — Liquid end, horizontal plunger power pump



301 Cylinder, liquid	309 Manifold, suction	315 Packing
303 Plunger	310 Box, liquid stuffing	316 Crosshead, upper
306 Valve assembly, discharge	311 Gland, liquid stuffing box	324 Ring, gland
307 Valve assembly, suction	312 Ring, follower	
308 Manifold, discharge	314 Bushing, throat	

Figure 6.1.11.1c — Liquid end, vertical plunger power pump

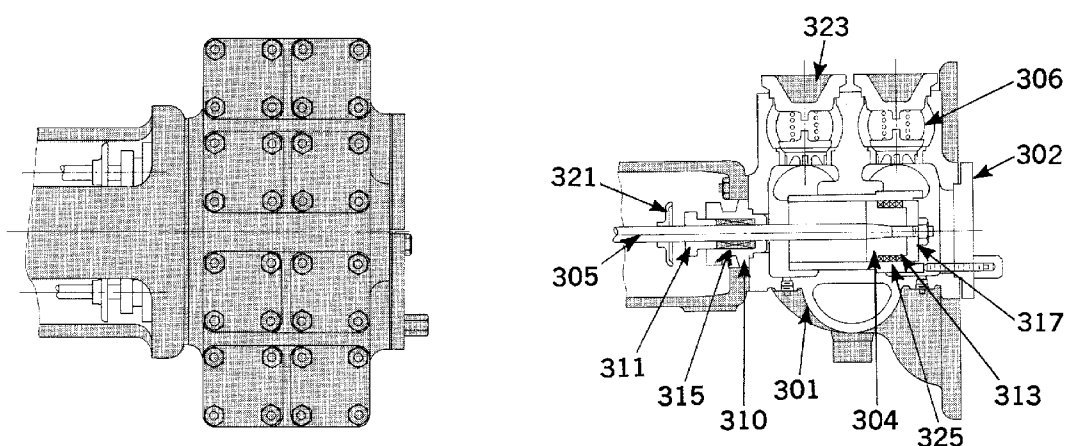


Figure 6.1.11.1d — Liquid end, horizontal side pot piston pump

301 Cylinder, liquid	310 Box, liquid stuffing	321 Deflector
302 Head, liquid cylinder	311 Gland, liquid stuffing box	323 Cover, valve
304 Piston, liquid	313 Ring, liquid piston	325 Liner, cylinder
305 Rod, liquid piston	315 Packing	
306 Valve assembly, discharge	317 Follower, piston	

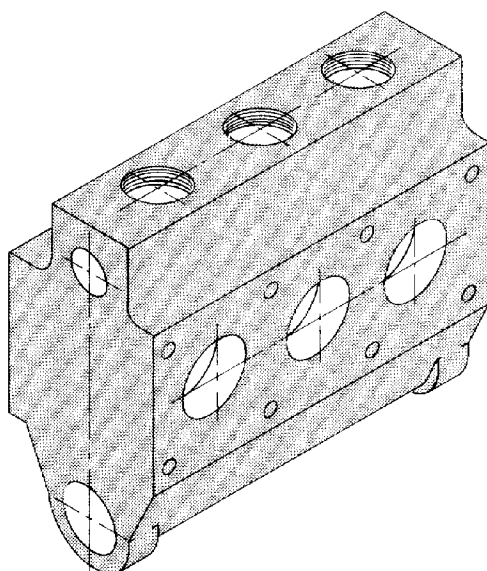


Figure 6.1.11.2 — Liquid cylinder

Table 6.1.11.1 — List of parts by key name – liquid end parts

Name	Number	Figure in which number appears	Abbreviations
Box, liquid stuffing	310	6.1.11.1b, 6.1.11.1c, 6.1.11.1d, 6.1.11.3	Box liq stfg
Bushing, throat	314	6.1.11.1b and c	Bush thrt
Cover, valve	323	6.1.11.1b and d	Cov val
Cover, liquid valve chest	318	6.1.11.3	Cov liq val chest
Crosshead, upper	316	6.1.11.1c	Xhead up
Cylinder, liquid	301	6.1.11.1b, 6.1.11.1c, 6.1.11.1d, 6.1.11.3	Cyl liq
Deflector	321	6.1.11.1b and d	Defl
Flange, discharge companion	331	6.1.11.1b	Flg disch comp
Flange, suction companion	332	6.1.11.1b	Flg suct comp
Follower, piston	317	6.1.11.1d, 6.1.11.3	Fol pist
Foot, liquid cylinder	333	6.1.11.3	Ft liq cyl
Gland, liquid stuffing box	311	6.1.11.1b, 6.1.11.1c, 6.1.11.1d, 6.1.11.3	Gld liq stfg box
Head, liquid cylinder	302	6.1.11.1b, 6.1.11.1d, 6.1.11.3	Hd liq cyl
Liner, cylinder	325	6.1.11.1d, 6.1.11.3	Lnr cyl
Manifold, discharge	308	6.1.11.1c	Manf disch
Manifold, suction	309	6.1.11.1b, 6.1.11.1c	Manf suct
Nut, piston jam	327	6.1.11.3	Nut pist jam
Nut, piston	326	6.1.11.3	Nut pist
Packing	315	6.1.11.1b, 6.1.11.1c, 6.1.11.1d, 6.1.11.3	Pkg
Piston, liquid	304	6.1.11.1d, 6.1.11.3	Pist liq
Plate, valve	319	6.1.11.3	Pl val
Plug	320	6.1.11.3	Plug
Plunger	303	6.1.11.1b, 6.1.11.1c	Plgr
Ring, follower	312	6.1.11.1b, 6.1.11.1c, 6.1.11.3	Ring fol
Ring, gland	324	6.1.11.1c	Ring gld
Ring, lantern	322	6.1.11.1b	Ring lan
Ring, liquid piston	313	6.1.11.1d, 6.1.11.3	Ring liq pist
Rod, liquid piston	305	6.1.11.1d, 6.1.11.3	Rod liq pist
Valve assembly, discharge	306	6.1.11.1b, 6.1.11.1c, 6.1.11.1d, 6.1.11.3	Val assy disch
Valve assembly, suction	307	6.1.11.1b, 6.1.11.1c, 6.1.11.3	Val assy suct

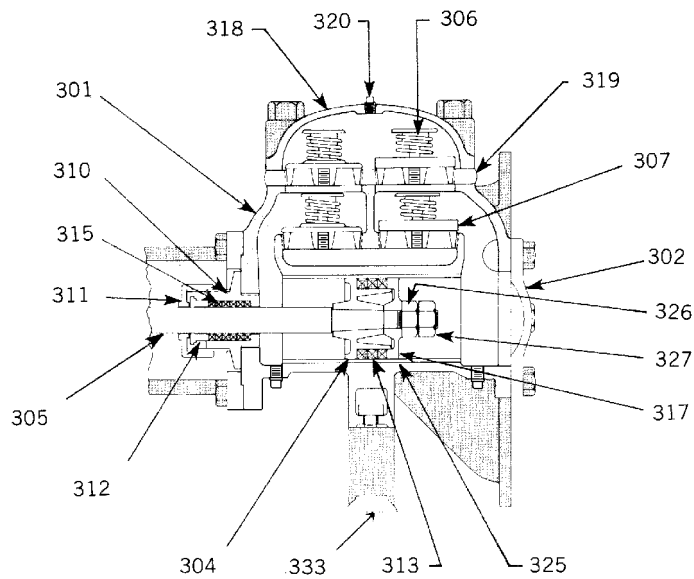


Figure 6.1.11.3 — Liquid end, horizontal valve plate piston pump

301 Cylinder, liquid	311 Gland, liquid stuffing box	320 Plug
302 Head, liquid cylinder	312 Ring, follower	325 Liner, cylinder
304 Piston, liquid	313 Ring, liquid piston	326 Nut, piston
305 Rod, liquid piston	315 Packing	327 Nut, piston jam
306 Valve assembly, discharge	317 Follower, piston	333 Foot, liquid cylinder
307 Valve assembly, suction	318 Cover, liquid valve chest	
310 Box, liquid stuffing	319 Plate, valve	

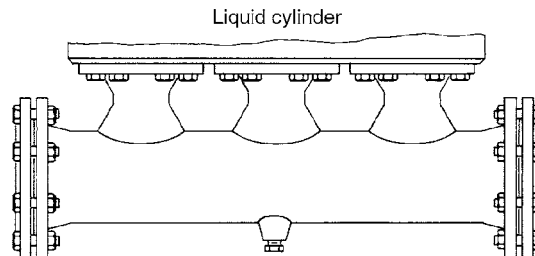


Figure 6.1.11.4 — Manifold

6.1.11.6 Valve plate (valve deck)

A plate that contains the suction or discharge valves (see Figure 6.1.11.3).

6.1.11.7 Piston

A cylindrical body that is attachable to a rod and is capable of exerting pressure on a liquid within the liquid cylinder. A piston usually has grooves for containing rings that seal against the cylinder or cylinder liner (see Figures 6.1.11.7a through e).

A piston in a reciprocating pump can be double-acting.

The pistons in Figures 6.1.11.7a and 6.1.11.7b have followers that retain the packing rings.

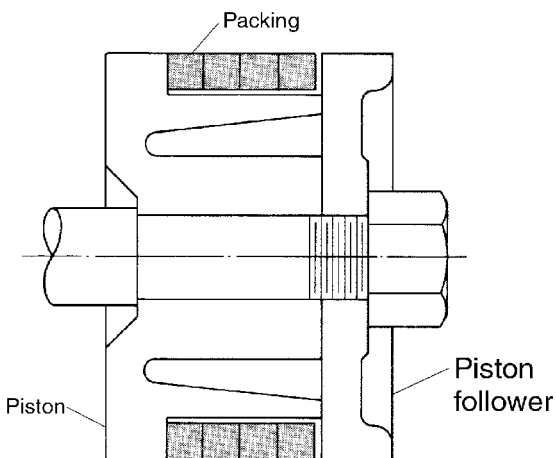


Figure 6.1.11.7a — Piston assembly

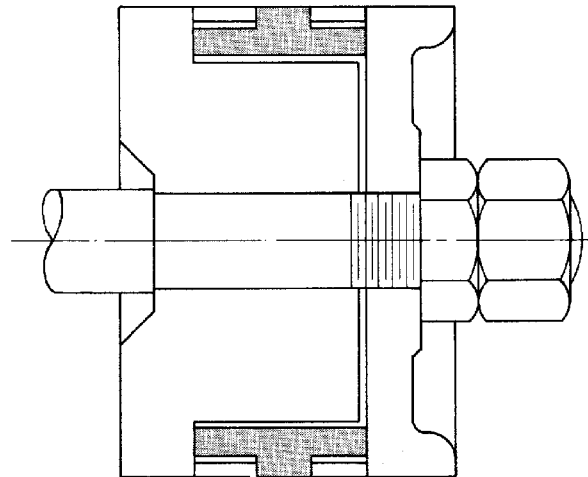


Figure 6.1.11.7b — Bull and snap piston

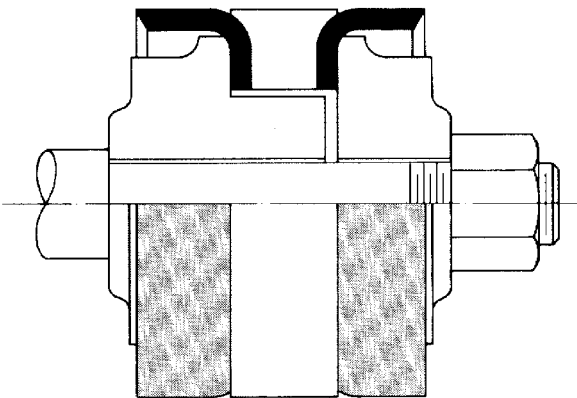


Figure 6.1.11.7c — Cup-type piston

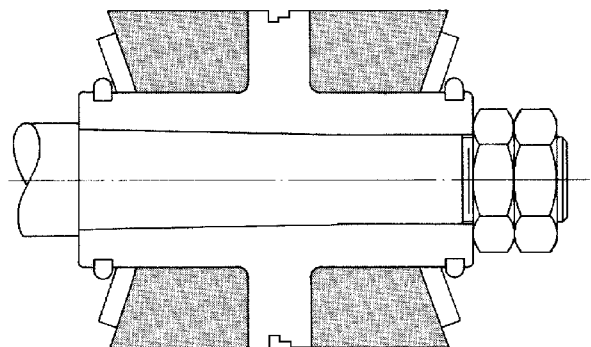


Figure 6.1.11.7d — Slush piston

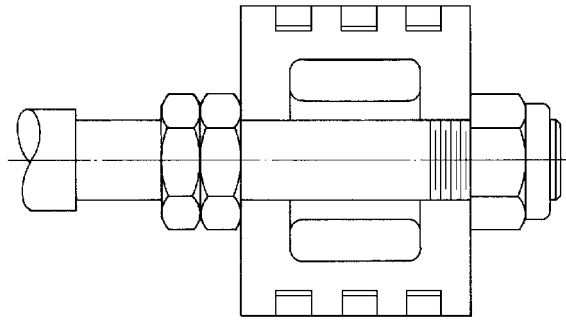


Figure 6.1.11.7e — Individual ring piston

6.1.11.8 Plunger

A smooth rod that is attachable to a crosshead and is capable of exerting pressure on a liquid within the liquid cylinder (see Figure 6.1.11.8). Sealing rings for a plunger are stationary, the plunger sliding within the rings.

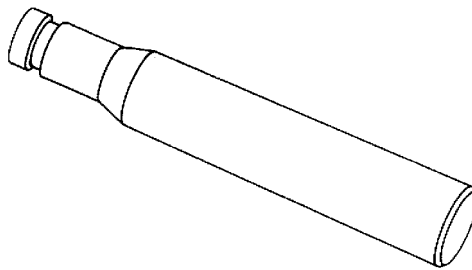


Figure 6.1.11.8 — Plunger

A plunger is single-acting, requiring a double-acting pump to have two plungers on each crosshead axis (see Figure 6.1.10.1a).

6.1.11.9 Stuffing box

A cylindrical cavity through which the plunger or piston rod reciprocates and in which liquid leakage is controlled by means of packing (see Figure 6.1.11.9).

A follower ring and throat bushing are used to guide the plunger or rod as it reciprocates. The throat bushing and follower ring contain the packing within the stuffing box.

6.1.11.10 Packing

A material used to provide a seal around the plunger, piston rod, or piston (see Figure 6.1.11.10).

6.1.11.11 Gland

A part that retains the packing in the stuffing box (see Figure 6.1.11.11).

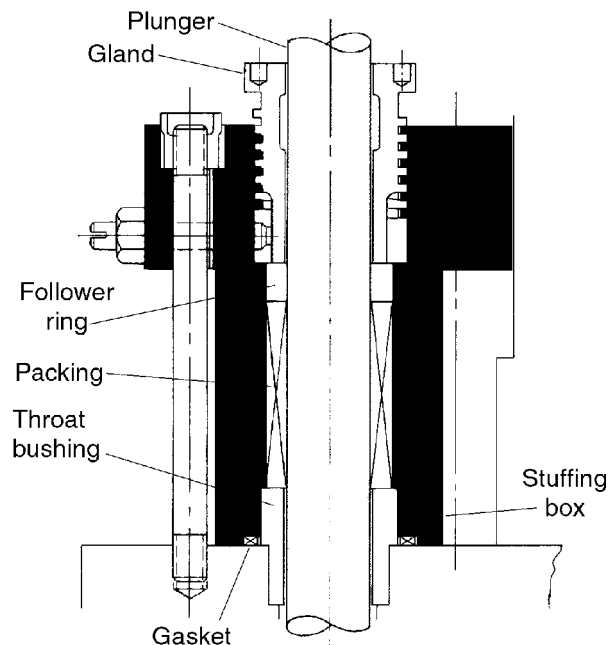


Figure 6.1.11.9 — Stuffing box

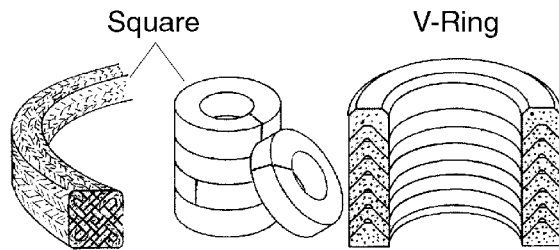


Figure 6.1.11.10 — Packing

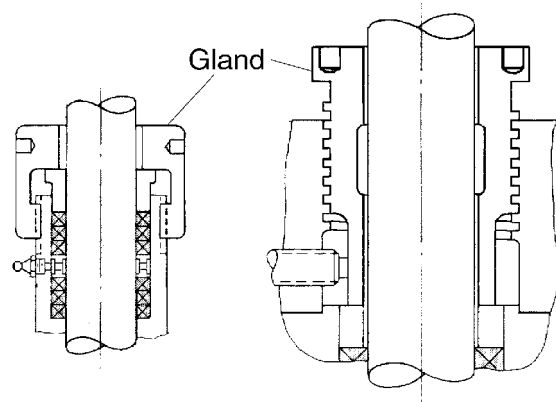


Figure 6.1.11.11 — Gland

6.1.11.12 Lantern ring (seal cage)

A ring located in the stuffing box to provide space for the introduction of a lubricant or a barrier liquid (see Figure 6.1.11.12).

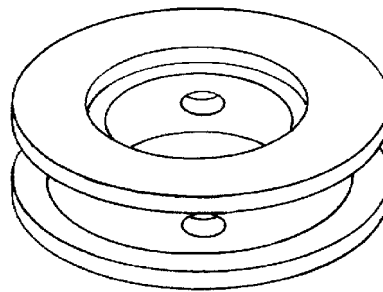


Figure 6.1.11.12 — Lantern ring

6.1.11.13 Valve assembly

Usually consists of a seat, valve, spring, and spring retainer. It allows liquid to enter and leave each pumping chamber of the cylinder. Each pumping chamber has one or more suction and discharge valve(s) (see Figures 6.1.11.13a through d).

6.1.11.14 Upper crosshead

Used in vertical plunger pumps to transmit the reciprocating motion of the side rod to the plunger (see Figure 6.1.11.1a).

6.1.12 Power end

That portion of the pump in which the rotating motion of the crankshaft is converted to a reciprocating motion through connecting rods and crossheads (see Figures 6.1.12a, b, and c).

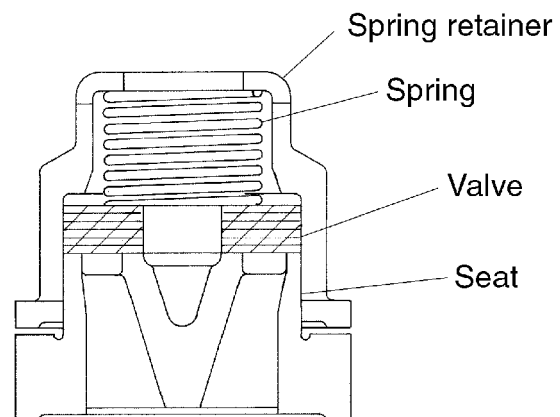


Figure 6.1.11.13a — Plate valve assembly

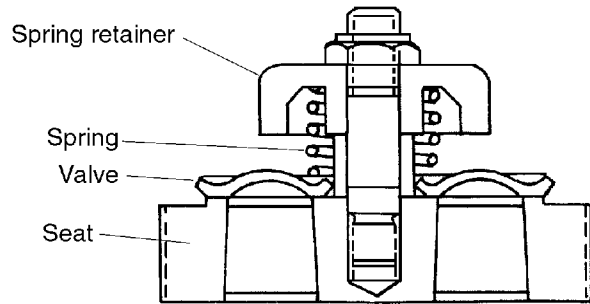


Figure 6.1.11.13b — Disc valve assembly

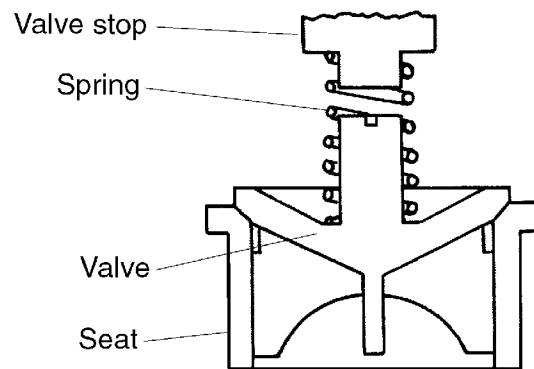


Figure 6.1.11.13c — Wing guided valve assembly

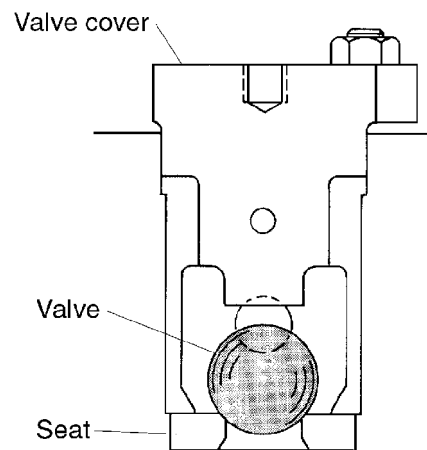
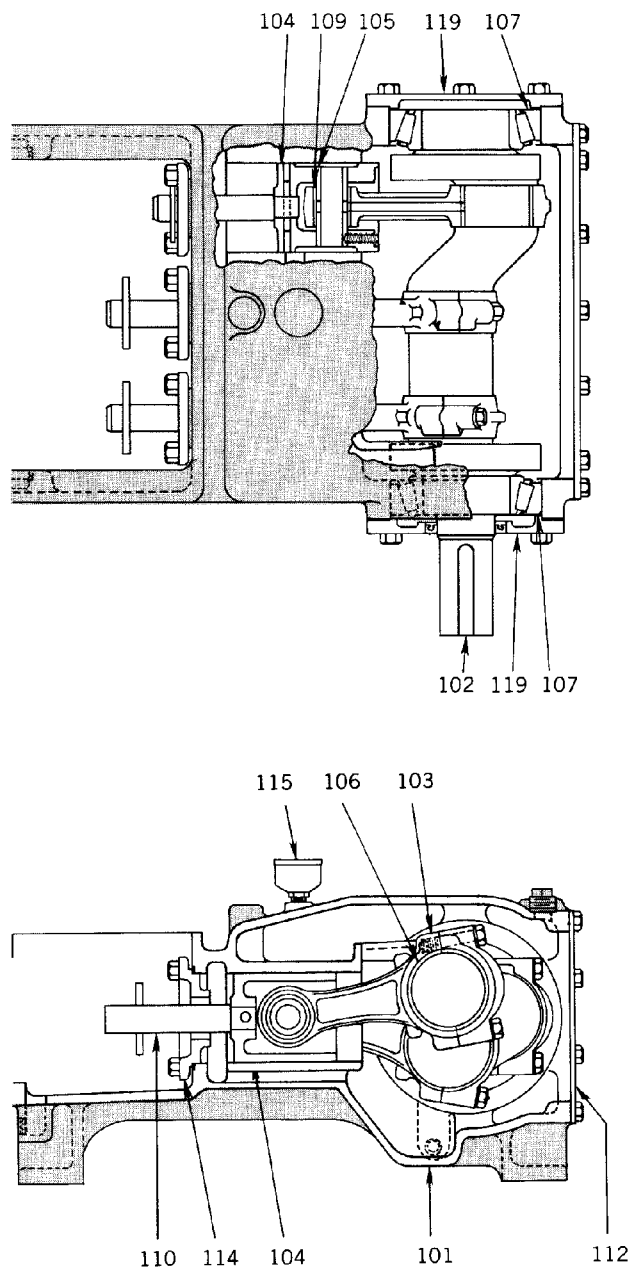
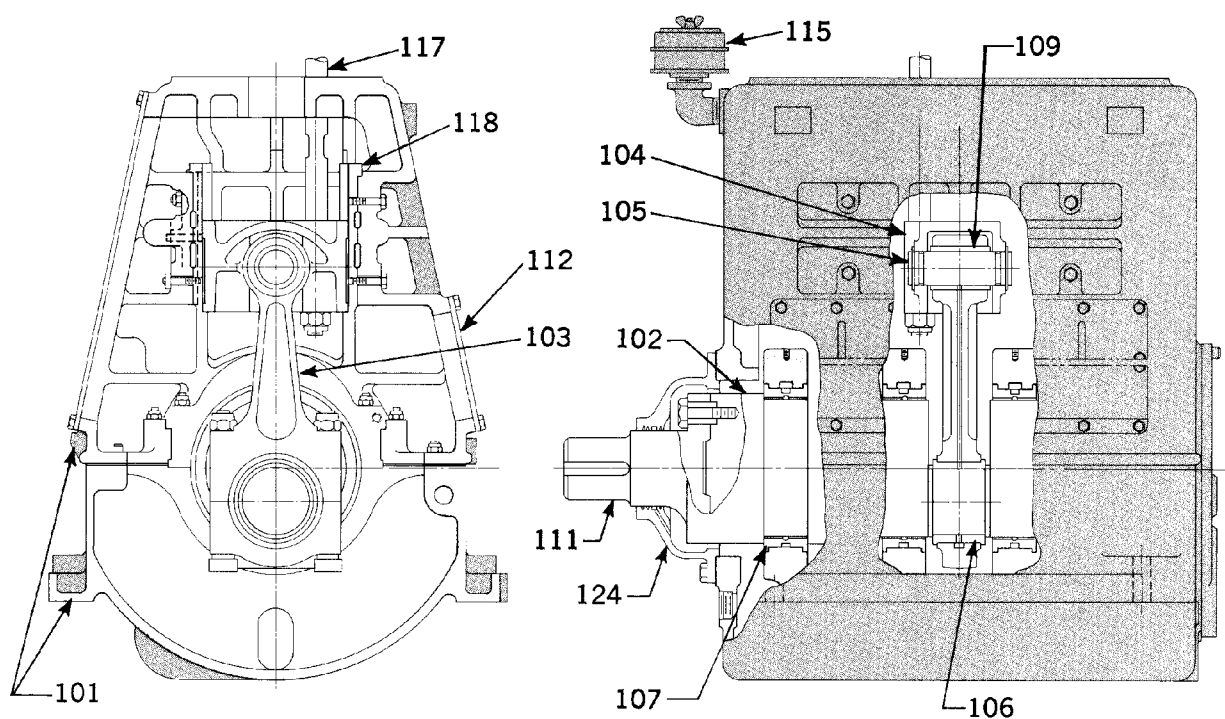


Figure 6.1.11.13d — Ball valve assembly



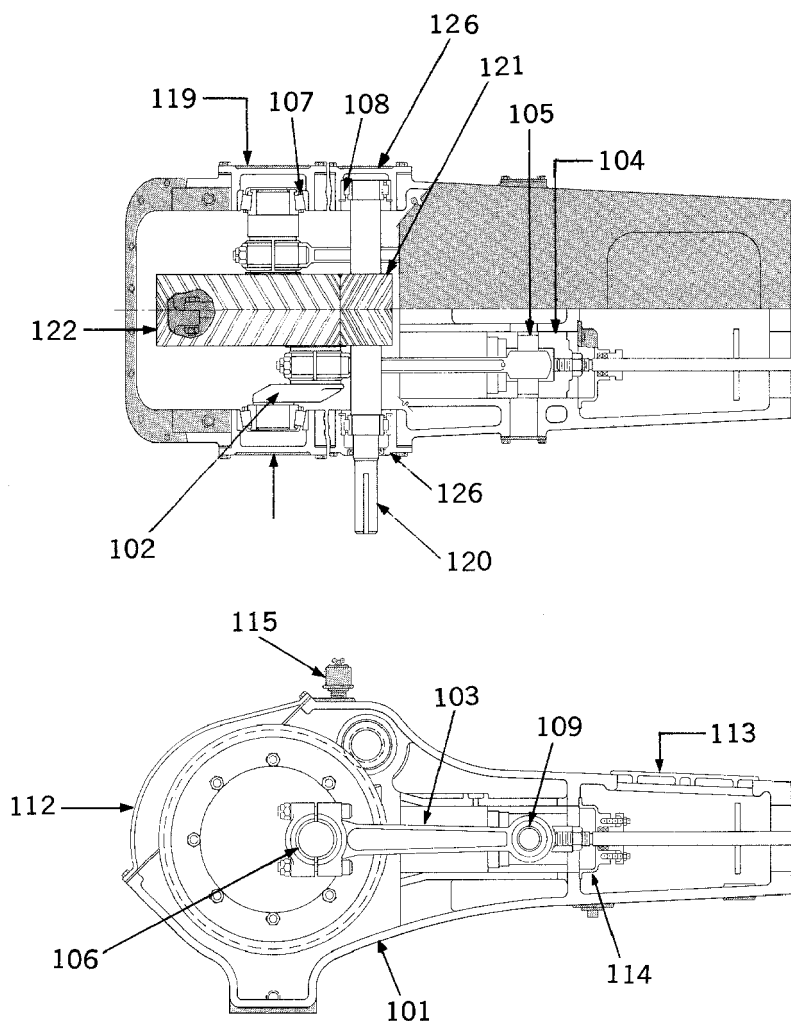
- | | | | | | |
|-----|------------------|-----|--------------------------|-----|-----------------------------|
| 101 | Frame, power | 106 | Bearing, crankpin | 114 | Box, wiper |
| 102 | Crankshaft | 107 | Bearing, main crankshaft | 115 | Breather |
| 103 | Rod, connecting | 109 | Bearing, wrist pin | 119 | Housing, crankshaft bearing |
| 104 | Crosshead, power | 110 | Extension, crosshead | | |
| 105 | Pin, wrist | 112 | Cover, crankcase | | |

Figure 6.1.12a — Power end, horizontal plunger power pump



101	Frame, power	106	Bearing, crankpin	115	Breather
102	Crankshaft	107	Bearing, main crankshaft	117	Rod, side
103	Rod, connecting	109	Bearing, wrist pin	118	Way, crosshead
104	Crosshead, power	111	Extension, crankshaft	124	Cover, crankshaft extension
105	Pin, wrist	112	Cover, crankcase		

Figure 6.1.12b — Power end, vertical plunger power pump



101	Frame, power	107	Bearing, main, crankshaft	115	Breather
102	Crankshaft	108	Bearing, pinion shaft	119	Housing, crankshaft bearing
103	Rod, connecting	109	Bearing, wrist pin	120	Pinion shaft
104	Crosshead, power	112	Cover, crankcase	121	Pinion
105	Pin, wrist	113	Cover, cradle	122	Gear
106	Bearing, crankpin	114	Box, wiper	126	Housing, bearing, pinion shaft

Figure 6.1.12c — Power end, horizontal duplex power pump with integral gears

6.1.12.1 Power end parts

The following sections describe major power frame components that are shown in Figures 6.1.12a, 6.1.12b, and 6.1.12.c. A listing by part name is shown in Table 6.1.12.1, which also shows the standard abbreviation.

6.1.12.2 Power frame

That portion of the power end that contains the crankshaft, connecting rods, crosshead, and bearings used to transmit power and motion to the liquid end. It may consist of one or two pieces (if two, there is one upper and one lower half) (see Figure 6.1.12.2).

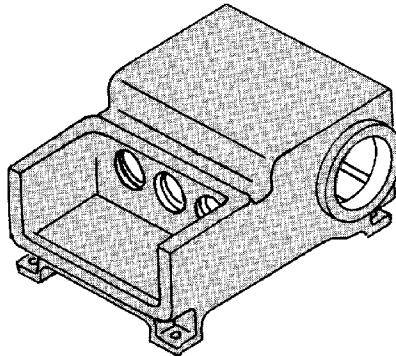


Figure 6.1.12.2 — Power frame (one piece)

6.1.12.3 Crankshaft

The stepped shaft that transmits power and motion to the connecting rods. Main bearings and connecting rods are fitted on this member (see Figure 6.1.12.3).

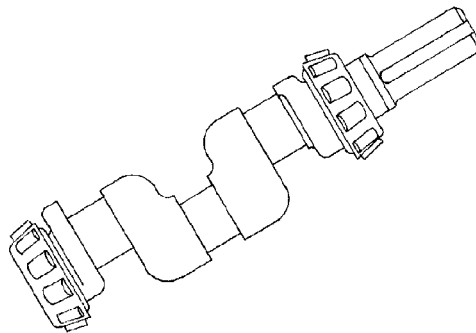


Figure 6.1.12.3 — Crankshaft

Table 6.1.12.1 — List of parts by key name – power end parts

Name	Number	Figure in which parts appear	Abbreviations
Bearing, crankpin	106	6.1.12.6, 6.1.12a, 6.1.12b, 6.1.12c	Brg crkpin
Bearing, main crankshaft	107	6.1.12.4a, 6.1.12.4b, 6.1.12a, 6.1.12b, 6.1.12c	Brg main crksht
Bearing, pinion shaft	108	6.1.12c	Brg pin sft
Bearing, wrist pin	109	6.1.12.8, 6.1.12a, 6.1.12b, 6.1.12c	Brg wst pin
Box, wiper	114	6.1.12a, 6.1.12c	Box wiper
Breather	115	6.1.12a, 6.1.12b, 6.1.12c	Brthr
Cover, crankcase	112	6.1.12a, 6.1.12b, 6.1.12c	Cov crkcase
Cover, crankshaft extension	124	6.1.12b	Cov crkshft ext
Cover, cradle	113	6.1.12c	Cov crdl
Crankshaft	102	6.1.12.3, 6.1.12a, 6.1.12b, 6.1.12c	Crkshft
Crosshead, power	104	6.1.12.7, 6.1.12a, 6.1.12b, 6.1.12c	Xhead pwr
Extension, crosshead	110	6.1.12.10, 6.1.12a	Ext xhead
Extension, crankshaft	111	6.1.12b	Ext crksft
Extension, frame	123	6.1.12.11	Ext fr
Frame, power	101	6.1.12a, 6.1.12b, 6.1.12c	Fr pwr
Gear	122	6.1.12c	Gear
Housing, crankshaft bearing	119	6.1.12a, 6.1.12c	Hsg crksft brg
Housing, pinion shaft bearing	126	6.1.12c	Hsg pin sft brg
Pin, wrist	105	6.1.12a, 6.1.12b, 6.1.12c	Pin wst
Pinion	121	6.1.12c	Pin
Pinion shaft	120	6.1.12c	Pin sft
Rod, connecting	103	6.1.12.5, 6.1.12a, 6.1.12b, 6.1.12c	Rod conn
Rod, side	117	6.1.12b	Rod side
Way, crosshead	118	6.1.12b	Way xhead