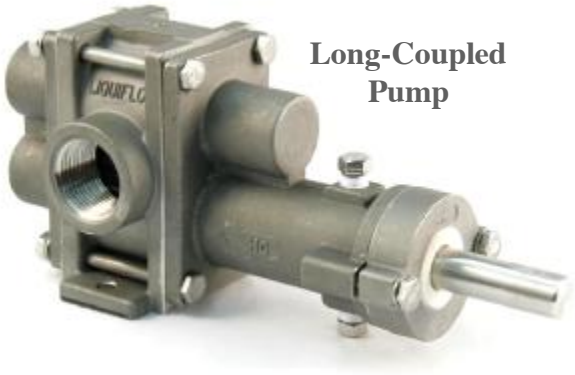
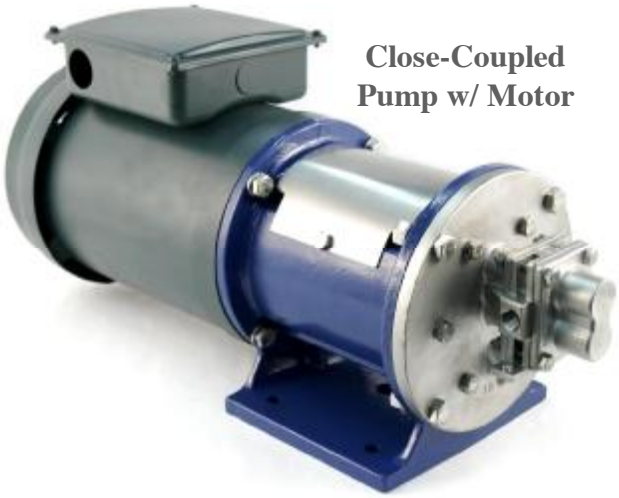
INSTALLATION, OPERATION & MAINTENANCE MANUAL

H-SERIES & 3-SERIES SEALED GEAR PUMPS



Long-Coupled Pump



Close-Coupled Pump w/ Motor

H-SERIES: Models H1F, H3F, H5R, H5F, H7N, H7R, H7F, H9R & H9F

3-SERIES: Models 31F, 33F, 35R, 35F, 37R, 37F, 39R, 39F & 311F

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443 North Avenue, Garwood, NJ 07027 USA Tel: 908-518-0777 Fax: 908-518-1847 www.liquiflo.com

Forward

This manual provides instructions for the installation, operation and maintenance of the Liquiflo H-Series and 3-Series Gear Pumps, Sealed Models H1F, H3F, H5R, H5F, H7N, H7R, H7F, H9R & H9F; and 31F, 33F, 35R, 35F, 37R, 37F, 39R, 39F & 311F. It is critical for any user to read and understand the information in this manual along with any documents this manual refers to prior to installation and start-up.

Liquiflo shall not be liable for damage or delays caused by a failure to follow the instructions for installation, operation and maintenance as outlined in this manual.

Thank you for purchasing a Liquiflo product.

LIQUIFLO STANDARD TERMS AND CONDITIONS APPLY UNLESS SPECIFIED IN WRITING BY LIQUIFLO.

Detailed Table of Contents

Section 1: General Information

1.1 General Instructions

This manual covers the H-Series Sealed Gear Pumps, Models H1F thru H9F; and the 3-Series Sealed Gear Pumps, Models 31F thru 39F, and 311F.

The materials of construction of the pump are selected based upon the chemical compatibility of the fluid being pumped. The user must verify that the materials are suitable for the surrounding atmosphere.

If the fluid is non-conductive, methods are available to mechanically ground the isolated shaft. This is only necessary if the surrounding atmosphere is extremely explosive or stray static charges are present.

Upon receipt of your Liquiflo pump:

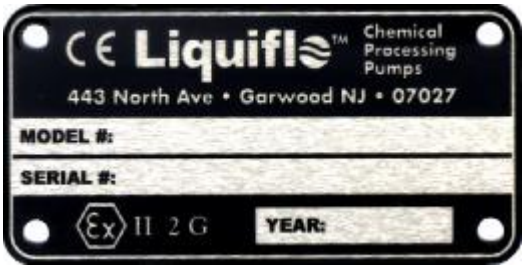
A) Verify that the equipment has not been damaged in transit.

B) Verify that the pump *Serial Number* is stamped on the pump's rear housing.

C) Verify that the *Liquiflo Stainless Steel Nameplate* is secured to the pump's housing:

D) For ATEX certification, verify that the following *Stainless Steel Tag* is attached to the pump:

Explanation of ATEX Tag	
Group II	Explosive atmospheres
Category 2	Equipment provides a high level of protection. Explosive atmospheres are likely to occur.
Category 3	Equipment provides a normal level of protection. Explosive atmospheres are unlikely to occur.
D	Dust
G	Gas



E) Record the following information for future reference:

Model Number:
Serial Number:
Date Received:
Pump Location:
Pump Service:

NOTE: By adding a **K** prior to the pump's Model Code, a **Repair Kit** can be obtained which consists of the following parts: mechanical seal with seal seat and gaskets, drive and idler gears, drive and idler shafts, wear plates, bearings, retaining rings, keys, housing alignment pins, bearing lock pins and O-rings.

1.2 Pump Specifications

Table 1A: Performance Specifications (English System Units)

Pump Series	Pump Model	Max Flow	Max Speed	Max ΔP	Max Viscosity [2]	NPSHR [3]	Dry Lift [3]	TD [4]
	UNITS:	GPM	RPM	PSI	cP	ft	ft	GPR
H-Series	H1F	0.48	1750	225 [1]	100,000	3	0.5	.000276
	H3F	1.45	1750	225 [1]	100,000	2	1.5	.000828
	H5R	2.41	1750	225 [1]	100,000	2	2	.001379
	H5F	3.38	1750	225 [1]	100,000	2	4	.001930
	H7N	5.37	1750	225 [1]	100,000	5.2	6	.003070
	H7R	8.59	1750	225 [1]	100,000	5.2	6	.004910
	H7F	10.7	1750	225 [1]	100,000	5.2	7	.006140
	H9R	15.1	1750	225 [1]	100,000	4	6	.008610
	H9F	21.5	1750	225 [1]	100,000	3	14	.01228
3-Series	31F	0.48	1750	100	100,000	3	0.5	.000276
	33F	1.45	1750	100	100,000	2	1.5	.000828
	35R	2.41	1750	100	100,000	2	2	.001379
	35F	3.38	1750	100	100,000	2	4	.001930
	37R	8.59	1750	100	100,000	5.2	6	.004910
	37F	10.7	1750	100	100,000	5.2	7	.006140
	39R	15.1	1750	100	100,000	4	6	.008610
	39F	21.5	1750	100	100,000	3	14	.01228
	311F	21.5	1750	80	100,000	3	14	.01228

Table 1B: Performance Specifications (SI System Units)

Pump Series	Pump Model	Max Flow	Max Speed	Max ΔP	Max Viscosity [2]	NPSHR [3]	Dry Lift [3]	TD [4]
	UNITS:	LPM	RPM	bar	mPas	m	m	LPR
H-Series	H1F	1.83	1750	15.5 [1]	100,000	0.9	0.15	.001045
	H3F	5.48	1750	15.5 [1]	100,000	0.6	0.46	.003134
	H5R	9.13	1750	15.5 [1]	100,000	0.6	0.6	.005220
	H5F	12.8	1750	15.5 [1]	100,000	0.6	1.2	.007306
	H7N	20.3	1750	15.5 [1]	100,000	1.6	1.8	.011621
	H7R	32.5	1750	15.5 [1]	100,000	1.6	1.8	.018586
	H7F	40.7	1750	15.5 [1]	100,000	1.6	2.1	.023242
	H9R	57.0	1750	15.5 [1]	100,000	1.2	1.8	.032592
	H9F	81.3	1750	15.5 [1]	100,000	0.9	4.3	.04648
3-Series	31F	1.83	1750	6.9	100,000	0.9	0.15	.001045
	33F	5.48	1750	6.9	100,000	0.6	0.46	.003134
	35R	9.13	1750	6.9	100,000	0.6	0.6	.005220
	35F	12.8	1750	6.9	100,000	0.6	1.2	.007306
	37R	32.5	1750	6.9	100,000	1.6	1.8	.018586
	37F	40.7	1750	6.9	100,000	1.6	2.1	.023242
	39R	57.0	1750	6.9	100,000	1.2	1.8	.032592
	39F	81.3	1750	6.9	100,000	0.9	4.3	.04648
	311F	81.3	1750	5.5	100,000	0.9	4.3	.04648

NOTES:

1 Max ΔP (Differential Pressure) is derated to 125 PSI (8.6 bar) for viscosities < 10 cP (mPas).

2 Fluid viscosities > 150 cP (mPas) should use pumps with trimmed gears to reduce power consumption and increase pump efficiency. High-viscosity fluids may require larger pumps with trimmed gears operating at lower speeds. Consult factory.

3 NPSHR and Dry Lift are Specified @ Max Speed and 1 cP (mPas).

4 TD (Theoretical Displacement) is based on new pump operating @ Max Speed and ΔP = 0.

Table 2: Absolute Temperature & Pressure Ratings

Pump Series	Pump Models	Minimum Operating Temperature		Maximum Operating Temperature (1)		Maximum Operating Pressure (3)	
	UNITS:	°F	°C	°F	°C	PSIG	bar (g)
H-Series	H1F, H3F, H5R & H5F	-40	-40	500	260	300	20.7
	H7N, H7R, H7F, H9R & H9F	-40	-40	500	260	225	15.5
3-Series	31F, 33F, 35R & 35F	-40	-40	500	260	300	20.7
	37R, 37F, 39R, 39F & 311F	-40	-40	500	260	225	15.5

NOTES:

1 The actual maximum surface temperature depends not on the pump but primarily on the temperature of the fluid being pumped. Temperature class can be controlled with the use of thermal sensors. Pump surfaces will be approximately 20 °F (7 °C) above the temperature of the fluid being pumped.

2 Pump is designed to operate within the ambient temperature range of -4 °F (-20 °C) and 104 °F (40 °C).

3 For pumps with ANSI 150# RF Flanges, the Maximum Operating Pressure Rating of the flange is 285 PSIG within the temperature range of -20 to 100 °F. Above 100 °F, derate by 0.29 PSIG/°F.

Table 3: Maximum Torque Specifications (in-lbs)

Parameter	H-Series	H1F	H3F	H5R	H5F	H7N	H7R	H7F	H9R	H9F	
	3-Series	31F	33F	35R	35F		37R	37F	39R	39F	311F
Idler Gear Teflon		—	4	7	10	14	22	27	38	54	54
Idler Gear Carbon		3	9	15	21	28	45	56	79	113	113
Idler Gear Celcon/Delrin		4	11	19	26	36	57	71	99	142	142
Idler Gear PEEK		4	12	20	28	38	61	76	107	153	153
Idler Gear Ryton		4	12	20	28	38	61	76	107	153	153
Double Metal Gears		23	23	74	74	134	189	189	189	189	189

Table 4: Weight Data

Parameter	H-Series	H1F	H3F	H5R	H5F	H7N	H7R	H7F	H9R	H9F		Unit
	3-Series	31F	33F	35R	35F		37R	37F	39R	39F	311F	
Pump Weight*		2.5	2.5	3.5	3.5	6.5	6.5	6.5	8.0	9.8	9.8	lbs
		1.1	1.1	1.6	1.6	2.9	2.9	2.9	3.6	4.4	4.4	kg
Pump Weight with Close-Coupled Option*		23	23	24	24	29	29	29	34	36	36	lbs
		10	10	11	11	13	13	13	15	16	16	kg

* Weight of pump with threaded ports, excluding motor.

Table 5: Material Data

Component		Material(s)
Pump Housing		316 Stainless Steel, Alloy-20 or Alloy-C
Mounting Hardware		18-8 Stainless Steel
Mounting Bracket (Pedestal)*		Epoxy Painted Cast Iron
Motor Frames (C-Face)		NEMA 56C/56HC, 143/145TC & 182/184TC; IEC 71/80/90 (B5 Flange)
Bearings		Carbon, Carbon-60, Teflon, PEEK or Silicon Carbide (**Note 1**)
Wear Plates		Carbon, Carbon-60, Teflon, PEEK or Ceramic (**Note 1**)
Gears		316 SS, Alloy-C, PEEK, Ryton, Celcon, Delrin, Teflon or Carbon (**Note 1**)
Shafts		316 Stainless Steel or Alloy-C (**Note 2**)
Coating on Shafts		Uncoated, Ceramic Chrome Oxide or Tungsten Carbide
Housing Pins		316 Stainless Steel or Alloy-C (**Note 2**)
Bearing Pins		Teflon, 316 Stainless Steel or Alloy-C (**Note 2**)
Retaining Rings		316 Stainless Steel or Alloy-C (**Note 2**)
Keys		316 Stainless Steel or Alloy-C (**Note 2**)
O-rings/Gaskets		Teflon, Viton, EPDM, Buna-N, Kalrez or 316 SS/PFA Encapsulated
Dynamic Seal	**Packing**	Braided Teflon or Graphoil
	Lip Seal	Viton U-Cup
	Mechanical Seals	Seal Face: Carbon or Teflon ; Seal Seat: Ceramic or Silicon Carbide ; Seal Wedge: Teflon or Graphoil ; Metallic Body: Single Internal: **Note 2** ; External and Double: 316 SS

NOTES: * Close-coupled configuration

1 Teflon is 25% glass-filled PTFE.
2 Metallic material will match pump housing material. (Exception: **Note 3**)
3 Alloy-20 pumps will have all metallic internal parts made from Alloy-C.

1.3 Model Coding

A 14-position **Model Code** is used to completely describe a specific sealed pump. This code is required when ordering either a new pump or a repair kit or replacement parts for an existing pump. The table below describes the Model Code and gives a specific example:

Table 6: Sealed Pump Model Code Description & Example

Position #	Description	Pump Model Code Example: H5FS6PEEU000001	
		Code	Selection
1	Pump Model (Size)	H5	Model H5F (H5 = Pump Size; F = Full Capacity)
2	Pump Model (Capacity)	F	
3	Basic Material & Port Type	S	316 SS Housing and Shafts & NPT Ports
4	Drive Gear	6	316 SS Drive Gear
5	Idler Gear	P	PEEK Idler Gear
6	Wear Plates	E	Carbon 60 Wear Plates
7	Bearings	E	Carbon 60 Bearings
8	Sealing Arrangement	U	Carbon/SiC Single Internal Mechanical Seal
9	Bearing Flush	0	No Bearing Flush
10	Shaft Coating	0	No Shaft Coating (Bare 316 SS Shafts)
11	O-rings	0	Teflon O-rings
12	Retaining Rings	0	316 SS Retaining Rings
13	Bearing Pins	0	Teflon Bearing Pins
14	Coupling Method	1	Close-Coupled for 143TC or 145TC Motor Frame

NOTE: See the Liquiflo Product Catalog or the Liquiflo Website (www.liquiflo.com) for complete Model Coding information.

1.4 Pump Installation

During installation of the pump and supporting equipment, follow the guidelines given in **Section 3**. Pay special attention to all cautionary notes in this section.

1.5 Start-Up

Before operating the pump, inspect the system as outlined in **Section 4**. Do not start the pump until the inspection is satisfactory and all safety precautions have been taken.

1.6 Operation & Troubleshooting

The successful and safe operation of a pump is not only dependent on the pump but also on each of the system components. It is therefore important to monitor the entire pumping system during operation and to perform the necessary maintenance to keep the system running smoothly.

A normally operating sealed gear pump will deliver a steady and pulse-less flow, be relatively quiet and have a predictable flow rate based on the pump speed, fluid viscosity and differential pressure across the pump. Refer to the performance curves of the specific pump model being operated (see Liquiflo Product Catalog or website: www.liquiflo.com). Sealed pumps operating normally will have virtually no leakage, except those with packing, which may require some leakage to properly lubricate the seal (see **Appendix 4**). Sealed pumps must not be run dry for more than a few seconds or damage to the seal will result.

If a significant problem is observed during operation, the pump should be stopped so that corrective action can be taken. The observed problem could have several possible causes, and multiple remedies for each cause. For help with problem solving, refer to the Troubleshooting Guide given in **Appendix 7**.

1.7 Maintenance & Repair

The pump has a dynamic seal and internal bearings, wear plates, gears and shafts which require replacement over time due to physical wear. The center housing of the pump may also incur physical wear and require replacement (see **Appendix 3**). O-rings and retaining rings should always be replaced when rebuilding the pump.

Standard repair kits are available to facilitate repair of the pump. A repair kit for a sealed pump includes the following parts: sealing components (packing rings, lip seal or mechanical seal), bearings, wear plates, gear-shaft assemblies, O-rings and gaskets, bearing lock pins and housing alignment pins. The single mechanical seal includes the seal seat and the double mechanical seal includes both the inboard and outboard seal seats.

Before performing maintenance on the pump, review the safety precautions given in **Section 2**. Removal of the pump from the piping system is covered in **Section 5.2**. To disassemble a bare sealed pump, follow the procedure in **Section 5.3**. To replace the seal or other parts of the pump, follow the assembly procedure in **Section 5.4**. Maintenance of pumps with the *close-coupled configuration* is covered in **Section 5.5**. When performing maintenance, pay special attention to all cautionary notes given in these sections.

1.8 Repair Kits & Replacement Parts

Repair kits and replacement parts for the pumps can be purchased from your local Liquiflo distributor. Refer to **Appendices 5** and **6** for individual parts information.

1.9 Returned Goods Authorization (RGA)

If it is necessary to return the pump to the factory for service,

1) Contact your local Liquiflo distributor to discuss the return, obtain a Returned Goods Authorization Number (**RGA #**) and provide the distributor with the required information (see RGA Record below).
2) Clean and neutralize pump.
3) Package the pump carefully and include the **RGA #** in a visible location on the outside surface of the box.
4) Ship pump to factory, freight prepaid.

Returned Goods Authorization (RGA) Record		
1	**RGA #**	**(Supplied by Distributor)**
2	**Distributor Name**	
3	**Order Date**	
4	**Customer PO#**	
5	**Return Date**	
6	**Item(s) Returned**	
7	**Serial Number(s)**	
8	**Reason for Return**	
9	**Fluid(s) Pumped**	
10	**Notes**	

NOTE: Pump must be cleaned and neutralized prior to shipment to the factory.

Section 2: Safety Precautions

2.1 General Precautions

- **Always** lock out the power to the pump driver when performing maintenance on the pump
- **Always** lock out the suction and discharge valves when performing maintenance on the pump
- **Never** operate the pump without safety devices installed
- **Never** operate the pump with suction and/or discharge valves closed
- **Never** operate the pump out of its design specifications
- **Never** start the pump without making sure that the pump is primed
- **Never** use heat to disassemble pump
- Inspect the entire system before start-up
- Monitor the system during operation and perform maintenance periodically or as required by the application
- Decontaminate pump using procedures in accordance with federal, state, local and company environmental regulations
- Before performing maintenance on the pump, check with appropriate personnel to determine if skin, eye or lung protection is required and how best to flush the pump
- When performing maintenance, pay special attention to all cautionary statements given in this manual. **Failure to observe safety precautions can result in personal injury, equipment damage or malfunction.** Cautionary statements will have the following format:

CAUTION! (Statement)

Section 3: Pump & Motor Installation

3.1 Installation of Pump, Motor and Base

Refer to the Hydraulic Institute Standards for proper installation procedures of the base, pump and motor. Observe the following guidelines:

1) The foundation area must be rigid and level for maintaining pump alignment.

2) The pump and motor assembly must be securely fastened to the base, and the base must be securely attached to the ground.

3) For long-coupled pumps, the pump and motor shafts must be manually aligned to eliminate excessive radial loads on the pump that will cause vibration and lead to premature pump failure. (Note: If the pump was delivered as a complete long-coupled assembly, it was properly aligned at the factory.) Alignment should be checked by taking measurements at the coupling. Flexible couplings are not intended to compensate for misalignment. Therefore, both angularity and parallelism should be checked and, if necessary, corrected. If these are off by more than 0.015 inches (0.4 mm), the assembly should be realigned. (Note: For sealed pumps with *close-coupled configuration*, no alignment procedure between the pump and motor is required.)

4) The flexible insert of the mechanical coupling between the pump and motor must be free to move axially – a distance of 1/16 to 1/8 inches – to prevent axial loads from being applied to the pump.

5) For long-coupled pumps, after the pump and motor shafts have been properly aligned, install the coupling guard over the mechanical coupling and fasten to the base plate. (Note: If the pump was delivered as a complete long-coupled assembly, the coupling guard was properly installed at the factory.)

CAUTION! Do not operate the pump unless the Coupling Guard has been properly installed on the base plate.

6) The pump inlet should be as close to the liquid source as practical and preferably below it.

7) The pump and motor should be accessible for servicing and inspection.

8) The pump and motor should be cleaned periodically to prevent the build-up of dust.

3.2 General Piping Requirements

Guidelines for piping are given in the Hydraulic Institute Standards and should be reviewed prior to pump installation.

1) All piping must be supported independently and must line up naturally with pump ports.

CAUTION! Do not use the pump to support the piping or allow the piping to apply stress to the pump ports. This can distort the alignment of the pump housing with internal parts and lead to rapid wear or malfunction.

2) Piping runs should be designed to minimize friction losses.

3) Suction and discharge piping should be the same size or larger than the inlet and outlet ports.

4) The piping should be arranged to allow the pump to be flushed and drained prior to the removal of the pump for servicing. Valves and unions should be installed to allow the pump to be isolated during maintenance.

5) The piping system should be thoroughly cleaned prior to installation of the pump.

3.3 Gear Pump Requirements

1) A positive displacement pump should have a **pressure relief valve** installed in the discharge line. The relief valve should be the closest valve to the discharge port of the pump and should bypass the discharge line back to the supply tank.

2) The maximum particle size capable of being passed by the pumps is 37 microns. When pumping fluids containing solids, a **filter** of at least 400 U.S. Mesh should be installed in the suction line.

3) Concentration of solids should be limited to 1% by volume. Exceeding 1% can cause the wear rate to increase to an unacceptable level, resulting in a rapid decrease in pump performance. In addition to solids concentration, the specific wear rate also depends on the size, shape and hardness of the particles, the operating speed and the materials used to construct the pump.

3.4 General Motor Requirements

1) The motor must be compatible with the pump and conditions of the application.

2) The motor supply voltage must match the nameplate voltage of the motor.

3) The motor should never be operated outside of its design specifications.

4) The motor should be inspected periodically and serviced or replaced as required.

CAUTION! Lock out power to the motor before servicing or replacing.

3.4.1 Motor Selection

1) For sealed pumps with *close-coupled configuration*, the motor frame must be compatible with the pump mounting bracket. Choices are NEMA 56C, 56HC, 143TC, 145TC, 182TC & 184TC, and IEC 71, 80 & 90 (B5 flange). NEMA 182/184TC motor frames will require an *adapter plate* (P/N SP0046) and four *adapter mounting bolts* (P/N 641105) to mount the motor to the bracket. (Note: Complete close-coupled pumps ordered for use with NEMA 182/184TC motor frames will be supplied with the adapter plate and adapter mounting bolts.)

2) The motor must have an enclosure that is compatible with the application conditions. If an explosion-proof motor is required, the *temperature code* of the motor must be acceptable for the fluid that will be pumped.

3) The speed and power output rating of the motor must be sufficient for the conditions of service. The power output rating of the motor should exceed the maximum power that will be required by the pump over its operating range.

3.4.2 Motor Hook-Up

1) Electrical wiring of the motor should be performed by a certified electrician.

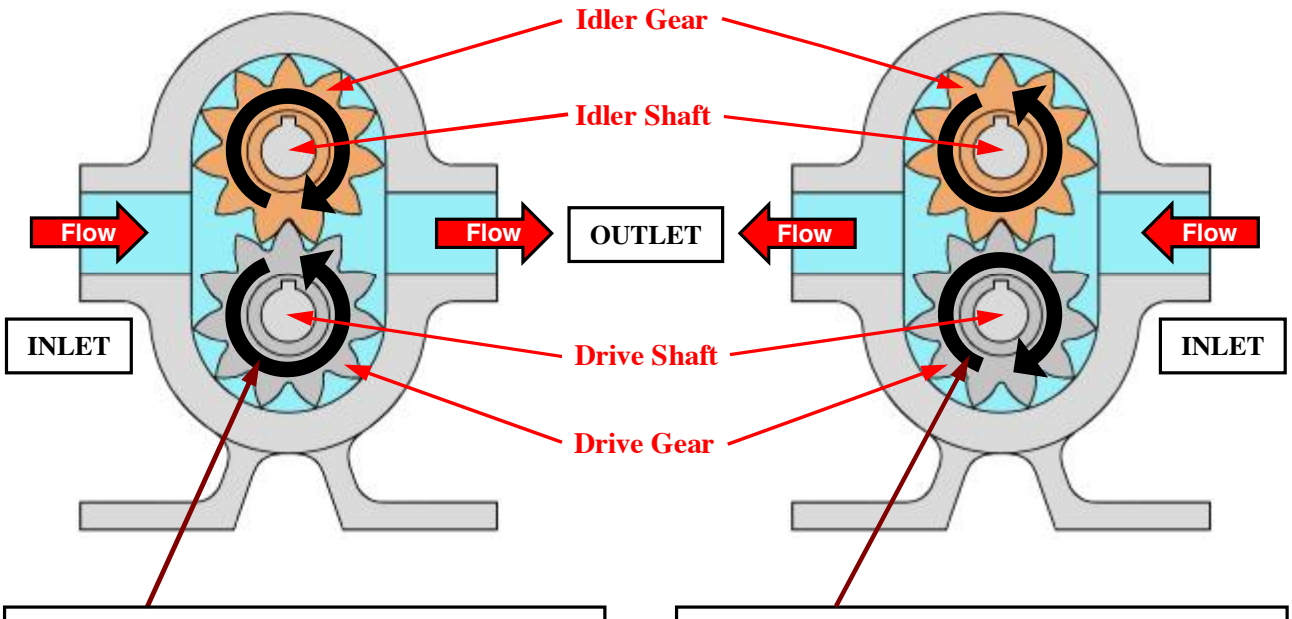
2) Follow the recommendations of the motor manufacturer and observe all electrical wiring safety standards.

3) The motor supply voltage must match the motor nameplate voltage or serious motor damage or fire can result.

CAUTION! Lock out power to the motor before connecting to power line.

3.4.3 Motor Direction

The motor shaft is mechanically coupled to the drive shaft of the pump. Both shafts will turn in the same direction. Because the gear pump is bi-directional, the pump shaft can turn in either direction to produce flow in either direction. The direction of rotation of the motor shaft (same as that of the pump drive shaft) will determine which side of the pump is the *inlet* (suction side) and which side is the *outlet* (discharge side). For the pump models covered in this manual, the flow direction will be as shown below:



Counterclockwise Rotation of Motor Shaft:

Fluid will enter the pump at the left side (inlet) and be discharged at the **right** side (outlet).

Clockwise Rotation of Motor Shaft:

Fluid will enter the pump at the right side (inlet) and be discharged at the **left** side (outlet).

Section 4: Start-Up & Operation

4.1 Precautions Prior to Starting Pump

1) Verify that the pump and motor are suitable for the conditions of service.

2) Verify that all suction and discharge valves are open before starting the pump.

3) Prime the pump and jog the motor to check the rotation. As viewed from the pump end, a clockwise rotation of the motor will result in fluid discharge to the left; counterclockwise rotation will result in fluid discharge to the right (see Page 12).

4) The pump is capable of pulling a dry lift, but it is still recommended that the pump be primed prior to starting.

5) A **pressure relief valve** should be installed in the discharge line to protect the pump from any kind of line blockage including the inadvertent closing of an isolation valve.

6) If the fluid contains suspended solids, a **filter** of at least 400 U.S. Mesh should be installed in the suction line. Concentration of solids should be limited to 1% by volume.

7) Ensure that all safety devices are installed before operating pump (i.e., coupling guard, etc.).

4.2 Operating Requirements

1) Do not operate the pump without fluid inside it.

CAUTION! Do not run pump dry for more than a few seconds or damage to the seal will result. Extended dry running can damage other internal parts.

2) The pump should be operated with at least 20 PSI (1.4 bar) differential pressure to ensure that internal components are properly lubricated by the pumped fluid.

3) Adequate suction pressure must be available for the pump to function properly (see NPSHR data on Page 4).

4) Do not operate the pump outside of its design specifications (see Pages 4 and 5).

4.3 Troubleshooting

During pump operation, inspect for:

(1) Unusual noise
(2) Product leakage
(3) Expected suction and discharge pressures
(4) Product flow

If any problems are encountered with the above items, stop the pump and take corrective action. For help with troubleshooting, refer to **Appendix 7**.

Section 5: Maintenance & Repair

The pump has internal bearings, wear plates, gears, shafts and a dynamic seal (i.e., mechanical seal, lip seal or packing) which require replacement over time due to physical wear. The center housing of the pump may also incur physical wear and require replacement (see **Appendix 3**). O-rings and retaining rings should always be replaced when rebuilding the pump.

5.1 Work Safety

Before performing maintenance, review the safety precautions given in **Section 2** (see Page 9).

5.2 Removal from System

Before servicing, prepare the pump as follows:

CAUTION! If the pump was used to move hazardous or toxic fluids, it must be flushed and decontaminated prior to removal from the system piping. Refer to the Material Safety Data Sheet (MSDS) for the liquid and follow all prescribed safety precautions and disposal procedures.

1 Flush the pump.

2 Stop the motor and lock out the electrical panel.

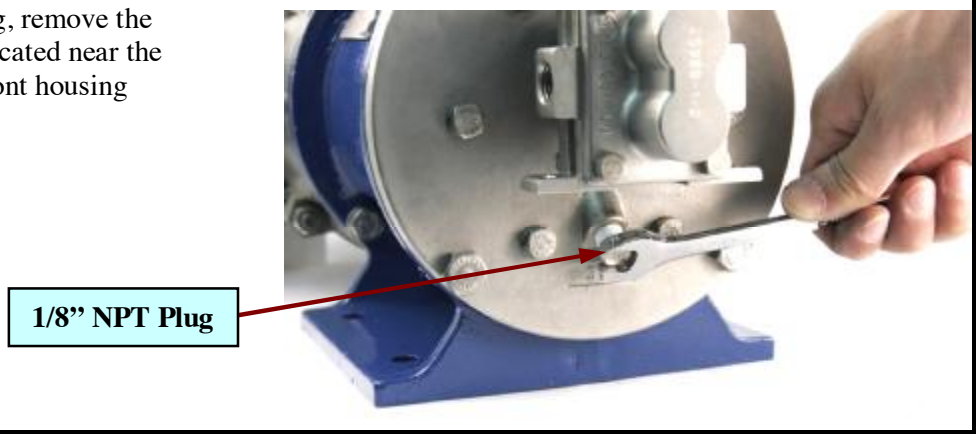
CAUTION! Be certain the pump's motor switch is in the OFF position and the power to the motor is locked out.

3 Close the suction and discharge isolation valves.

4 Disconnect the pump from the system piping and remove any residual liquid remaining in the pump. For close-coupled pumps, drain the seal housing by removing the 1/8" NPT plug on the pump's front housing (see photo below).

Location & Removal of Drain Plug for Close-Coupled Pumps

To drain the seal housing, remove the **1/8" NPT plug** that is located near the bottom of the pump's front housing (see photo).



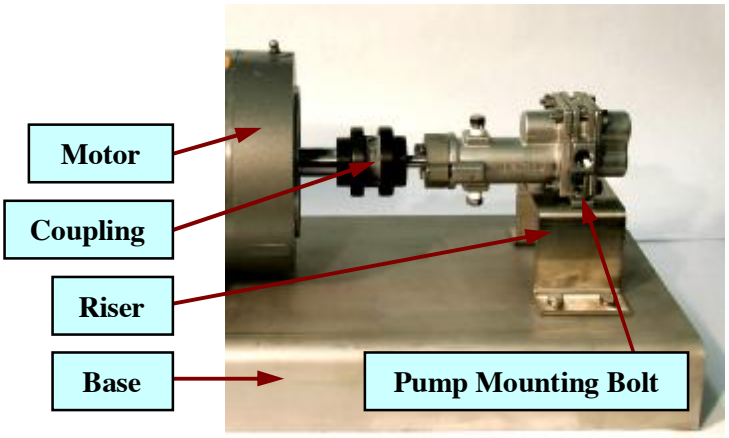
5.3 PUMP DISASSEMBLY

Follow the procedure below and refer to the drawings in **Appendix 6**.

---

1 Remove the pump mounting bolts; then separate the pump from the base or riser.

NOTE: A long-coupled pump & motor assembly (without coupling guard) is shown at right. The coupling setscrews do not have to be loosened to remove the pump. The sealed pumps usually have two mounting bolts; exceptions are Models H9F, 39F and 311F, which have four mounting bolts.



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2 Remove the coupling flange from the pump shaft by loosening the setscrew.

3 Inspect the end of the drive shaft and remove any high spots, scratches or burrs.

NOTE: Irregularities in the surface of the drive shaft can be caused by the tightening of the coupling setscrews during assembly. If necessary, polish the shaft with very fine sandpaper. This will aid in the removal and installation of the mechanical seal and prevent damage to the Teflon seal wedge.

REMOVAL OF SEALS:

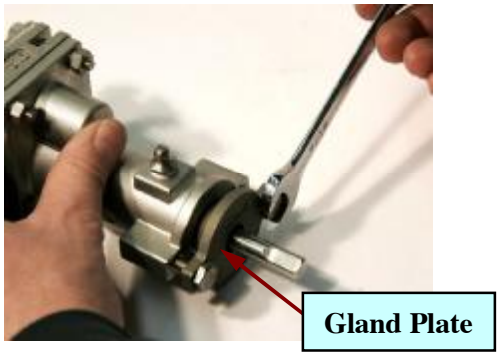
4 The pump can have any one of five different types of seals installed. Remove the pump's seal by referring to the applicable section given below:

Section	Seal Removal	Page #	Reference Drawing	Page #
A	Packing Seal	16	Sectional #1	49
B	Lip Seal	16	Sectional #2	50
C	Single Internal Mechanical Seal	17	Sectional #3	51
D	External Mechanical Seal	17	Sectional #4	52
E	Double Mechanical Seal	18	Sectional #5	53

NOTE: If only the seal needs replacing, proceed directly to the Installation of Seals section (Pages 25 to 31) after removing the seal. If other parts need replacing, continue the disassembly procedure (see Page 19).

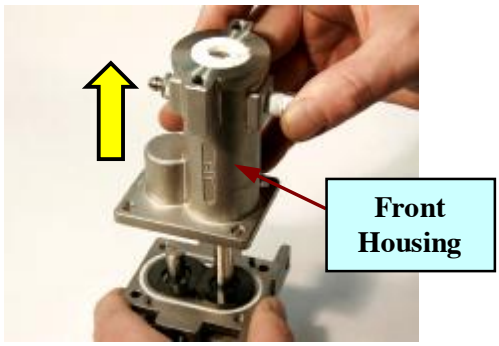
A: **Packing Removal** (Refer to Sectional Drawing #1 – Page 49)

A1 Remove the two screws (16) and separate the gland plate (17) from the pump.

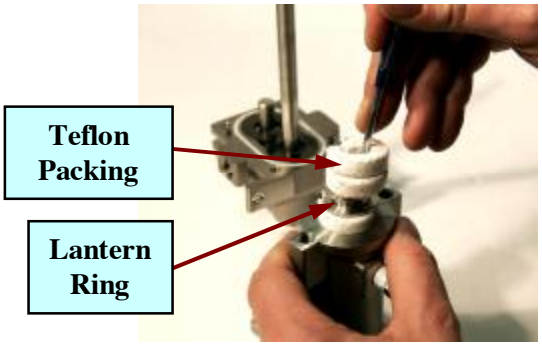


A2 Remove the housing bolts (4).

A3 Lift off the front housing (8), as shown.



A4 Remove the packing (18) and lantern ring (11) from the front housing.



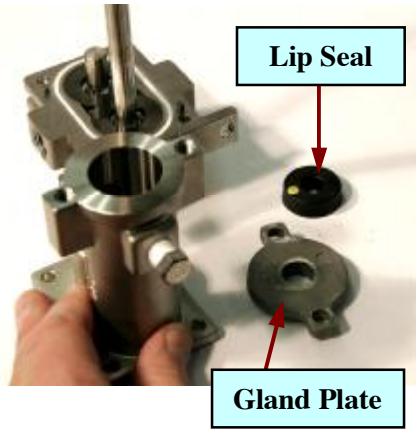
NOTE: The packing and lantern ring can be pulled out using a hooked tool, as shown.

B: **Lip Seal Removal** (Refer to Sectional Drawing #2 – Page 50)

B1 Remove the two screws (16) and separate the gland plate (17) from the pump.

B2 Remove the housing bolts (4) and then lift off the front housing (8) from the center housing (21).

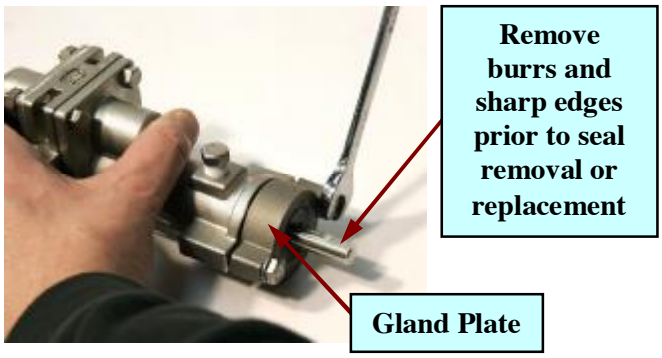
B3 Remove the lip seal (11) from the front housing (8).

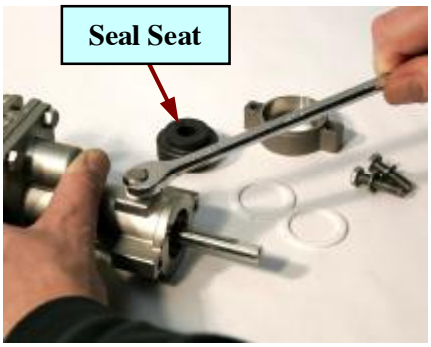


C: Single Internal Mechanical Seal Removal (Refer to Sectional Drawing #3 – Page 51)

C1 Remove the two screws (16) and separate the gland plate (17) and seal seat (24) from the pump. Remove the gaskets (18) from the seal seat and discard.

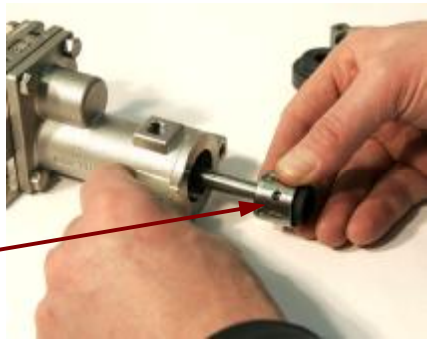
C2 Remove the 1/8" NPT plug (9).





C3 Loosen **all** setscrews on the mechanical seal body (11).

C4 Slide the mechanical seal (11) out of the front housing (8) and remove it from the drive shaft.



NOTE: The setscrews are accessible thru the 1/8" NPT port on the front housing. Rotate the shaft to access the setscrews.

NOTE: Prior to removal or replacement of the seal, be sure to remove any burrs from the end of the drive shaft by polishing the the shaft with very fine sandpaper.

D: External Mechanical Seal Removal (Refer to Sectional Drawing #4 – Page 52)

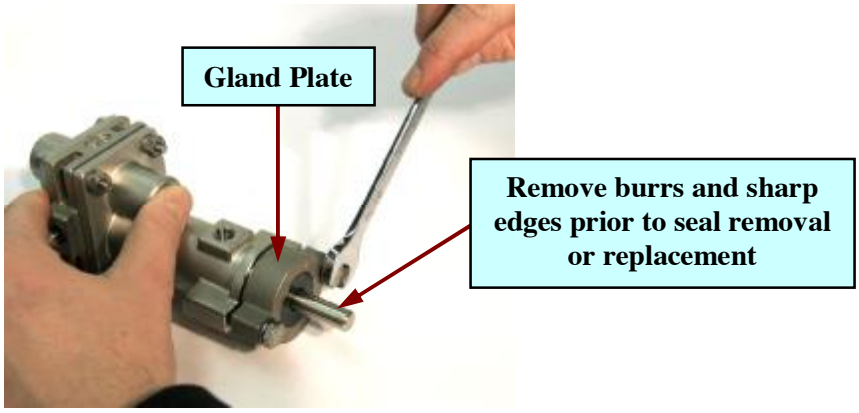
D1 Loosen **all** setscrews on the body of the mechanical seal (11).

D2 Remove the mechanical seal from the drive shaft (20).

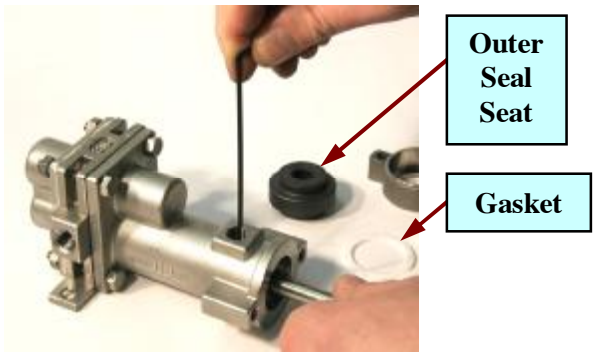
NOTE: Prior to removal or replacement of the seal, be sure to remove any burrs from the end of the drive shaft by polishing the shaft with very fine sandpaper.

E: **Double Mechanical Seal Removal** (Refer to Sectional Drawing #5 – Page 53)

E1 Remove the two screws (16) and separate the gland plate (17) and outer seal seat (24) from the pump. Remove the gaskets (18) from the seal seat and discard.



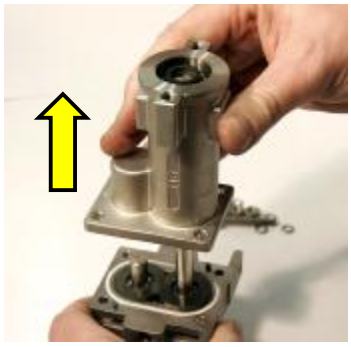
E2 Loosen **all** setscrews on the mechanical seal body (11).



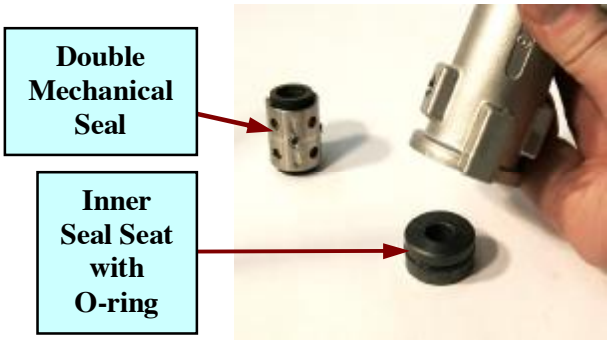
E3 Remove the housing bolts (4).

NOTE: The setscrews are accessible thru the 1/8" NPT port on the front housing. Rotate the drive shaft to access the setscrews.

E4 Remove the double mechanical seal (11) from the drive shaft (20) by lifting off the front housing (8), as shown.



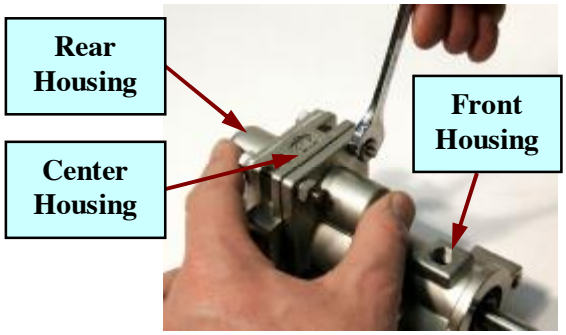
E5 Press out the inner seal seat (25) from the front housing. Discard the seal seat O-ring (26).



NOTE: Prior to removal or replacement of the seal, be sure to remove any burrs from the end of the drive shaft by polishing the shaft with very fine sandpaper.

Disassembly Procedure: (Continued)

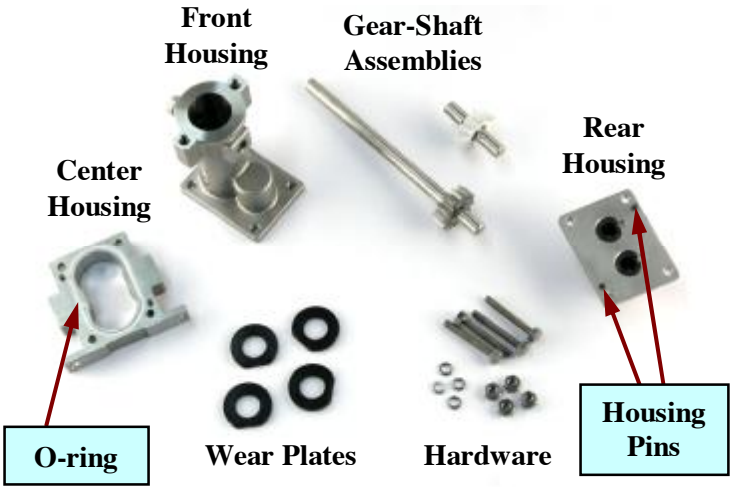
5 If not already done, remove the four housing bolts (4) and separate the front housing (8), center housing (21) and rear housing (2).



---

6 Remove the wear plates (7), housing pins (12) and the drive and idler gear-shaft assemblies. Remove the O-rings (5) from the center housing (21) and discard.

NOTE: Liquiflo Repair Kits come with the gears and shafts preassembled. If you are using a repair kit to rebuild the pump, it is not necessary to separate the gears from the shafts. If this is the case, skip **Step 7** and proceed directly to **Step 8**.

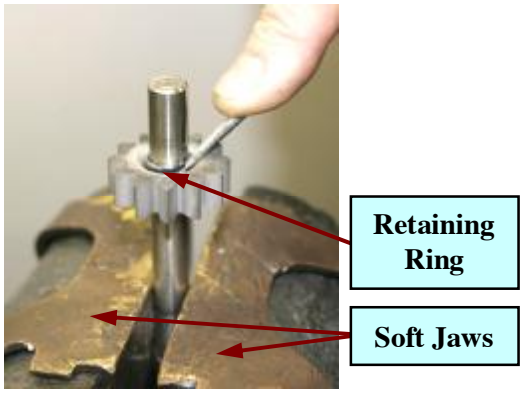


Gear-Shaft Disassembly:

7

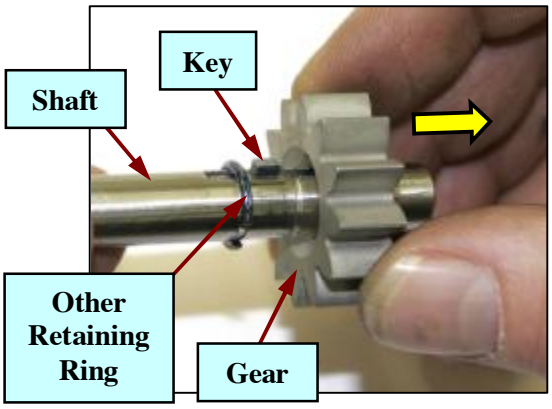
CAUTION! Be careful not to damage the drive and idler shafts.

a. Remove one retaining ring (14) from the shaft (1 or 20).



NOTE: Use special vice jaws made of aluminum, bronze, brass or other soft material so as not to dent or damage the shaft (see photo above).

b. Separate the gear (6 or 22) and key (23B or 23A) from the shaft.



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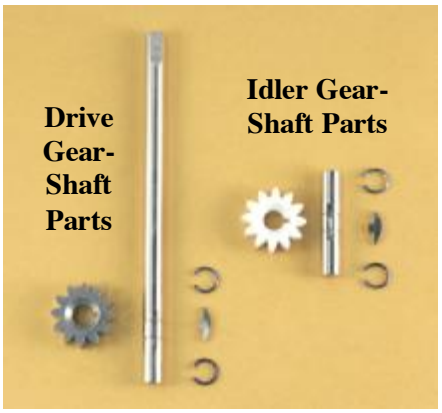
c. Remove the other retaining ring (14) from the shaft.

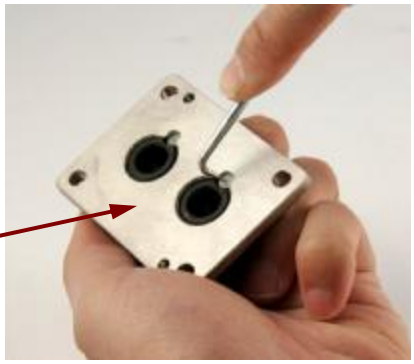
NOTE: One method for removing the retaining ring is shown at right. First bridge the shaft with a close fitting open-end wrench and then strike the wrench handle with a mallet to dislodge the retaining ring from the groove (see photo).



Removal of Bearing Lock Pins:

8 Remove the bearing lock pins (13) from the front and rear housings.

NOTE: If the pins are made of Teflon, a pointed tool can be used to extract them, as shown. If the pins are metallic, the bearings should be removed first (see **Step 9**).

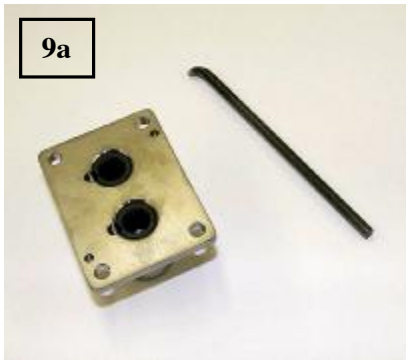


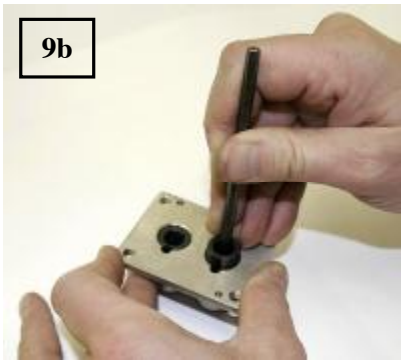
Removal of Bearings:

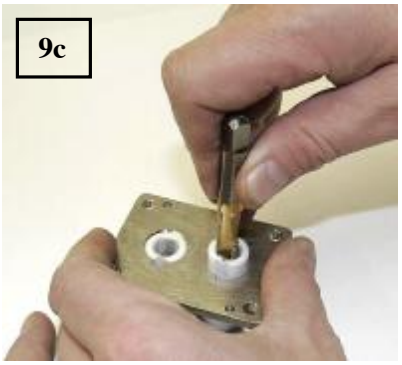
Most bearings for these pumps were designed to have a light press fit into the front and rear housings. Removal is generally accomplished by destroying the bearings. The bearings can be pulled out using a hooked tool (see Photos **9a** and **9b**). Plastic bearings, such as Teflon, can also be extracted by using a tap that is slightly larger than the bearing inner diameter (see Photo **9c**).

9 Remove the bearings (3A and 3B) from the front and rear housings.

CAUTION! Be careful not to damage the housing bores when removing the bearings.







END OF DISASSEMBLY PROCEDURE

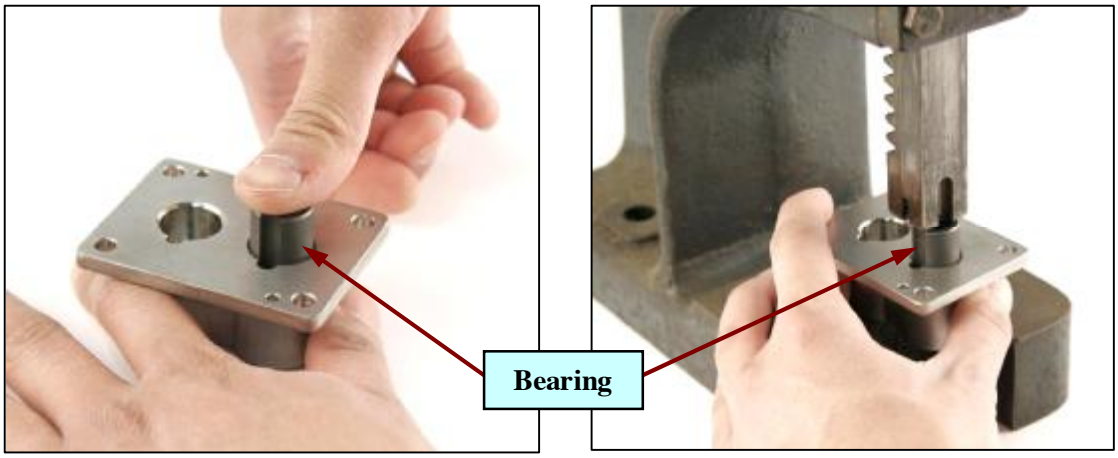
5.4 PUMP ASSEMBLY

Follow the procedure below and refer to the drawings in **Appendix 6**.

Installation of Bearings into Front and Rear Housings:

1 Insert the bearings (3A & 3B) into the housing bores while aligning the grooves for the bearing lock pins.

NOTE: If the bearings have not yet been removed from the front and rear housings, refer to **Step 9** of the disassembly procedure (see Page 20). The bearings normally require a light press fit to insert them into the housings. A mechanical press can be used to facilitate this process (see photos).



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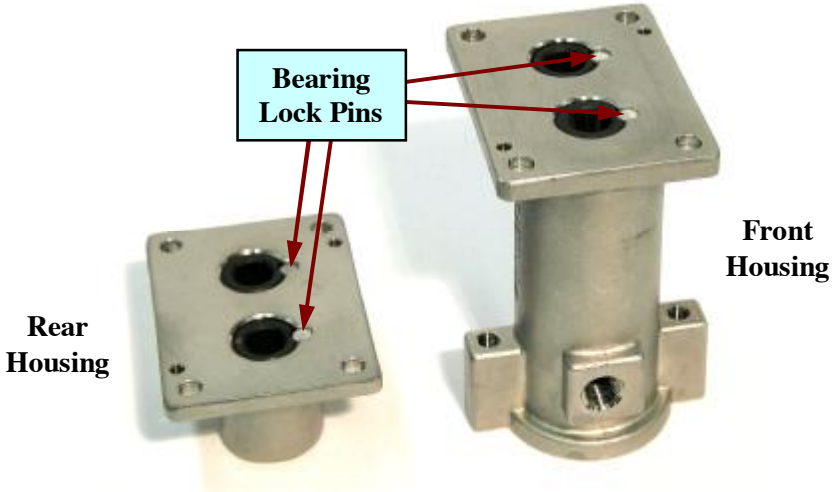
2 Insert the bearing lock pins (13) into the front and rear housings.

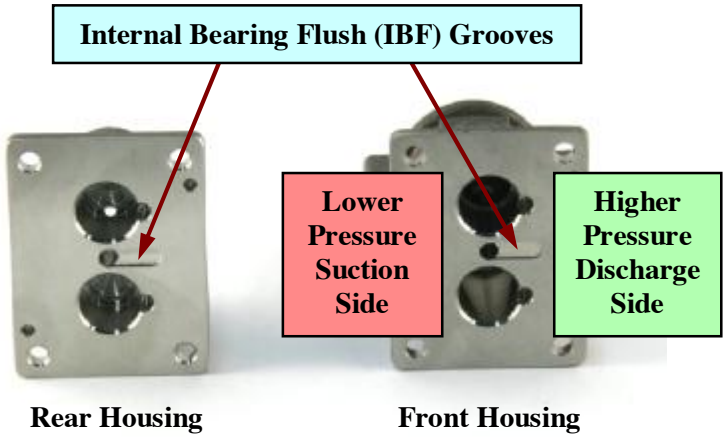
NOTE: The pins serve to prevent the bearings from rotating. They are normally made of Teflon. Metallic pins are available for high temperature applications.



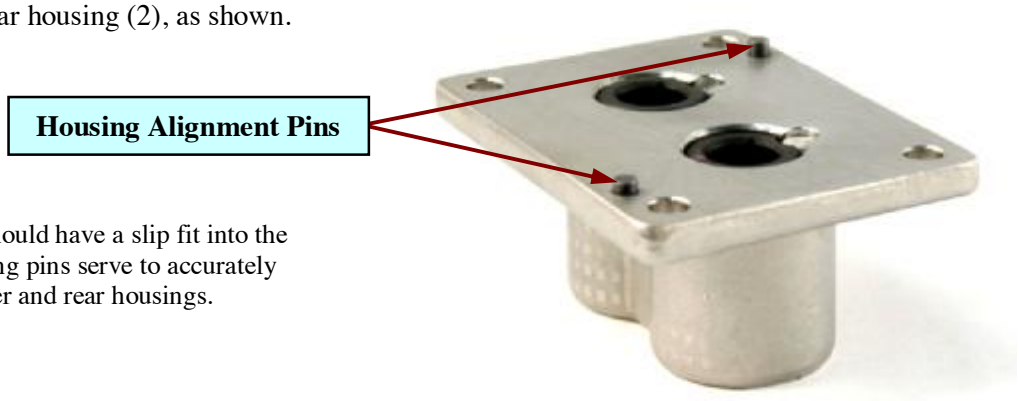
NOTE: Standard housings (i.e., not containing bearing flush grooves) are shown above. Pumps ordered with the Internal Bearing Flush (IBF) option will have modified front and rear housings (see top of Page 22).

Internal Bearing Flush Option

Pumps ordered with the Internal Bearing Flush (IBF) option will have **modified front and rear housings**, as shown at right. The purpose of the IBF option is to more effectively lubricate and cool the bearings when pumping extremely thin or extremely thick liquids. When assembling the pump, the IBF grooves must be oriented on the higher pressure discharge side of the pump.



3 Insert two housing alignment pins (12) into the rear housing (2), as shown.

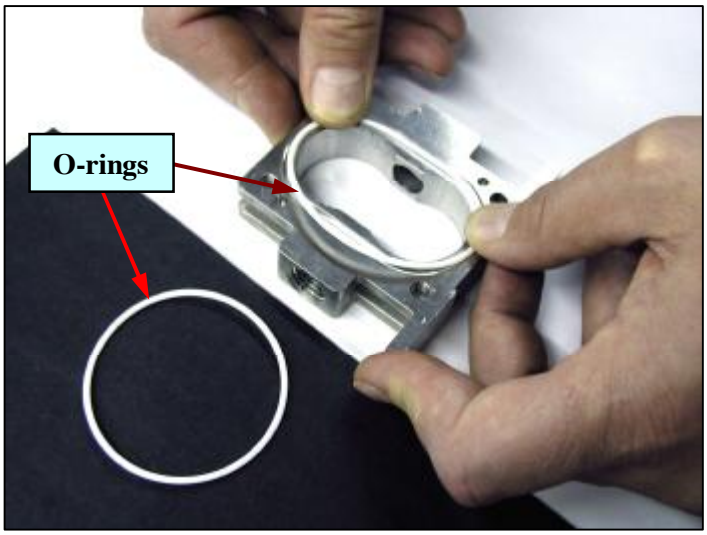


NOTE: The pins should have a slip fit into the housing. The housing pins serve to accurately align the front, center and rear housings.

---

4 Install housing O-rings (5) into the racetrack-shaped grooves of the center housing (21).

CAUTION! Do not reuse O-rings.



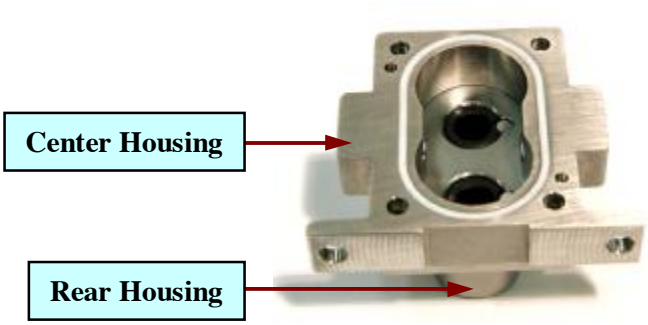
Installation of Wear Plates

Most Liquiflo wear plates are manufactured with cut-outs or grooves to provide liquid relief paths to reduce hydraulically induced gear separation forces that exist during pump operation. These forces decrease pump life by placing significant loads on the shafts and bearings. To be effective, the relief grooves must face toward the gears.

NOTE: Failure to orient the wear plates properly will reduce the operating life of the pump.

5 Place the center housing (21) onto the rear housing (2) with orientation as shown.

NOTE: Make certain the center housing seats properly over the housing alignment pins. If the rear housing has an IBF groove, the groove must face towards the discharge side of the pump (see Page 22).



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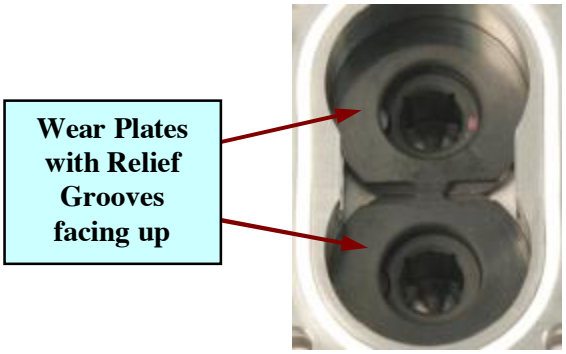
6 Place two wear plates (7) into position, as shown.

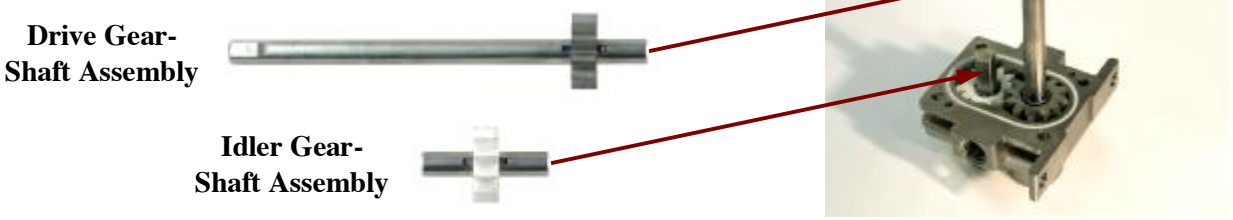
NOTE: If the wear plates are relieved, the cut-outs must face up (see photo). This will orient the relief grooves toward the gears.



---

7 Insert the gear-shaft assemblies into the housing, as shown.

NOTE: Liquiflo Repair Kits contain the gears and shafts preassembled, as shown below. If the gears and shafts are not assembled, see **Appendix 5** for the assembly procedure.



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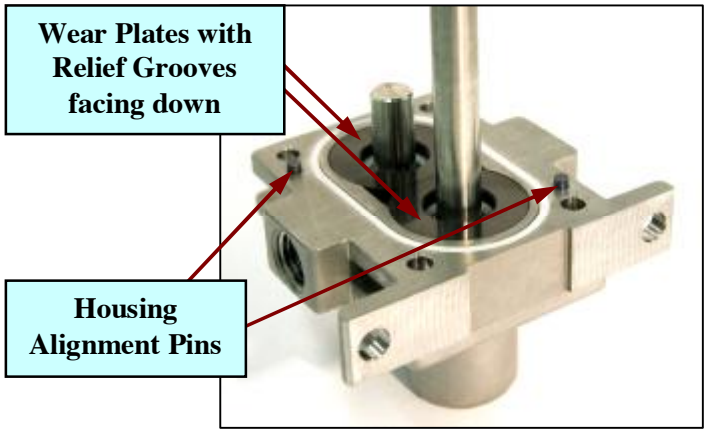
8 Place two wear plates (7) on top of the gears, as shown.

NOTE: If the wear plates are relieved, the cut-outs must face down, toward the gears.



9 Insert two housing alignment pins (12) into the center housing.

NOTE: Perform **Step 10** only if the pump will be assembled with a double mechanical seal. For all other seal types, proceed directly to **Step 11**.

Installation of Inboard Seal Seat (Double Mechanical Seal Only):

10 **a.** Install the seal seat O-ring (26) onto the seal seat (25); then lubricate the outside surface of the O-ring.

NOTE: Use a lubricant that is compatible with the elastomer and the fluid that will be pumped. This will ease installation of the seal seat into the front housing.

CAUTION! Do not reuse O-rings.

---

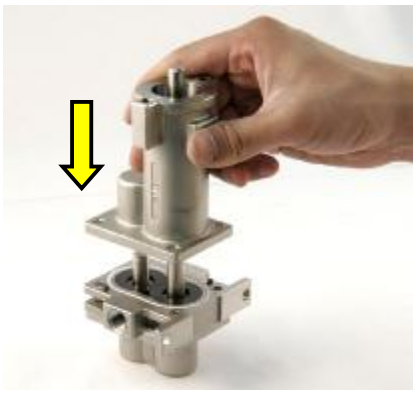
b. Insert the inner seal seat (25) into the front housing (8).

c. Press the seal seat firmly into the bottom of the housing.

NOTE: The lapped (polished) surface of the seal seat must be directed upwards. Depending on the pump model, seal seats may be lapped on one or both sides.

---

11 Install the front housing (8) to the center-rear housing, as shown.



NOTE: Be certain the front housing seats properly over the housing alignment pins in the center housing. If the pump has an IBF option, the IBF grooves in the front and rear housings must be oriented on the discharge side of the pump (see top of Page 22).

---

12 Attach the housings together using four sets of bolts (4), nuts (10) and lockwashers (15).

NOTE: Apply anti-seize compound to the bolts. Refer to **Appendix 1** for the torque specifications of the fasteners. When tightening the bolts, use a star pattern torque sequence on the fasteners to ensure even compression on the O-ring's surface. With Teflon O-rings, repeat this process several times, waiting between retightening. This is necessary because the Teflon will cold flow and require a certain amount of time to properly seat. Continue the process until the bolts no longer require retightening.

---

13 Turn the drive shaft by hand to ensure that the gears will rotate freely inside the housing.

INSTALLATION OF SEALS:

14 The pump can have any one of five different types of seals. Install the appropriate seal by referring to the applicable section given in the table below:

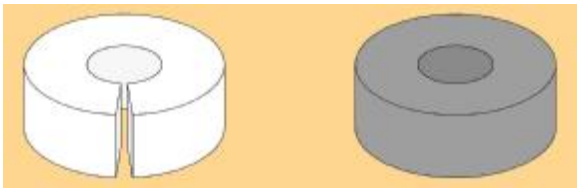
Section	Seal Installation	Page #(s)	Reference Drawing	Page #
A	Packing Seal	26	Sectional #1	49
B	Lip Seal	27	Sectional #2	50
C	Single Internal Mechanical Seal	28-29	Sectional #3	51
D	External Mechanical Seal	30	Sectional #4	52
E	Double Mechanical Seal	31	Sectional #5	53

A: **Packing Installation** (Refer to Sectional Drawing #1 – Page 49)

Packing

The "stuffing box" section of the pump's front housing requires five rings of packing and a lantern ring, positioned as shown in Sectional Drawing #1. The lantern ring allows grease or flush fluid to enter the pump and lubricate the packing. The standard packing material is braided Teflon, which is suitable for application temperatures up to 350°F. Above 350°F, Graphoil packing should be used.

The Teflon packing used in Liquiflo pumps has a split-ring design. Adjacent rings should be staggered by 180° to increase performance and minimize leakage. Graphoil packing has a solid-ring design and therefore does not require staggering.

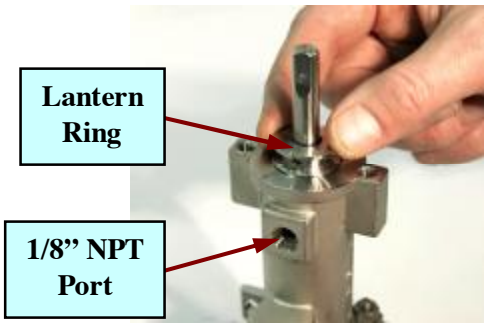


Teflon Packing Ring **Graphoil Packing Ring**

A1 Insert the first three packing rings (18) into the front housing (8).

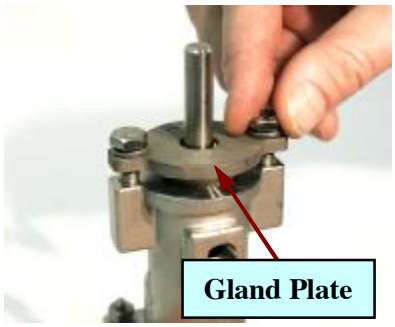
NOTE: Be sure to stagger the splits in adjacent rings 180° apart.

A2 Install the lantern ring (11).



NOTE: After installation, the lantern ring should be visible thru the 1/8" NPT ports.

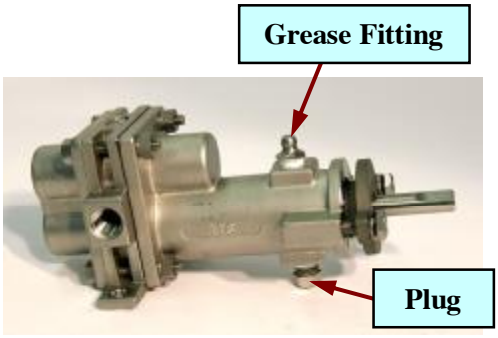
A3 Install the two remaining packing rings (18); then install the gland plate (17) using the gland screws (16). Tighten the screws by hand.



CAUTION! Do not overtighten the gland screws. Tighten by hand only.

NOTE: Stagger the splits in the rings by 180°. The compression of the packing must be adjusted during pump operation (see **Appendix 4**).

A4 Install the grease fitting (24) and plug (9) into the front housing.



Pump with Packing Seal

NOTE: Apply Teflon tape to the threads of the fitting and plug to prevent leakage.

B: Lip Seal Installation (Refer to Sectional Drawing #2 – Page 50)

B1 Place the lip seal (11) on the drive shaft with the flat surface facing up.

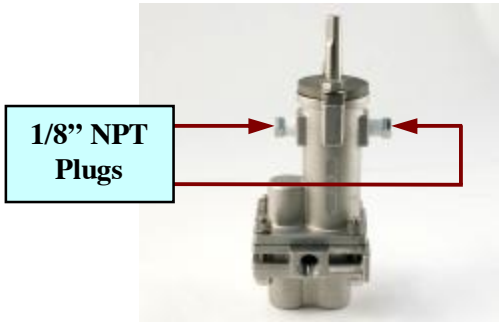
B2 Press the lip seal into the front housing, as shown.

NOTE: The top surface of the seal should be slightly below the top surface of the front housing.

B3 Install the gland plate (17) using the gland screws (16) and lockwashers (19).

NOTE: See **Appendix 1** for the torque specifications of the gland screws.

B4 Install the plugs (9) into the front housing.



NOTE: Apply Teflon tape to the threads of the plugs to prevent leakage.

Precautions for Installation of Mechanical Seals (Applicable to Sections C, D & E)

1 If the drive shaft exhibits excessive wear, the shaft must be replaced.

2 Remove all burrs and setscrew marks from the drive shaft before installing the mechanical seal. This will prevent damaging the seal wedge during installation of the seal. Damage to the seal wedge can cause the seal to leak.

3 Do not scratch or handle the lapped face of the seal.

4 A new mechanical seal is supplied with retaining clips covered by tape. The clips compress the seal springs, eliminating spring pressure on the seal wedge. To ease installation and prevent damaging the wedge, do not remove the clips until after the seal is installed on the shaft. Once the clips are removed, the spring pressure will cause the wedge to seal against the shaft.

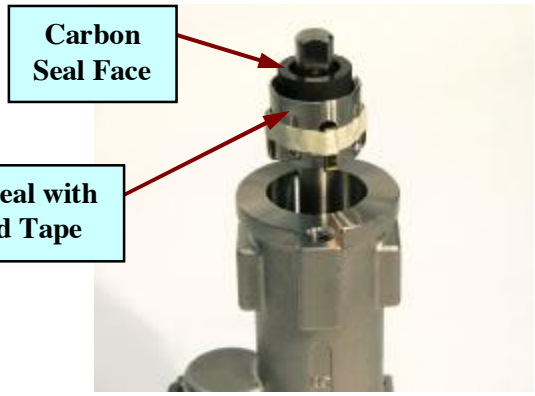
5 Do not reuse seal seat gaskets or O-rings.

C: Single Internal Mechanical Seal Installation (Refer to Sectional Drawing #3 – Page 51)

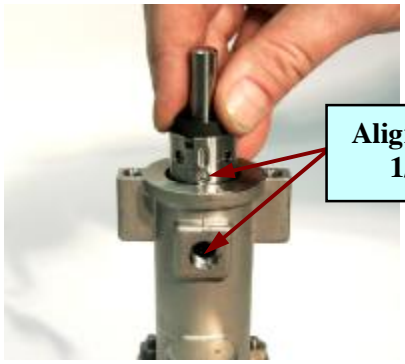
C1

CAUTION! Remove all burrs and setscrew marks from the drive shaft prior to installation of the mechanical seal. Do not remove the retaining clips from the seal until after the seal is installed on the shaft.

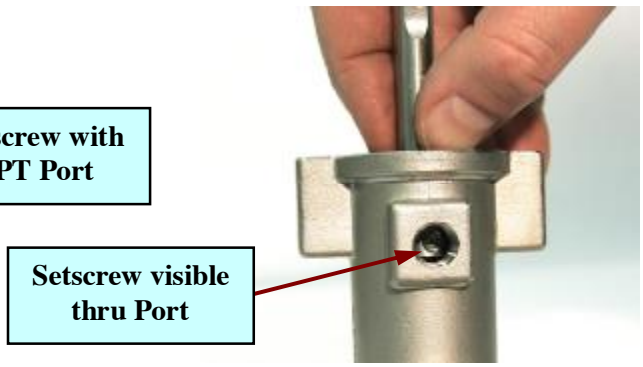
Slide the mechanical seal (11) on the drive shaft (20) with the seal face directed away from the housing, as shown.



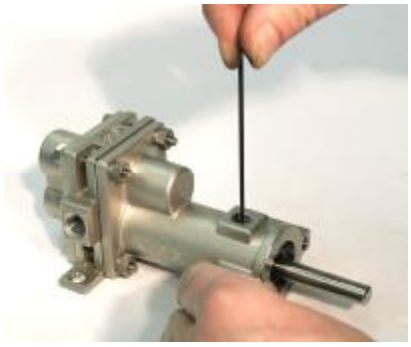
C2 Remove the tape and retaining clips; then orient the seal body as shown.



C3 Push the seal into the housing until the setscrew is visible thru the 1/8" NPT port.

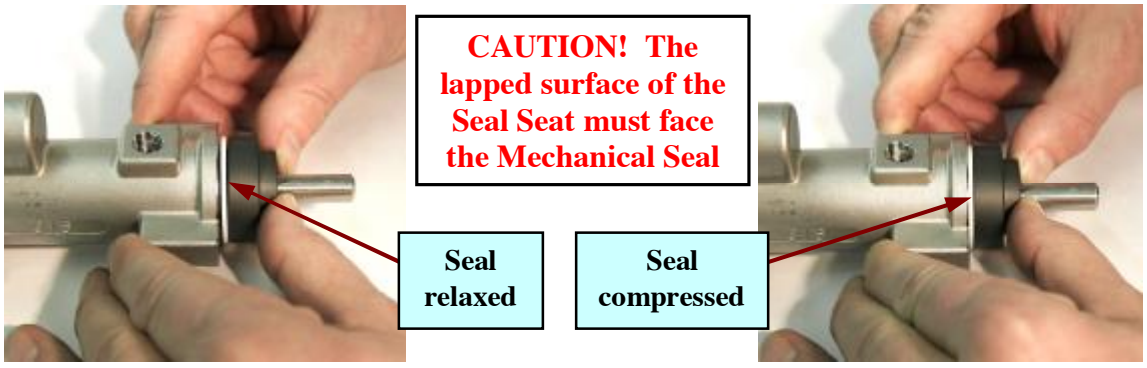


C4 Lightly tighten the setscrew on the body of the mechanical seal.



C5 Install one seal seat gasket (18) on the lapped side of the seal seat (24).

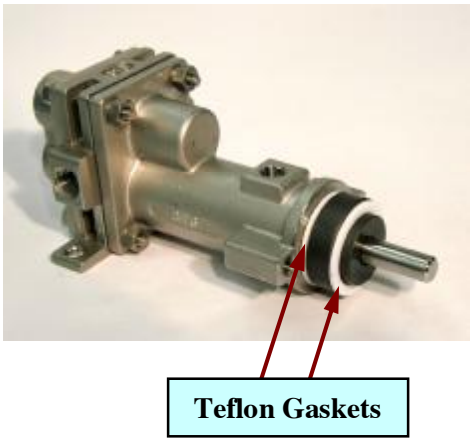
C6 Slide the seal seat (with gasket installed) on the drive shaft, as shown; then test the compression of the seal by pushing the seal seat face against the mechanical seal face. The proper compression gap is 1/16" (1.6 mm). If necessary, reposition the mechanical seal on the shaft to set the compression distance to the proper value.



C7 Once the position of the mechanical seal is properly set, tighten **all** setscrews on the seal body.

NOTE: Rotate the shaft in steps to access each setscrew thru the 1/8" NPT port on the front housing.

C8 Install the other gasket (18) on the outside face of the seal seat (24).



C9 Install the gland plate (17) using the gland screws (16) and lockwashers (19).

NOTE: See **Appendix 1** for the torque specifications of the gland screws.

C10 Install the two 1/8" NPT plugs (9).

NOTE: Apply Teflon tape to the threads of the plugs to prevent leakage.

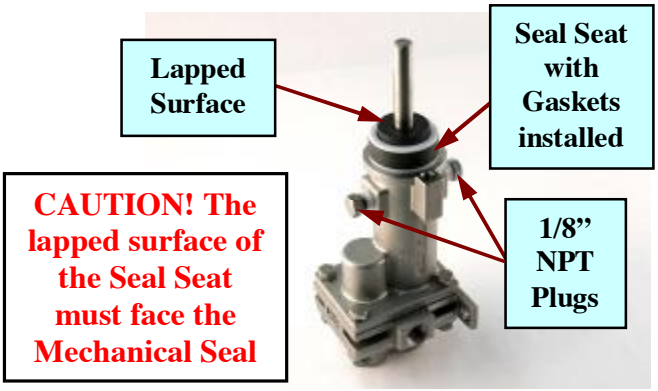
D: External Mechanical Seal Installation (Refer to Sectional Drawing #4 – Page 52)

D1 Install the 1/8" NPT plugs (9) into the front housing (8).

D2 Install the seal seat gaskets (18) on the seal seat (24).

D3 Install the seal seat onto the front housing with the lapped surface facing up.

NOTE: Apply Tefon tape to the threads of the plugs to prevent leakage.



CAUTION! The lapped surface of the Seal Seat must face the Mechanical Seal

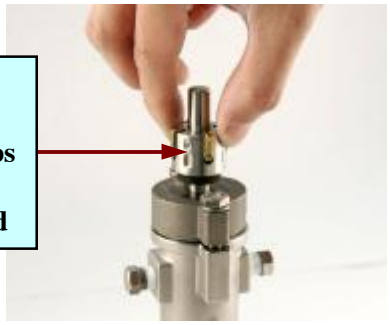
---

CAUTION! Remove all burrs and setscrew marks from the drive shaft prior to installation of the mechanical seal. Do not remove the retaining clips from the seal until after the seal is installed on the shaft.

D4 Install the gland plate (17) to the front housing (8) using the gland screws (16) and lockwashers (19).

NOTE: See **Appendix 1** for the torque specifications of the gland screws.

D5 Slide the mechanical seal (11) on the drive shaft (20).



NOTE: The seal face of the mechanical seal must face towards the seal seat.

D6 Remove the retaining clips from the seal. Compress the mechanical seal face against the seal seat face by 1/16" (1.6 mm) and then tighten **all** setscrews on the body of the seal.

NOTE: Do not remove the compression force until all of the setscrews have been tightened.

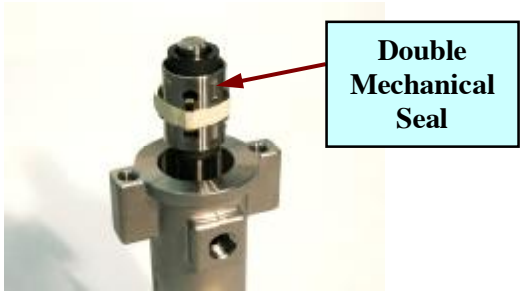
Pump with External Mechanical Seal

E: **Double Mechanical Seal Installation** (Refer to Sectional Drawing #5 – Page 53)

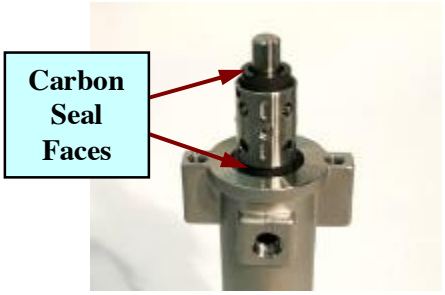
E1 If not previously done, install the inboard seal seat (25) with O-ring (26) into the front housing. (See **Step 10** of the Pump Assembly procedure on Page 24.)

CAUTION! Remove all burrs and setscrew marks from the drive shaft prior to installation of the mechanical seal. Do not remove the retaining clips from the seal until after the seal is installed on the shaft.

E2 Slide the double mechanical seal (11) on the drive shaft (20).

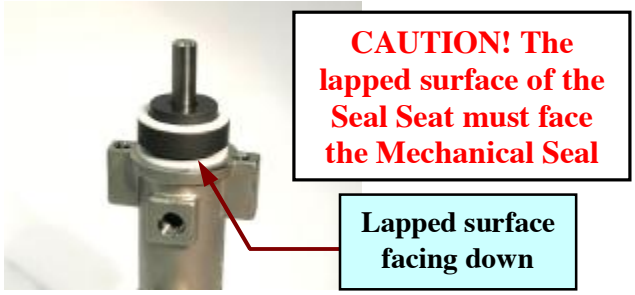


E3 Remove the tape and retaining clips from the mechanical seal.



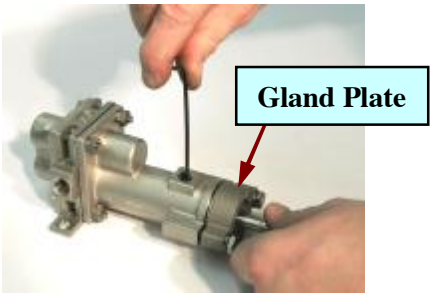
NOTE: Because the double mechanical seal is symmetrical, the seal faces can be oriented either way.

E4 Slide the mechanical seal into the front housing (8); then install the outboard seal seat (24) with gaskets (18).



NOTE: The double mechanical seal will self-position once the gland plate is installed.

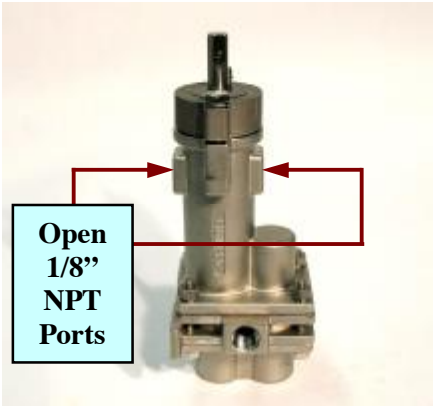
E5 Install the gland plate (17) using the gland hardware (16 & 19); then tighten **all** seal setscrews.



NOTE: See **Appendix 1** for the torque specifications of the gland screws.

NOTE: The 1/8" NPT ports must be connected to the *barrier fluid lubrication system* for supporting the double mechanical seal during pump operation (see **Appendix 4**).

CAUTION! Failure to properly support the double mechanical seal will result in premature seal wear and leakage.



END OF ASSEMBLY PROCEDURE

5.5 CLOSE-COUPLED CONFIGURATION

Liquiflo sealed pumps are also available in a Close-Coupled (CC) configuration. These pumps offer several advantages over long-coupled sealed pumps. Close-coupled pumps are inherently self-aligning. This feature simplifies installation and eliminates the maintenance issues caused by misalignment of the pump and motor. In addition, the pump and motor are both supported by a sturdy Cast Iron pedestal and the pump is dimensionally interchangeable with Liquiflo mag-drive pumps (see **Appendix 6**, Page 57).

The Close-Coupled sealed pumps are compatible with several NEMA and IEC motor frames (see Table 5, Page 6) and are available with either packing or mechanical seals (single, double or external).

5.5.1 Disassembly Procedure – Close-Coupled Configuration with Single Mechanical Seal

NOTE: Refer to Exploded View Drawing #2 on Page 55.

1 Unbolt the front housing (8) from the pedestal (34).

2 Remove the pump module.

3 Remove the coupling flange (37) from the shaft (20).

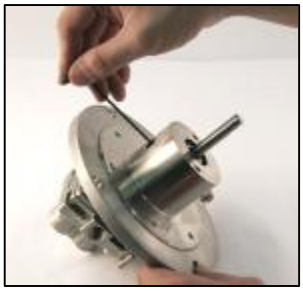
4 Remove the gland plate (17).

5 Remove the seal seat (24) and gaskets (18).

6 Remove one 1/8" NPT plug (9).

NOTE: Remove any burrs or scratches from the end of the drive shaft prior to removing the mechanical seal.

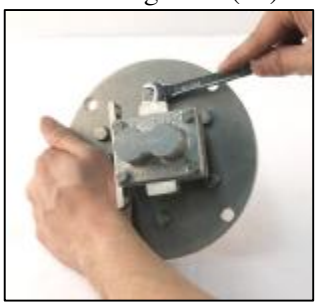
7 Loosen **all** setscrews on body of seal (11).



8 Slide out the mechanical seal.

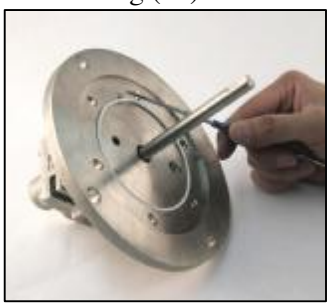
9 Remove the seal from the drive shaft.

10 Remove the six seal housing bolts (29).

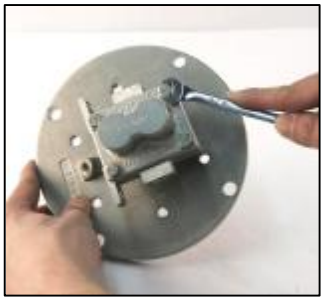


11 Remove the seal housing (28).

12 Remove the seal housing O-ring (27) and discard.



13 Remove the four housing bolts (4).



14 Remove the front housing (8).

15 Remove the center and rear housings (21 & 2).

16 Separate the wear plates (7), housing pins (12) and gear-shaft assemblies.

17 Remove the O-rings (5) from the center housing and discard.

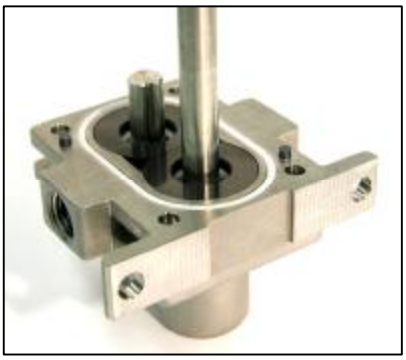
NOTE: To separate the gears from the shafts or to remove the bearings and bearing lock pins from the front and rear housings, see Pages 19 & 20.

5.5.2 Assembly Procedure – Close-Coupled Configuration with Single Mechanical Seal

NOTE: Observe the Precautions for Installation of Mechanical Seals given on Page 27. Refer to Exploded View Drawing #2 on Page 55.

1 Perform **Steps 1** to **9** of **Section 5.4** to assemble the section of the pump that is shown at right.

Assembly of rear and center housings, O-rings, bearings, bearing lock pins, wear plates, housing alignment pins and gear-shaft assemblies



2 Install the front housing (8).

NOTE: Be certain the front housing seats properly over the housing pins.

3 Install the housing hardware (4, 10 and 15) and fasten.

NOTE: See Note in **Step 12**, Page 25.

4 Rotate the drive shaft (20).

NOTE: The gears should rotate freely inside the housing.

---

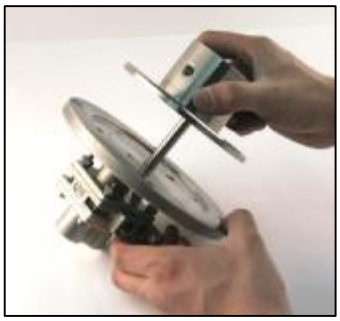
5 Install the seal housing O-ring (27).

CAUTION! Do not reuse O-rings.

6 Install one 1/8" NPT plug (9) into the seal housing (28).

NOTE: Apply Teflon tape to the threads of the plug to prevent leakage.

7 Install the seal housing (28) on the front housing (8).



NOTE: The seal housing should mate freely with the front housing.

CAUTION! To prevent damaging the seal wedge, remove any burrs or scratches on the end of the drive shaft before installing the mechanical seal. Damage to the wedge can cause leakage.

8 Install the seal housing hardware (29 & 30).

9 Fasten the seal housing bolts (29).

NOTE: See Note in **Step 12**, Page 25.

10 Install the single mechanical seal (11).

NOTE: Do not remove the seal retaining clips until after the seal is installed on the drive shaft.

---

11 Remove the seal retaining clips and push the seal inside the seal housing.

NOTE: The setscrew on the seal body should be visible thru the 1/8" NPT port.

12 Lightly tighten the setscrew and then install the seal seat (24) with gaskets (18).

CAUTION! The lapped surface of the Seal Seat must face down.

13 Measure the compression gap of the seal. The gap should be 1/16" (1.6 mm).

NOTE: If necessary, loosen the setscrew and reposition the seal to the proper compression gap.

---

14 Tighten **all** setscrews on the body of the seal.

NOTE: Rotate the shaft in steps to access each setscrew thru the 1/8" NPT port.

15 Install the gland plate (17) using the gland screws (16) and lockwashers (19).

NOTE: Refer to **Appendix 1** for the torque specifications of the gland screws.

16 Install the other 1/8" NPT plug (9) into the seal housing (28).

NOTE: Apply Teflon tape to the threads of the plug to prevent leakage.

---

17 Install the drain plug (9) into the front housing (8).

NOTE: Apply Teflon tape to the threads of the plug to prevent leakage.

18 Install the coupling flange (37) so that the end of the flange is flush with the end of the drive shaft; then lightly tighten the setscrew on the **flat part of the shaft**.

NOTE: Only tighten one setscrew on the flat part of the shaft. If the coupling has a second setscrew, it should not be tightened. This will prevent damaging the round part of the shaft.

---

19 Remove the door (35) from the pedestal (34).

NOTE: The door is secured to the pedestal with two bolts on opposite sides.

20 Install the motor coupling flange and insert (37 & 38).

NOTE: Do not tighten the coupling setscrew at this time.

21 Install the pump module to the pedestal.

NOTE: Ensure that the pump coupling flange mates with the flexible insert.

---

22 Attach the front housing to the pedestal using the mounting hardware (31, 32 & 33).

23 Loosen the setscrew on the pump coupling flange and then adjust the position of both flanges so that the flexible insert is free to move axially – a distance of about 1/16 to 1/8 inches.

CAUTION! After the coupling setscrews are tightened, be certain the flexible coupling insert is free to move or axial loads will be applied to the pump during operation, causing premature pump failure.

NOTE: Refer to **Appendix 1** for the torque specifications of the fasteners.

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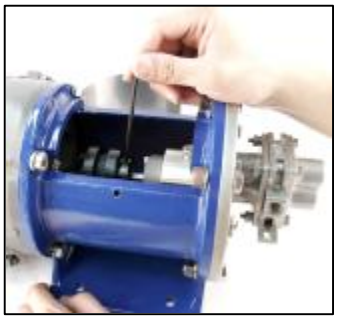
24 Tighten the pump and motor coupling setscrews.



NOTE: Tighten only the setscrew on the **flat part of the pump shaft**.

25 Reattach the door to the pedestal using two bolts (36).

NOTE: Refer to **Appendix 1** for the torque specifications of the fasteners.

Sealed Pump with Single Internal Mechanical Seal, Close-Coupled to Motor

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END OF ASSEMBLY PROCEDURE

NOTE: For the disassembly and assembly of Close-Coupled pumps having other types of seals, refer to Exploded View Drawing #2 on page 55.

Appendix 1: Fastener Torque Specifications

Maximum Torque Specifications for 18-8 Stainless Steel Bolts

Function	Pump Models	Bolt Size	Bolt Type	Qty. (per Pump)	Max Torque Specifications	
					(in-lbs)	(N-m)
Housing Assembly	H1F & H3F 31F & 33F	10-32 UNF x 1 ½	HHCS	4	31	3.5
	H5R & H5F 35R & 35F	10-32 UNF x 1.80	HHCS	4	31	3.5
	H7N & H7R 37R	1/4-20 UNC x 2 ¼	HHCS	4	75	8.5
	H7F 37F	1/4-20 UNC x 2 ½	HHCS	4	75	8.5
	H9R 39R	1/4-20 UNC x 3	HHCS	4	75	8.5
	H9F 39F & 311F	1/4-20 UNC x 3 ¾	HHCS	4	75	8.5
Gland Plate Assembly	H1F - H9F 31F - 39F & 311F	1/4-28 UNF x 1*	HHCS	2	94	10.6
ADDITIONAL BOLTS for SEALED PUMPS with CLOSE-COUPLED CONFIGURATION						
Seal Housing Assembly	H1F - H9F 31F - 39F & 311F	1/4-28 UNF x 5/8	HHCS	6	94	10.6
Pedestal Door Assembly	H1F - H9F 31F - 39F & 311F	10-32 UNF x 5/8	HHCS	2	31	3.5
Pump-Pedestal Assembly	H1F - H9F 31F - 39F & 311F	3/8-16 UNC x 1 ¼	HHCS	4	236	26.7
Motor[1]-Pedestal Assembly	H1F - H9F 31F - 39F & 311F	3/8-16 UNC x 1	HHCS	4	236	26.7
Motor[2]-Adapter Assembly	H1F - H9F 31F - 39F & 311F	1/2-13 UNC x 1	SHCS	4	517	58.4
Adapter[2]-Pedestal Assembly	H1F - H9F 31F - 39F & 311F	3/8-16 UNC x 1	HHCS	4	236	26.7

* Bolt length is 3/4" for pumps with a Packing Seal and 5/8" for pumps with a Lip Seal.

[1] NEMA 56C, 56HC, 143TC & 145TC motor frames
[2] NEMA 182TC & 184TC motor frames

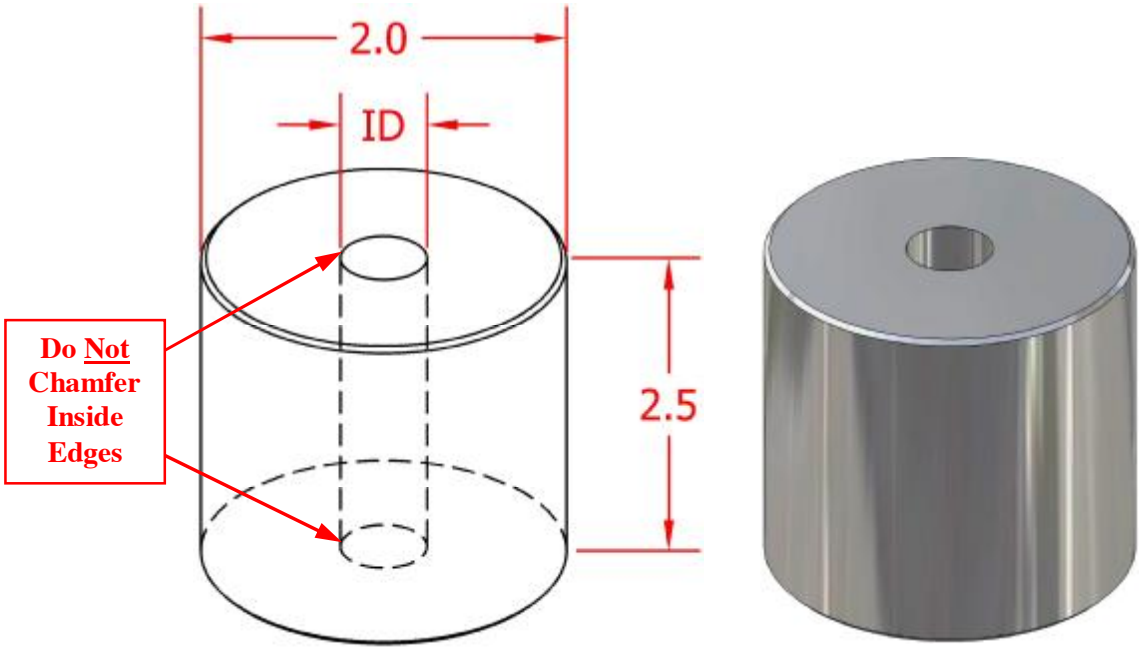
HHCS = Hex Head Cap Screw
SHCS = Socket Head Cap Screw

Appendix 2: Retaining Ring Tool Specifications

The following tool is recommended for the efficient and safe installation or removal of the retaining rings used in the pump. It should be manufactured from a hard material, such as steel.

Tool Dimensional Specifications (inches)

Tool #	For Pump Models	ID	ID Tolerance
1	**H1F & H3F; 31F thru 35F**	.378	+/- .001
2	**H5R & H5F; 37R, 37F & 311F**	.503	+/- .001
3	**H7N thru H9F; 39R & 39F**	.628	+/- .001



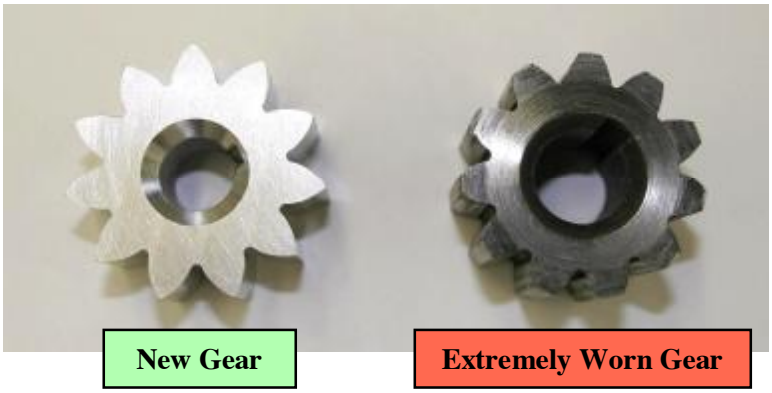
NOTE: The retaining ring tool is especially useful when assembling the gears on the drive and idler shafts (see **Appendix 5**).

Appendix 3: Wear Allowances

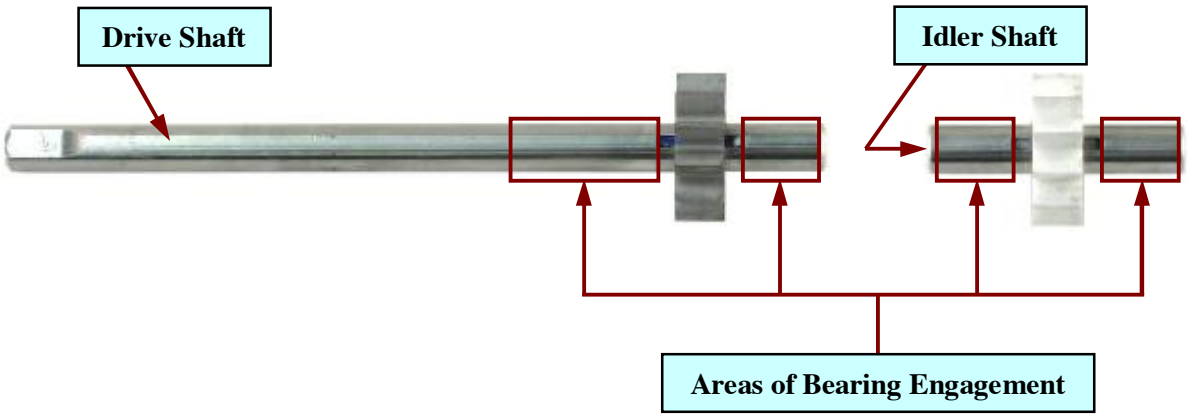
When a pump requires maintenance, a convenient way to restore the pump to like-new condition is to use a repair kit. The repair kit contains all *internal wear parts* as well as O-rings, retaining rings, bearing lock pins, housing alignment pins and keys.

In some cases, only certain parts may need to be replaced. The primary wear parts of the pump are the gears, shafts, wear plates and bearings. The center housing (secondary wear part) may also incur physical wear by contact with the gears caused by excessively worn bearings. (Note: the center housing is not included in a standard repair kit.) These wear parts can be reused if they are in acceptable condition. O-rings and retaining rings should not be reused. The following used parts should be inspected and evaluated for reuse based on the specifications given in the **Wear Allowances Chart** (see Page 41):

Gears: Spur gears should have a uniform tooth profile on both the leading and trailing edges. If the outer diameter of the gear is worn, pumping performance will degrade. Gears with minor wear should be evaluated for reuse by measuring the outer diameter and comparing it to the minimum diameter specification given in the Wear Allowances Chart. Gears with obvious major wear, such as flattened teeth or other significant wear on the profile, should be replaced (see photo below).

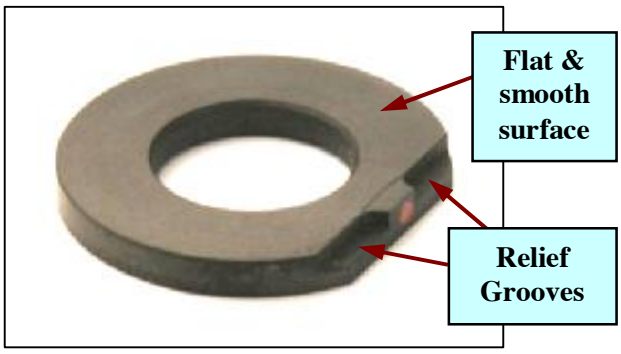


Shafts: The area of the shaft that is engaged in the bearings will wear over time depending on the service conditions and materials of construction (see photos below). Hard-coated shafts are available to minimize or eliminate wear of the shaft surfaces. Worn shafts may allow the gears to contact the center housing and accelerate both gear and center housing wear. The shaft bearing-engagement areas should be round and have minimum diameter as specified in the Wear Allowances Chart.



Appendix 3: Wear Allowances (Continued)

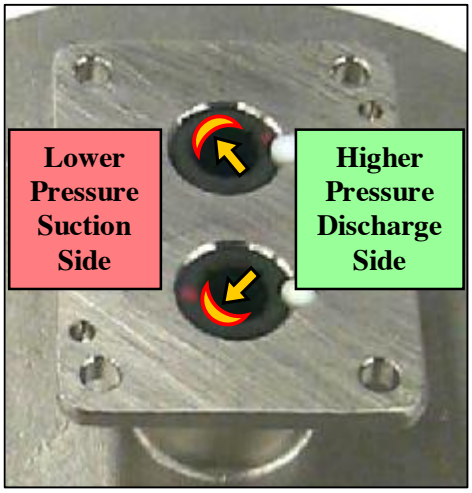
Wear Plates: This is a sacrificial part of the pump designed to protect the front and rear housings from wear by continual contact with the sides of the gears. Erosion of the wear plates increase clearances causing slip to increase. This results in a reduction in pump performance. Wear plates should have smooth surfaces and meet the minimum thickness requirements given in the Wear Allowances Chart. (Note: Most Liquiflo wear plates are manufactured with cut-outs or relief grooves to minimize hydraulically induced gear separation forces during pumping. These *relieved wear plates* increase pump life by reducing loads on bearings and shafts. A typical relieved wear plate is shown below.)



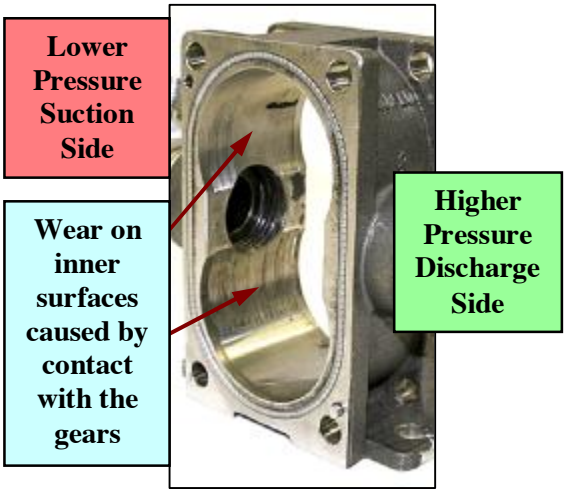
Typical Relieved Wear Plate

Measuring Wear Plate Thickness

Bearings: The H-Series and 3-Series pumps use sleeve-type bearings that are also known as *journal bearings*. These bearings are designed to support the shafts and precisely position the gears inside the housing. Worn bearings will eventually allow the rotating gears to contact the center housing, causing wear and eventual failure of both of these components. (See photo at below left for the typical wear pattern of the bearings.) If any wear of the bearings is observed, they should be replaced. The Wear Allowances Chart gives the maximum inner diameter that is acceptable for worn bearings.



Typical Wear Pattern of Bearings



Typical Wear Pattern of Center Housing

Center Housing: The typical failure mode for the center housing is from contact with the rotating gears, caused by extreme wear of the bearings and shafts. Evidence of contact or slight wear on the inside surfaces can be expected. However, if deep grooves or excessive wear is observed, the center housing should be replaced. (See photo at above right for the typical wear pattern of the center housing.) Reusing a worn center housing will cause pump performance to be lower than expected because of increased slip.

Appendix 3: Wear Allowances (Continued)

Wear Allowances Chart (Units: inches)

Pump Series	Pump Model	Gears		Shafts		Wear Plates		Bearings	
		Nom. O.D.	Min O.D.	Nom. O.D.	Min O.D.	Nom. Thick.	Min Thick.	Nom. I.D.	Max I.D.
H-Series	H1F	1.163	1.158	0.375	0.373	0.250	0.247	0.375	0.378
	H3F	1.163	1.158	0.375	0.373	0.125	0.122	0.375	0.378
	H5R	1.163	1.158	0.500	0.498	0.250	0.247	0.500	0.503
	H5F	1.163	1.158	0.500	0.498	0.125	0.122	0.500	0.503
	H7N	1.711	1.705	0.625	0.623	0.312	0.309	0.625	0.628
	H7R	1.711	1.705	0.625	0.623	0.125	0.122	0.625	0.628
	H7F	1.711	1.705	0.625	0.623	0.125	0.122	0.625	0.628
	H9R	1.711	1.705	0.625	0.623	0.125	0.122	0.625	0.628
	H9F	1.711	1.705	0.625	0.623	0.125	0.122	0.625	0.628
3-Series	31F	1.163	1.158	0.375	0.373	0.250	0.247	0.375	0.378
	33F	1.163	1.158	0.375	0.373	0.125	0.122	0.375	0.378
	35R	1.163	1.158	0.375	0.373	0.250	0.247	0.375	0.378
	35F	1.163	1.158	0.375	0.373	0.125	0.122	0.375	0.378
	37R	1.711	1.705	0.500	0.498	0.125	0.122	0.500	0.503
	37F	1.711	1.705	0.500	0.498	0.125	0.122	0.500	0.503
	39R	1.711	1.705	0.625	0.623	0.125	0.122	0.625	0.628
	39F	1.711	1.705	0.625	0.623	0.125	0.122	0.625	0.628
	311F	1.711	1.705	0.500	0.498	0.125	0.122	0.500	0.503

O.D. = Outer Diameter **I.D.** = Inner Diameter

NOTES:

1 Pump models that are not highlighted in the above table have gears with an even number of teeth. The diameter for these gears is measured from the tip of one tooth to the tip of the opposite tooth (see **Photo 1**). This measurement method gives the true diameter of the gears.

2 Pump models that are highlighted in the above table have gears with an odd number of teeth. Because no two teeth have tips that coincide with the actual gear diameter, this makes the true gear diameter difficult to measure. A practical field method for determining gear wear is to measure the "three-point diameter" of the gear. That is, place one jaw of the caliper on the tip of one tooth and the other jaw on the tips of both opposite teeth and record the distance (see **Photo 2**). The highlighted diameter values are based on this measurement method and are less than the true gear diameters. (For the true nominal gear diameters, see the chart on Page 46.)

3 All diameter values listed in the above table are based on standard (untrimmed) parts. Parts requiring viscosity or temperature trims will have dimensions based on the application. Consult factory.

Photo 1

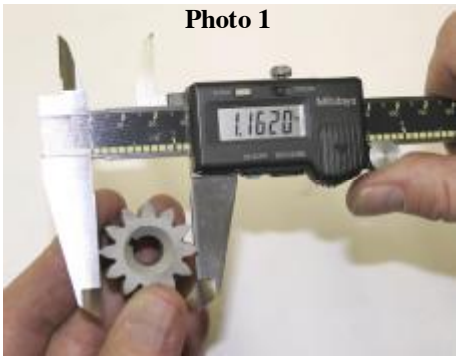
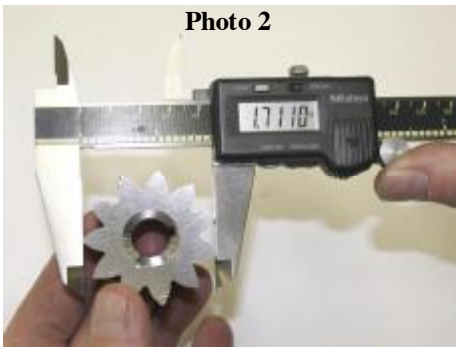


Photo 2



Appendix 4: Operation of Dynamic Seals

Liquiflo sealed pumps can be configured with any one of five distinct types of dynamic seals. The choice of seal will depend mainly on the pumping application. To maximize the lifetime of the seal and to ensure that it operates properly, it must be correctly installed and applied, and in some cases, properly adjusted or supported. This section covers the basic operation of the various seal arrangements used in Liquiflo pumps. (Refer to the Sectional Drawings in **Appendix 6**.)

A. Packing Seal

Although Packing is still used, it is not very common in the chemical processing industry because of its normal leak rate with low to moderate viscosity fluids. It is still considered to be an acceptable solution when pumping safe liquids or where the seal drainage can be captured. Flocculants, water and caustics are common examples of fluids which use this type of seal. Teflon is the standard packing material. Graphoil packing is used for high temperature applications over 350 °F up to 500 °F.

During operation, the shaft-packing interface must be lubricated to reduce frictional forces on the rotating drive shaft. Depending on the fluid, this can be accomplished in several ways: With low to moderate viscosity liquids, the gland screws are adjusted to provide a leak rate of about 8 to 10 drops per minute. With high viscosity liquids, grease can be administered into the seal chamber via the grease fitting. For crystallizing liquids, a flush fluid can be made to flow across the seal chamber, via the two 1/8" NPT ports. In all cases, the packing should be properly compressed by adjusting the glands screws. Under-compression will result in excessive leakage, and over-compression can cause excessive loading and heating of the drive shaft, which will lead to premature failure of the packing seal.

B. Lip Seal

The Lip Seal is the simplest dynamic seal but it is not very common because of its limitations. A U-cup shaped elastomer is used to seal the space between the rotating shaft and the stationary front housing. The hydraulic pressure inside the seal chamber forces the lips of the U-cup open which seals against the shaft and housing. Because the seal is an elastic material, it has significant physical, chemical and thermal limitations. However, it is a simple solution for pumping safe liquids under moderate conditions.

C. Single Internal Mechanical Seal

The Single Mechanical Seal arrangement is the dynamic seal standard and is by far the most commonly used when pumping any type of chemical where leakage needs to be minimized. Although widely used, this seal has some important limitations. The seal can tolerate only limited amounts of abrasive particles and because it is non-hermetic, it is not ideal for pumping fluids that can crystallize on contact with air. Crystals can build up around the edges of the seal and cause premature seal failure. Because of lubrication requirements, the maximum recommended fluid viscosity is 5,000 cP.

During operation, the rotating seal face seals against a stationary seal seat. To be effective, the working surfaces of the seal faces must be extremely flat and the pumped fluid must be present to lubricate the interface and remove the heat caused by friction. The sealing and frictional forces are a result of the mechanical spring pressure inside the seal body and the hydraulic pressure inside the seal chamber. If the pump is run dry for more than a few seconds, the frictional forces will cause rapid wear and damage the seal. Pumping very high viscosity fluids can also cause premature seal wear because of poor lubrication.

The most common seal combination is Carbon (seal face) vs. Ceramic or SiC (seal seat). If the seal is properly applied, it can be used to pump many chemicals up to differential pressures of 150 PSI or higher. Teflon can be used for the seal face material due to its superior chemical resistance, but it has a pressure limitation of 50 PSI. When pumping fluids containing very low levels of abrasives, SiC vs. SiC seal com-

Appendix 4: Operation of Dynamic Seals (Continued)

binations can be used. For higher levels of abrasives, a double mechanical seal can be used (see below). (Note: When pumping abrasive fluids, it is beneficial to use a larger pump running at lower speeds. This will significantly lower the wear rate and increase the working life of the pump. Gear pumps, in general, have limitations on pumping fluids containing suspended solid particles. See **Section 3.3**, Page 11.)

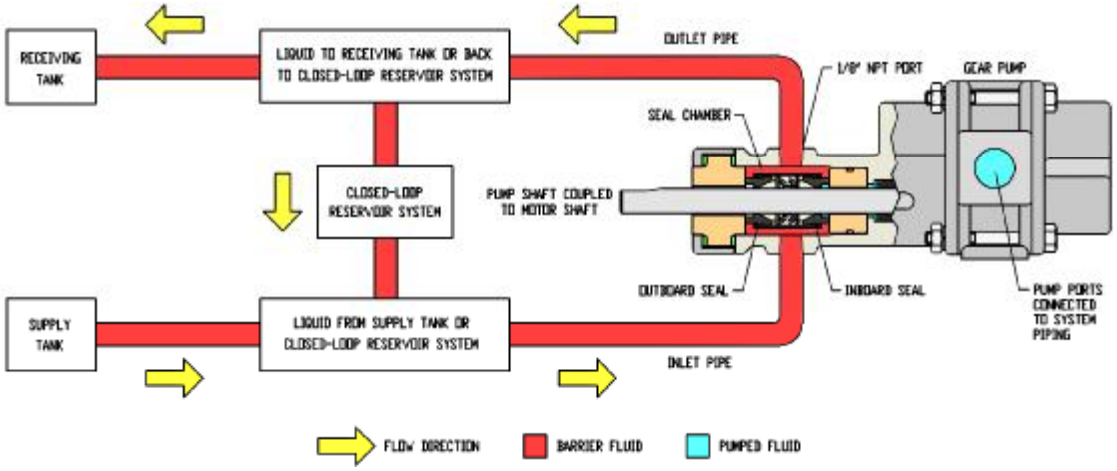
D. External Mechanical Seal

The External Mechanical Seal is similar to the Single Internal Mechanical Seal except that the seal is located on the outside of the pump housing. This arrangement has the following advantages: Because the seal is isolated from the seal chamber, the metallic seal body does not have to be chemically compatible with the pumped liquid and replacement of the mechanical seal is simplified because the pump does not always have to be disassembled. Another important advantage of the external seal is that it can be applied when system pressures are below atmospheric (< 0 PSIG or vacuum). This is because the atmospheric pressure will assist the mechanical spring pressure inside the seal body in holding the seal faces together. The main disadvantage of the external seal is that the hydraulic pressure inside the seal chamber is working against the seal faces. This makes the external seal less effective than the single internal seal when operating above atmospheric pressure. In addition, the external seal also has the same limitations as the single internal seal when pumping viscous, abrasive or crystallizing fluids.

E. Double Mechanical Seal

The Double Mechanical Seal is a more complex sealing arrangement, but when properly supported, it overcomes the limitations of the other seal types discussed above. As shown below, the double mechanical seal requires a *barrier fluid lubrication system* to cool and flush the seal faces. The barrier fluid must be safe and compatible with the pumpage, have a net flow across the seal chamber via the 1/8" NPT ports and must be pressurized to at least 15 PSI above the pump discharge pressure. The double mechanical seal is preferred for pumping abrasive, crystallizing or extremely hazardous fluids because the seal faces are only exposed to the flush fluid and the pumpage is completely contained by the inboard seal. The double seal can also pump viscous fluids greater than 5,000 cP and can even run dry as long as the barrier fluid is present. Failure to support the double seal will cause rapid wear and ensuing failure of both the inboard and outboard seals. The main disadvantage of the double seal is the added complexity and cost of the barrier fluid lubrication system. An alternative to the pump with a properly supported double mechanical seal is the sealless (magnetic-drive) pump. In addition to its simpler containment system, the mag-drive pump can prove to be a more reliable and cost-effective solution over time.

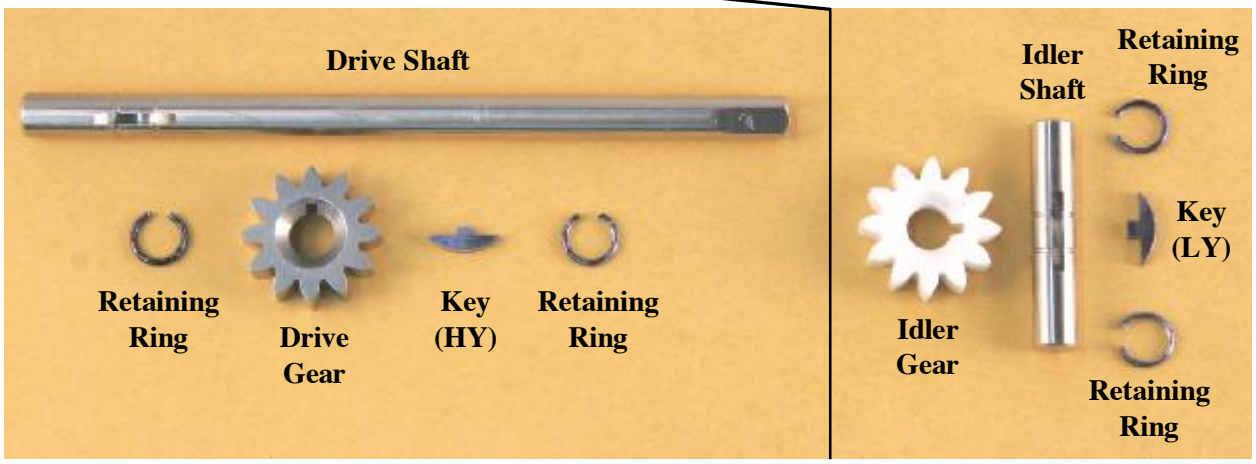
Barrier Fluid Lubrication System for Pump with Double Mechanical Seal



Appendix 5: Gear-Shaft Assembly

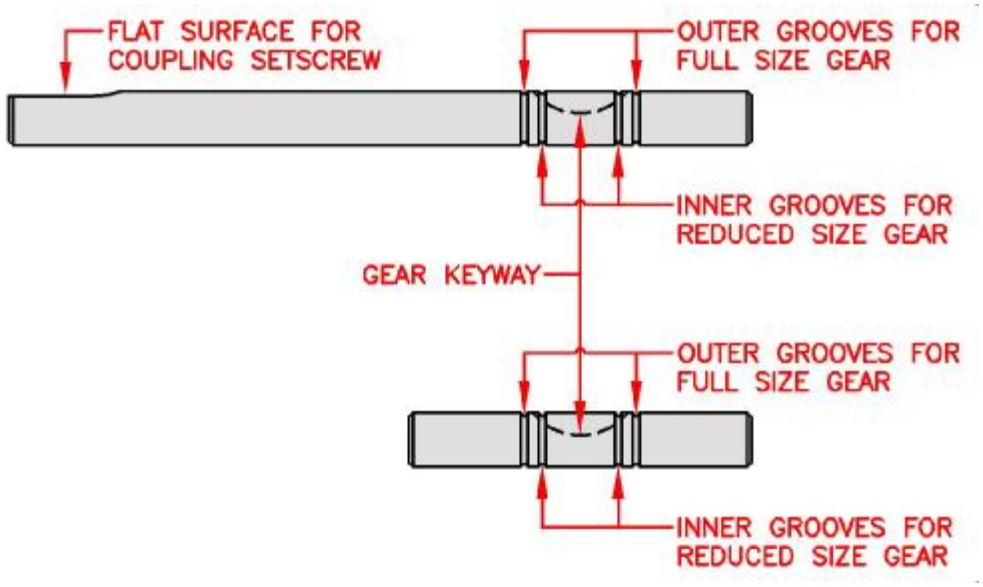
Parts List for Gear-Shaft Assemblies

Drive Gear-Shaft Parts		Idler Gear-Shaft Parts	
Part	**Quantity**	**Part**	**Quantity**
Drive Gear	1	Idler Gear	1
Drive Shaft	1	Idler Shaft	1
Key	1	Key	1
Retaining Ring	2	Retaining Ring	2



Description of Parts:

Shafts: As shown above, the pump contains two kinds of shafts: the *drive shaft* and the *idler shaft*. Both shafts have retaining ring grooves and a keyway for positioning the gears. The drive shaft also has a flat surface on one end for installing the mechanical coupling. The gears are positioned on the shafts using two retaining rings per gear. Depending on the pump model, some shafts may contain an inner and outer set of grooves to fit both full (F) and reduced (R) size gears. (See diagram below.)



Appendix 5: Gear-Shaft Assembly (Continued)

To identify the pump shafts, refer to the following chart:

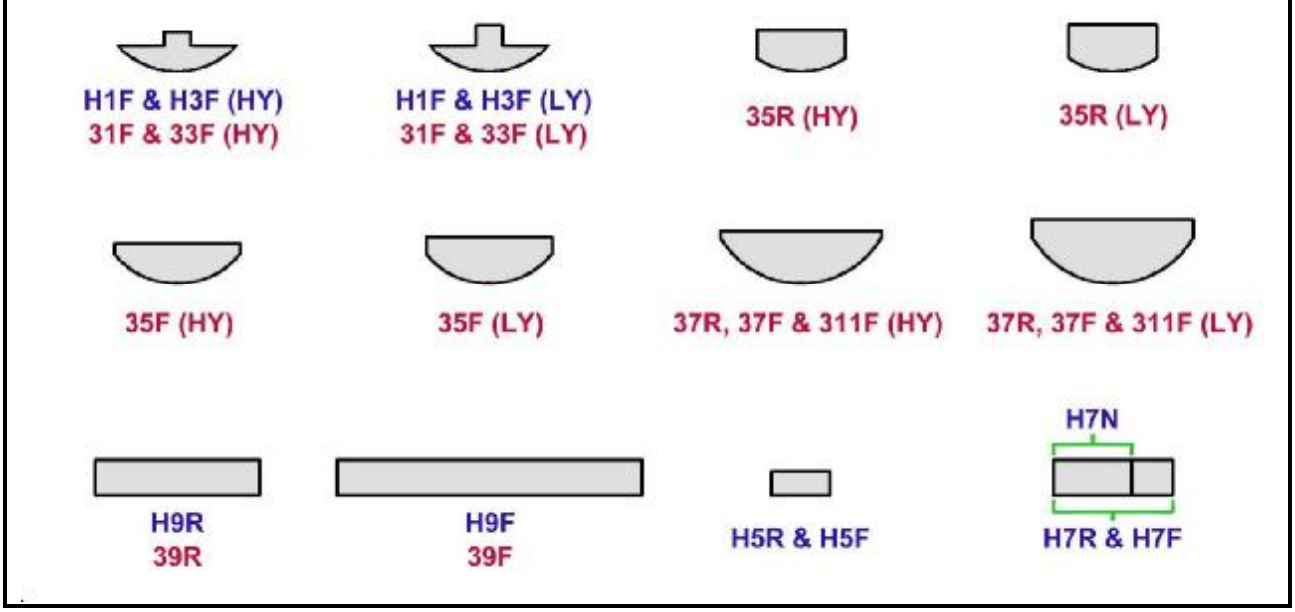
Shaft Identification Chart

Pump Series	For Pump Models	Shaft Diameter	Drive Shaft Length [1]	Drive Shaft Length [2]	Idler Shaft Length	# of Gear Retaining Ring Grooves
	UNITS:	in	in	in	in	—
H-Series	H1F & H3F	3/8	6.39	—	1.91	2
	H5R & H5F	1/2	6.87	—	2.40	4
	H7N	5/8	7.88	—	3.81	2
	H7R & H7F	5/8	7.88	—	3.81	4
	H9R	5/8	9.25	—	4.31	2
	H9F	5/8	10.00	—	5.06	2
3-Series	31F & 33F	3/8	6.39	7.11	1.91	2
	35R & 35F	3/8	6.87	8.00	2.40	4
	37R & 37F	1/2	7.88	10.00	3.81	4
	39R	5/8	9.25	—	4.31	2
	39F	5/8	10.00	—	5.06	2
	311F	1/2	10.00	—	5.06	2

1 - For all seal types except External Seal **2** - For External Seal only

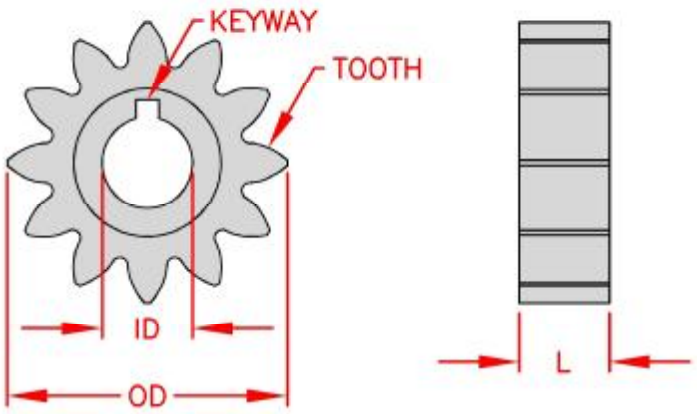
Keys: Three types of gear keys are used in the pumps: High-yield (HY), low-yield (LY) and rectangular. For Models H1F, H3F, 31F thru 37F, and 311F, high-yield keys are used for all gear materials except Teflon; low-yield keys are used only for Teflon gears. (Note: High-yield keys have a lower height than low-yield keys.) For Models H5R thru H9F, 39R and 39F, rectangular keys are used for all gears. To identify the keys, use the following chart:

Key Identification Chart **Note:** Key profiles are shown in actual size.



Appendix 5: Gear-Shaft Assembly (Continued)

Gears: The H-Series and 3-Series pumps use spur style gears, as shown below:



To identify the gears, use the following chart:

Gear Identification Chart

Pump Series	Pump Model	Gear Outer Diameter (OD)	Gear Inner Diameter (ID)	Gear Length (L)	# of Teeth
	UNITS:	in	in	in	—
H-Series	H1F	1.163	3/8	1/8 (3/8 Hub)	12
	H3F	1.163	3/8	3/8	12
	H5R	1.163	1/2	5/8	12
	H5F	1.163	1/2	7/8	12
	H7N	1.750	5/8	5/8	11
	H7R	1.750	5/8	1	11
	H7F	1.750	5/8	1 ¼	11
	H9R	1.750	5/8	1 ¾	11
	H9F	1.750	5/8	2 ½	11
3-Series	31F	1.163	3/8	1/8 (3/8 Hub)	12
	33F	1.163	3/8	3/8	12
	35R	1.163	3/8	5/8	12
	35F	1.163	3/8	7/8	12
	37R	1.750	1/2	1	11
	37F	1.750	1/2	1 ¼	11
	39R	1.750	5/8	1 ¾	11
	39F	1.750	5/8	2 ½	11
	311F	1.750	1/2	2 ½	11

Retaining Rings: The retaining rings are used to position the gears on the shafts. They should always be replaced when repairing the pump.

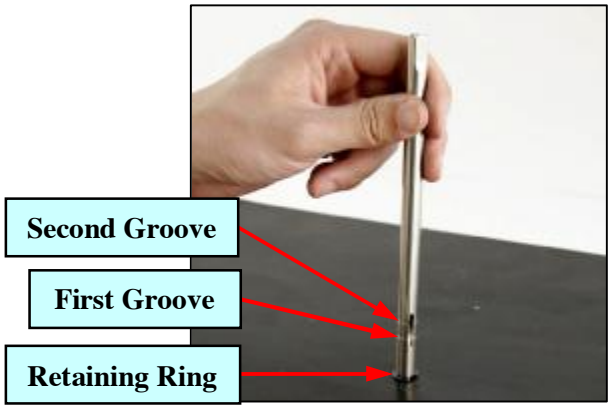
Appendix 5: Gear-Shaft Assembly (Continued)

Assembly Procedure:

CAUTION! Be careful not to damage the shafts.

1 Place one retaining ring (14) on a firm rubber mat and then place the shaft over the retaining ring, as shown.

NOTE: The pump shaft shown is the drive shaft for a H3F pump. This shaft has a 3/8" diameter and two gear retaining ring grooves (see Shaft Identification Chart on Page 45).



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2 Strike the top end of the shaft with a rubber mallet to force the retaining ring onto the bottom end of the shaft, as shown.

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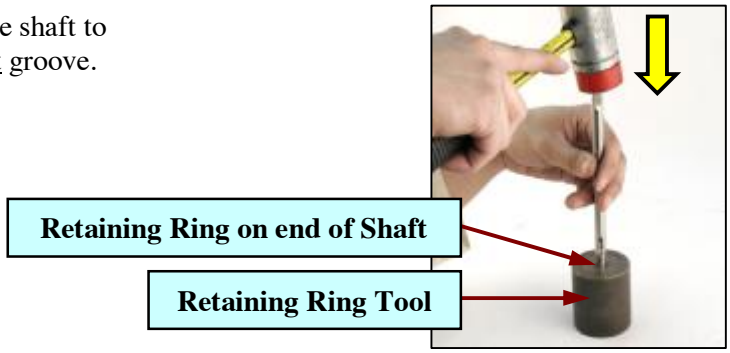
3 Using the retaining ring tool, tap the shaft to slide the retaining ring into the first groove.

NOTE: See **Appendix 2** for specifications on producing the retaining ring tool.



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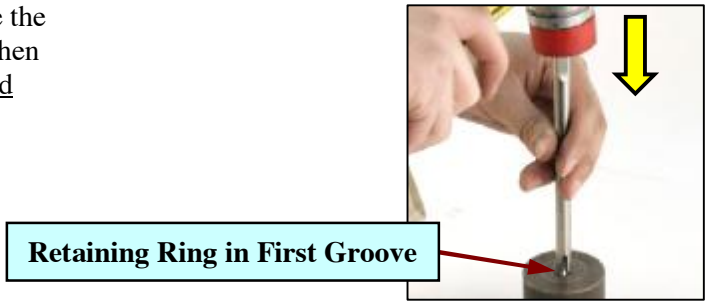
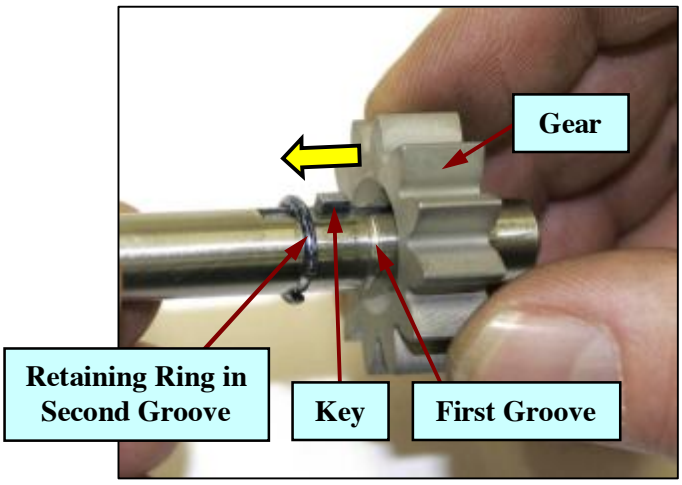
4 Strike the end of the shaft to dislodge the retaining ring from the first groove; then slide the retaining ring into the second groove by tapping the shaft.



Appendix 5: Gear-Shaft Assembly (Continued)

5 Install the key (23A) and gear (22) on the shaft.

NOTE: The gear shown is a H3F metallic drive gear. This gear requires a HY-type key (see the section on Keys on Page 45). Align the keyway of the gear with the key on the shaft; then slide the gear over the key until the gear contacts the retaining ring.



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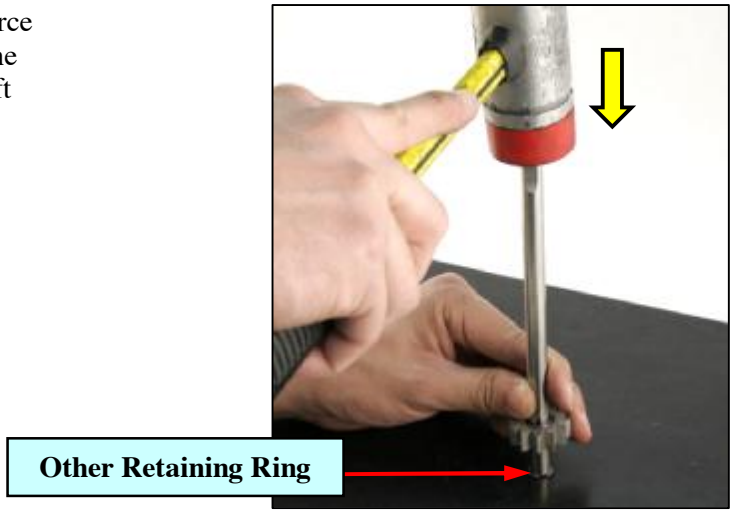
6 While holding the gear in place, force the other retaining ring (14) onto the end of the shaft by striking the shaft with the rubber mallet, as shown.



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7 Slide the retaining ring into the first groove. This will lock the gear on the shaft.

NOTE: As a check, pull the gear by hand along the axis of the shaft to make sure it is securely locked into position.

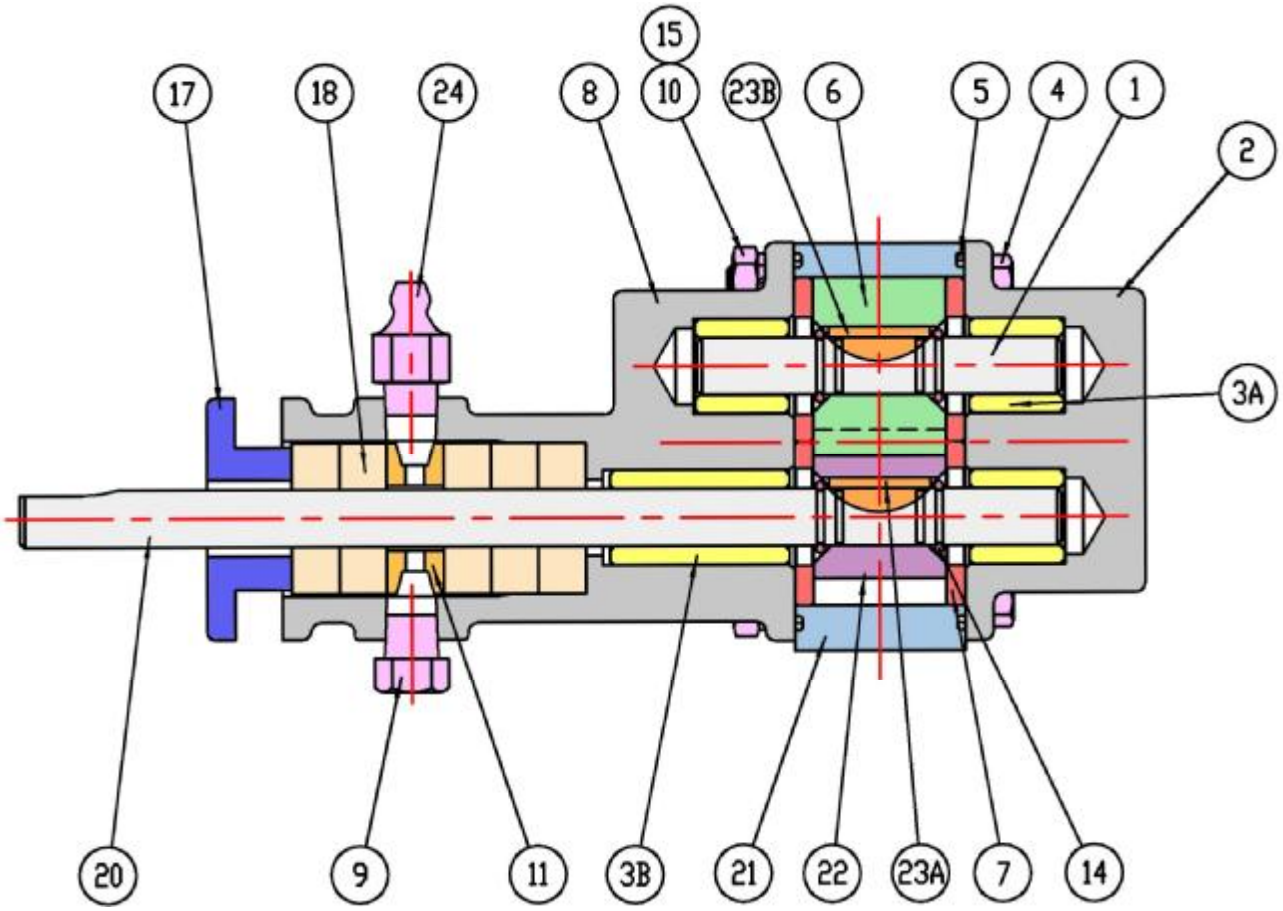
Drive Gear-Shaft Assembly

Idler Gear-Shaft Assembly

END OF PROCEDURE

Appendix 6: Reference Drawings

Sectional Drawing #1 - Pump with PACKING SEAL

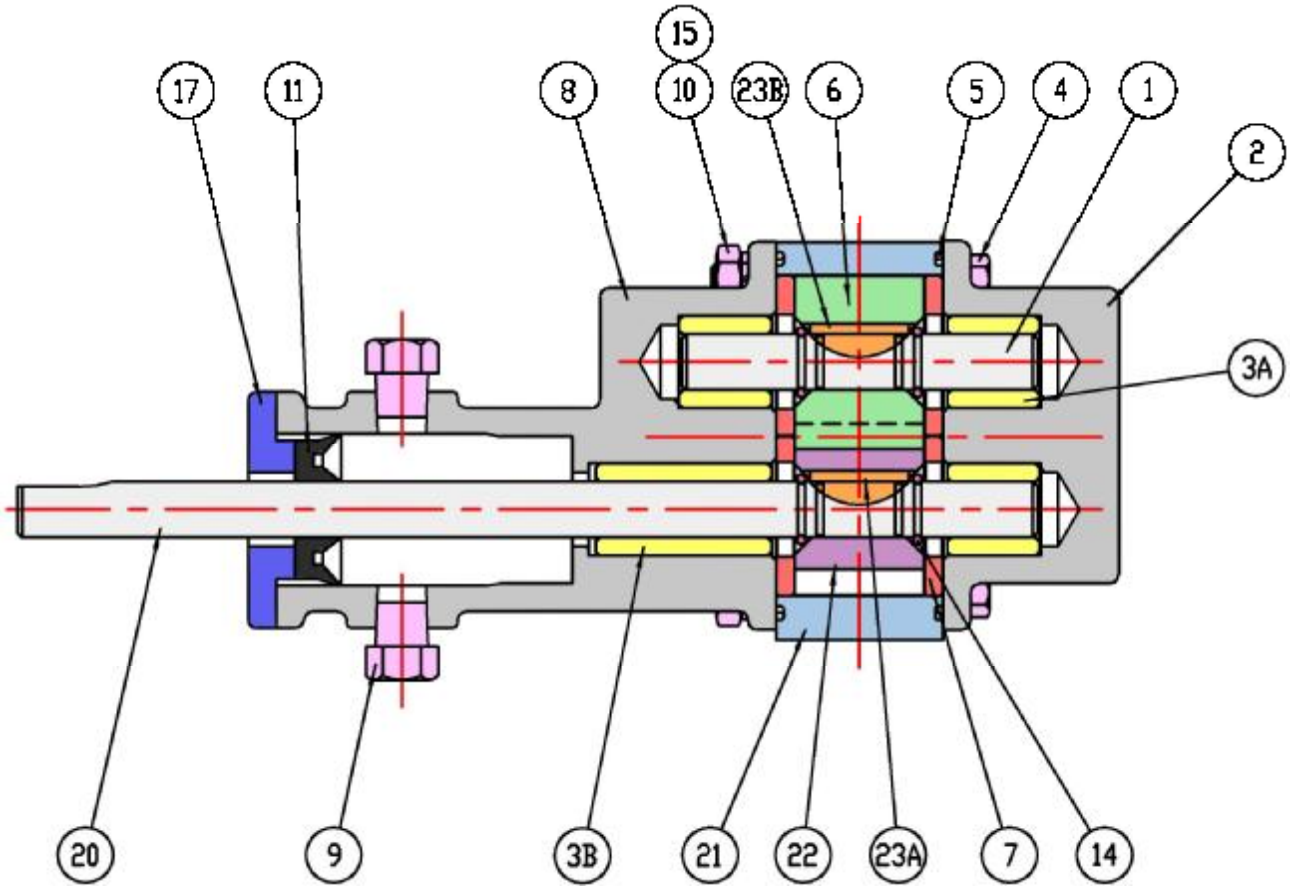


Item #	Description	Qty.	Item #	Description	Qty.
1	Idler Shaft	1	13	Pin, Bearing Lock (Not Shown)	4
2	Rear Housing	1	14	Retaining Ring, Gear	4
3A	Bearing, Short *	3	15	Lockwasher, Housing **	4
3B	Bearing, Long *	1	16	Screw, Gland (1/4-28 x 3/4 HHCS) (Not Shown)	2
4	Bolt, Housing (HHCS) **	4	17	Gland Plate	1
5	O-ring, Housing	2	18	Packing Ring	5
6	Idler Gear	1	19	N/A	—
7	Wear Plate	4	20	Drive Shaft	1
8	Front Housing	1	21	Center Housing	1
9	Plug, 1/8 NPT	1	22	Drive Gear	1
10	Nut, Housing **	4	23A	Key, Drive Gear	1
11	Lantern Ring	1	23B	Key, Idler Gear	1
12	Pin, Housing Alignment (Not Shown)	4	24	Grease Fitting	1

* Pump Models H7-H9, 37-39 & 311 each have four bearings of equal size. ** See Page 37 for bolt size.

Appendix 6: Reference Drawings (Continued)

Sectional Drawing #2 - Pump with LIP SEAL



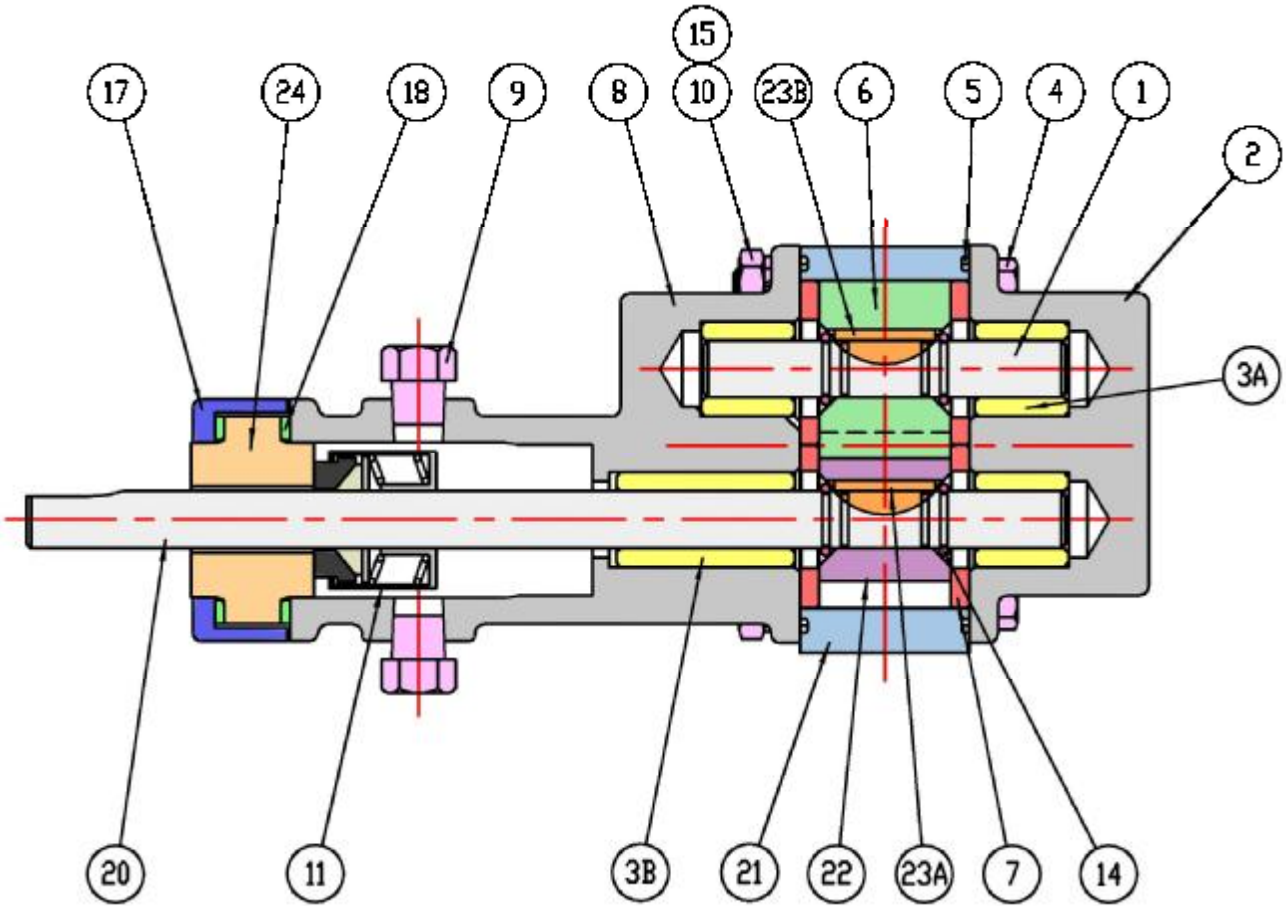
Item #	Description	Qty.	Item #	Description	Qty.
1	Idler Shaft	1	13	Pin, Bearing Lock (Not Shown)	4
2	Rear Housing	1	14	Retaining Ring, Gear	4
3A	Bearing, Short *	3	15	Lockwasher, Housing **	4
3B	Bearing, Long *	1	16	Screw, Gland (1/4-28 x 5/8 HHCS) (Not Shown)	2
4	Bolt, Housing (HHCS) **	4	17	Gland Plate	1
5	O-ring, Housing	2	18	N/A	–
6	Idler Gear	1	19	Lockwasher, Gland (1/4) (Not Shown)	2
7	Wear Plate	4	20	Drive Shaft	1
8	Front Housing	1	21	Center Housing	1
9	Plug, 1/8 NPT	2	22	Drive Gear	1
10	Nut, Housing **	4	23A	Key, Drive Gear	1
11	U-Cup Lip Seal	1	23B	Key, Idler Gear	1
12	Pin, Housing Alignment (Not Shown)	4	24	N/A	–

* Pump Models H7-H9, 37-39 & 311 each have four bearings of equal size.

** See Page 37 for bolt size.

Appendix 6: Reference Drawings (Continued)

Sectional Drawing #3 - Pump with SINGLE INTERNAL MECHANICAL SEAL

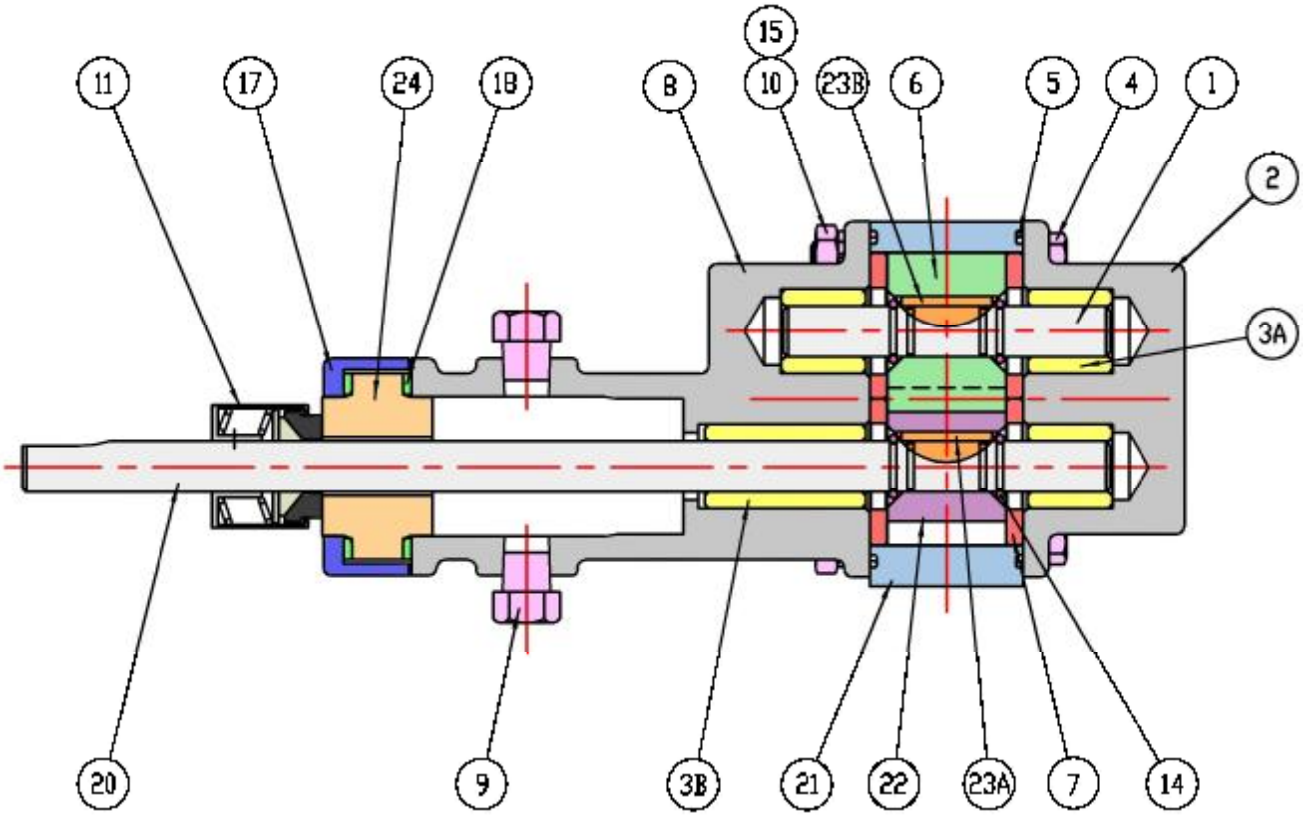


Item #	Description	Qty.	Item #	Description	Qty.
1	Idler Shaft	1	13	Pin, Bearing Lock (Not Shown)	4
2	Rear Housing	1	14	Retaining Ring, Gear	4
3A	Bearing, Short *	3	15	Lockwasher, Housing **	4
3B	Bearing, Long *	1	16	Screw, Gland (1/4-28 x 1 HHCS) (Not Shown)	2
4	Bolt, Housing (HHCS) **	4	17	Gland Plate	1
5	O-ring, Housing	2	18	Gasket, Seal Seat	2
6	Idler Gear	1	19	Lockwasher, Gland (1/4) (Not Shown)	2
7	Wear Plate	4	20	Drive Shaft	1
8	Front Housing	1	21	Center Housing	1
9	Plug, 1/8 NPT	2	22	Drive Gear	1
10	Nut, Housing **	4	23A	Key, Drive Gear	1
11	Mechanical Seal	1	23B	Key, Idler Gear	1
12	Pin, Housing Alignment (Not Shown)	4	24	Seal Seat	1

* Pump Models H7-H9, 37-39 & 311 each have four bearings of equal size. ** See Page 37 for bolt size.

Appendix 6: Reference Drawings (Continued)

Sectional Drawing #4 - Pump with EXTERNAL MECHANICAL SEAL

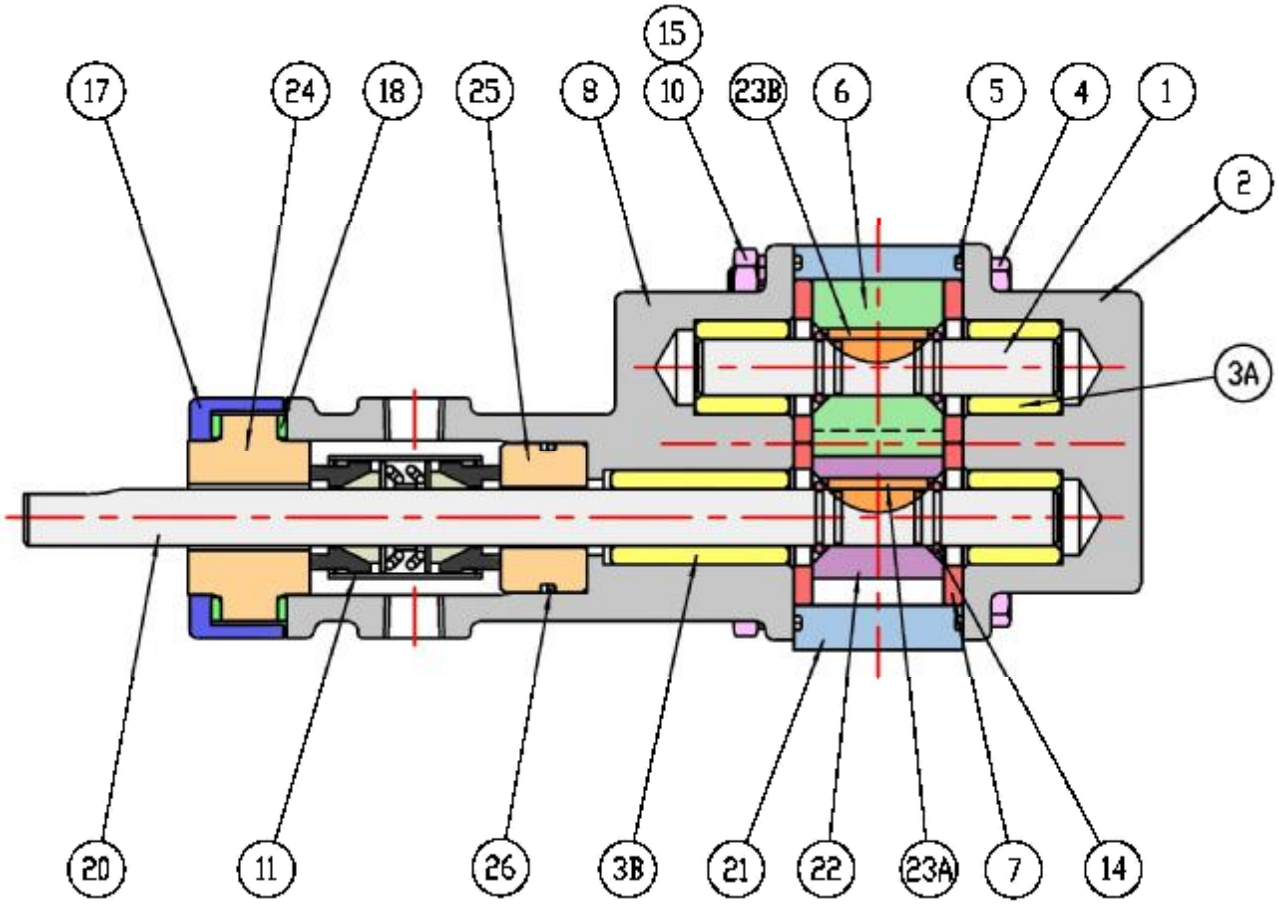


Item #	Description	Qty.	Item #	Description	Qty.
1	Idler Shaft	1	13	Pin, Bearing Lock (Not Shown)	4
2	Rear Housing	1	14	Retaining Ring, Gear	4
3A	Bearing, Short *	3	15	Lockwasher, Housing **	4
3B	Bearing, Long *	1	16	Screw, Gland (1/4-28 x 1 HHCS) (Not Shown)	2
4	Bolt, Housing (HHCS) **	4	17	Gland Plate	1
5	O-ring, Housing	2	18	Gasket, Seal Seat	2
6	Idler Gear	1	19	Lockwasher, Gland (1/4) (Not Shown)	2
7	Wear Plate	4	20	Drive Shaft	1
8	Front Housing	1	21	Center Housing	1
9	Plug, 1/8 NPT	2	22	Drive Gear	1
10	Nut, Housing **	4	23A	Key, Drive Gear	1
11	Mechanical Seal	1	23B	Key, Idler Gear	1
12	Pin, Housing Alignment (Not Shown)	4	24	Seal Seat	1

* Pump Models H7-H9, 37-39 & 311 each have four bearings of equal size. ** See Page 37 for bolt size.

Appendix 6: Reference Drawings (Continued)

Sectional Drawing #5 - Pump with DOUBLE MECHANICAL SEAL

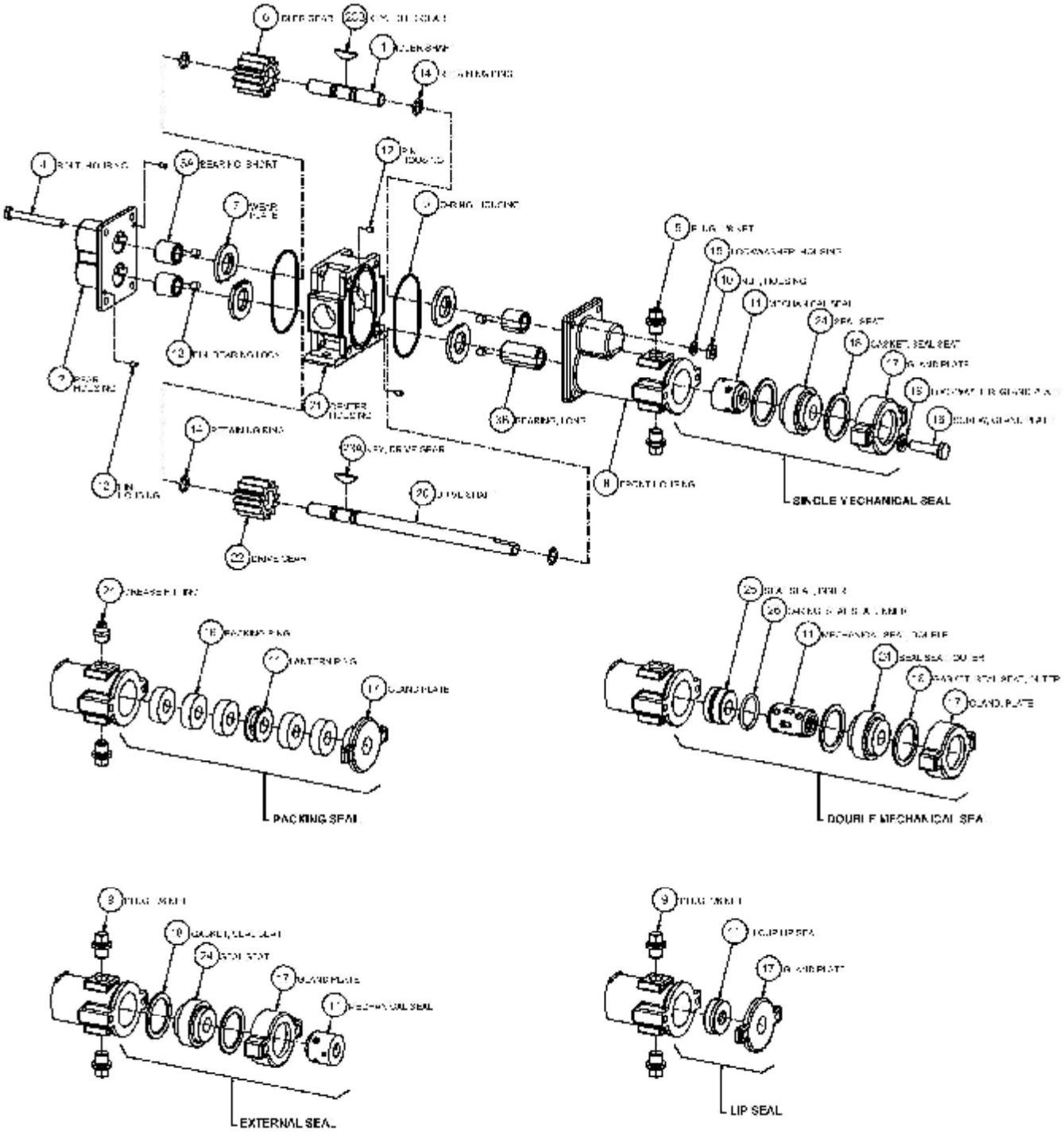


Item #	Description	Qty.	Item #	Description	Qty.
1	Idler Shaft	1	14	Retaining Ring, Gear	4
2	Rear Housing	1	15	Lockwasher, Housing **	4
3A	Bearing, Short *	3	16	Screw, Gland (1/4-28 x 1 HHCS) (Not Shown)	2
3B	Bearing, Long *	1	17	Gland Plate	1
4	Bolt, Housing (HHCS) **	4	18	Gasket, Seal Seat, Outer	2
5	O-ring, Housing	2	19	Lockwasher, Gland (1/4) (Not Shown)	2
6	Idler Gear	1	20	Drive Shaft	1
7	Wear Plate	4	21	Center Housing	1
8	Front Housing	1	22	Drive Gear	1
9	N/A	—	23A	Key, Drive Gear	1
10	Nut, Housing **	4	23B	Key, Idler Gear	1
11	Mechanical Seal, Double	1	24	Seal Seat, Outer	1
12	Pin, Housing Alignment (Not Shown)	4	25	Seal Seat, Inner	1
13	Pin, Bearing Lock (Not Shown)	4	26	O-ring, Seal Seat, Inner	1

* Pump Models H7-H9, 37-39 & 311 each have four bearings of equal size. ** See Page 37 for bolt size.

Appendix 6: Reference Drawings (Continued)

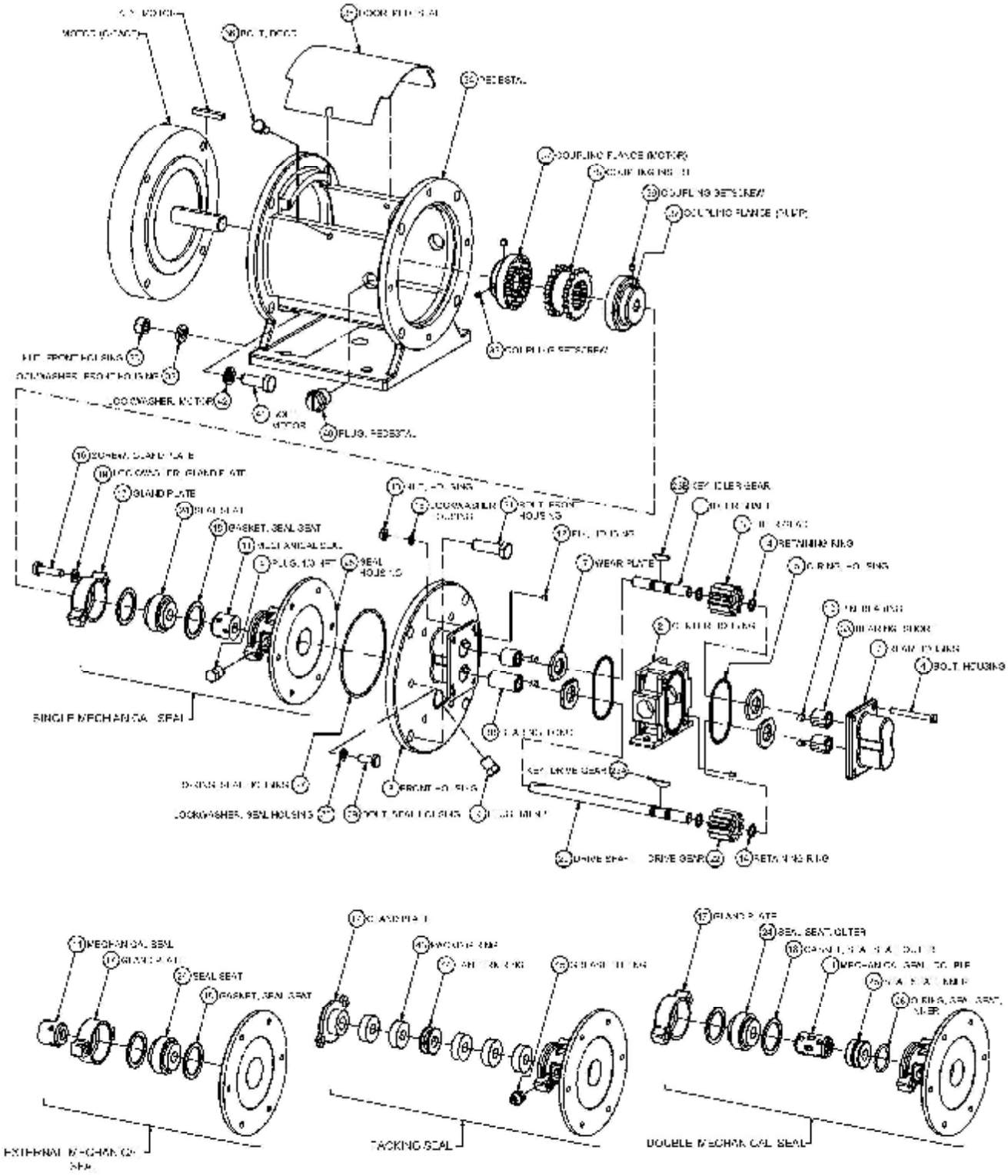
Exploded View Drawing #1 – Sealed Pump, Long-Coupled



Note: Pump Models H7-H9, 37-39 & 311 each have four bearings of equal size.

Appendix 6: Reference Drawings (Continued)

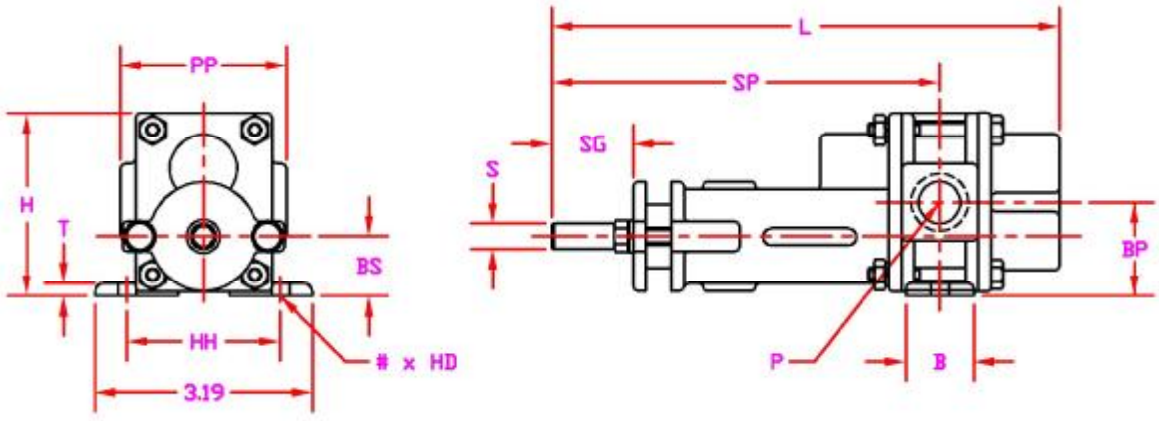
Exploded View Drawing #2 – Sealed Pump, Close-Coupled



Note: Pump Models H7-H9, 37-39 & 311 each have four bearings of equal size.

Appendix 6: Reference Drawings (Continued)

Dimensional Drawing #1 – Sealed Pump with Threaded Ports, Long-Coupled



Dimensional Data – Pump Ports

Pump Models		Port Size, Threaded [1] (P)	Port-to-Port, Threaded (PP)	Port Size, Flanged [2] (P)		Port-to-Port, Flanged (PP)
				ANSI	DIN	
H-Series	3-Series	in	in	in	mm	in
H1F/H3F	31F/33F	1/4	2.68	1/2	10	10.00
H5R/H5F	35R/35F	1/2	2.44	1/2	15	10.00
H7N/H7R/H7F	37R/37F	3/4	3.32	3/4	20	10.00
H9R	39R	1	3.50	1	25	10.00
H9F	39F/311F	1 ¼	4.00	1 ¼	32	10.00

Dimensional Data (inches) – Not Dependent on Seal Arrangement

Pump Models		# x Hole Diameter (HD)	Pump Height (H)	Base Height (T)	Base Length (B)	Hole-to-Hole (HH)	Base-to-Shaft CL (BS)	Base-to-Port CL (BP)	Shaft Diameter (S)	
H-Series	3-Series								H-Series	3-Series
H1F/H3F	31F/33F	2 x 0.26	2.69	0.19	0.63	2.76	0.88	1.38	3/8	3/8
H5R/H5F	35R/35F	2 x 0.26	2.69	0.19	1.00	2.26	0.88	1.38	1/2	3/8
H7N/H7R/H7F	37R/37F	2 x 0.28	3.94	0.19	0.88	2.62	1.25	2.00	5/8	1/2
H9R	39R	2 x 0.28	4.06	0.28	1.50	2.62	1.38	2.13	5/8	5/8
H9F	39F	4 x 0.28	4.06	0.28	2.23	2.62	1.38	2.13	5/8	5/8
—	311F	4 x 0.28	4.06	0.28	2.23	2.62	1.38	2.13	—	1/2

Dimensional Data (inches) – Dependent on Seal Arrangement

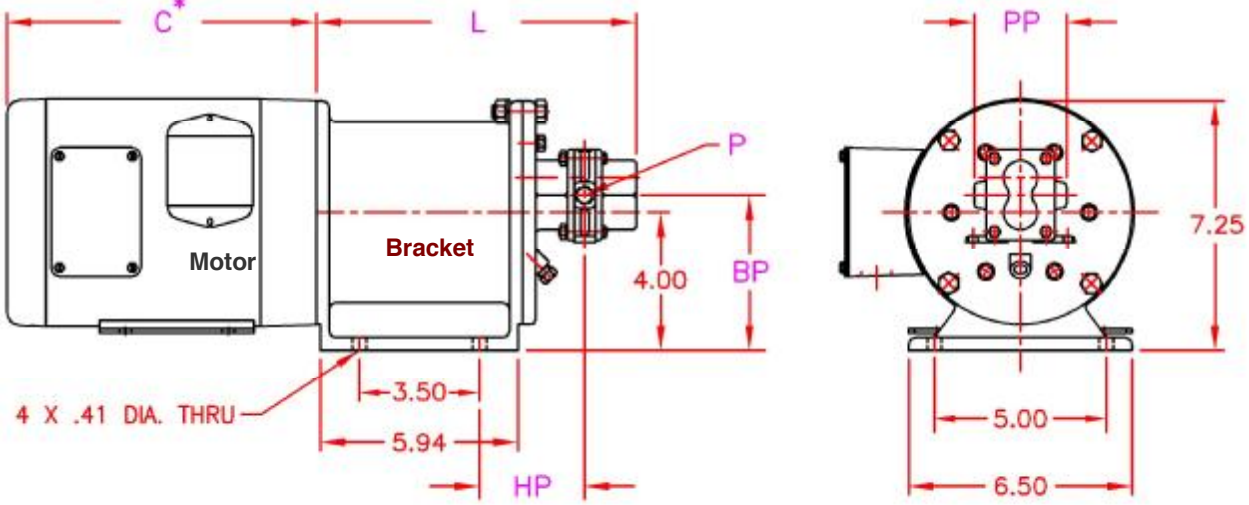
Pump Models		Packing Seal			Lip Seal [4]			Single & Double Mech. Seals			External Mech. Seal [4]		
H-Series	3-Series	SG [5]	SP	L [3]	SG	SP	L [3]	SG	SP	L [3]	SG	SP	L [3]
H1F/H3F	31F/33F	1.19	5.44	6.94	1.57	5.44	6.94	1.12	5.44	6.94	1.84	6.16	7.66
H5R/H5F	35R/35F	1.17	5.67	7.42	1.55	5.67	7.42	1.10	5.67	7.42	2.23	6.80	8.55
H7N/H7R	37R	1.20	5.98	8.20	1.57	5.98	8.20	1.26	5.98	8.20	3.38	8.10	10.32
H7F	37F	1.07	5.98	8.32	1.45	5.98	8.32	1.13	5.98	8.32	3.25	8.10	10.44
H9R	39R	1.93	7.09	9.68	—	—	—	1.99	7.09	9.68	—	—	—
H9F	39F/311F	1.94	7.47	10.44	—	—	—	2.00	7.47	10.44	—	—	—

1 Threaded ports are NPT or BSPT.
2 Flanges are ANSI 150# RF or DIN PN16 (not shown).
3 Add 0.31 inches if pump has Bearing Flush Plugs installed.
4 Not applicable for H-Series pumps.
5 Minimum dimension.

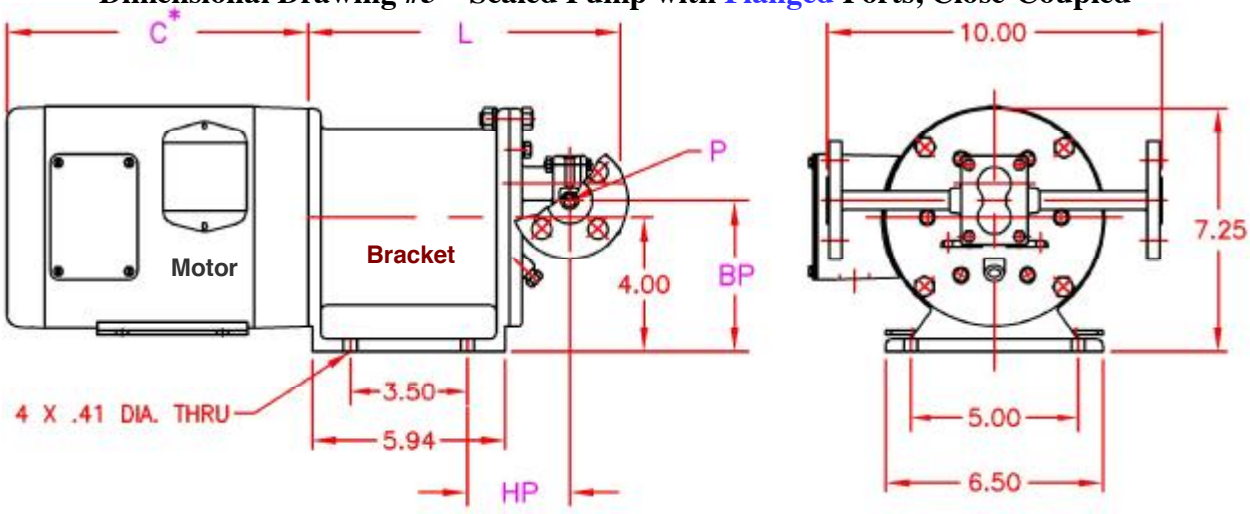
SG = End of Shaft-to-Gland
SP = End of Shaft-to-Port CL
L = Length of Pump

Appendix 6: Reference Drawings (Continued)

Dimensional Drawing #2 – Sealed Pump with Threaded Ports, Close-Coupled



Dimensional Drawing #3 – Sealed Pump with Flanged Ports, Close-Coupled



* See dimensional data from motor manufacturer for "C" Dimension.

Dimensional Data – Sealed Pump, Close-Coupled

Pump Models		Port Size, Threaded [1] (P)	Port Size, Flanged [2] (P)		Port-to-Port, Threaded (PP)	Length [3] (L)	Base-to-Port CL (BP)	Hole-to-Port CL (HP)
			ANSI	DIN				
H-Series	3-Series	in	in	mm	in	in	in	in
H1F/H3F	31F/33F	1/4	1/2	10	2.68	9.31	4.50	3.06
H5R/H5F	35R/35F	1/2	1/2	15	2.44	9.81	4.50	3.31
H7N/H7R	37R	3/4	3/4	20	3.32	10.72	4.75	3.75
H7F	37F	3/4	3/4	20	3.32	10.98	4.75	3.88
H9R	39R	1	1	25	3.50	11.47	4.75	4.12
H9F	39F/311F	1 ¼	1 ¼	32	4.00	12.22	4.75	4.50

1 Threaded ports are NPT or BSPT.
2 Flanges are ANSI 150# RF or DIN PN16.
3 Length (L) is measured from C-face of bracket to end of pump's rear housing. Add 0.31 inches if pump has Bearing Flush Plugs installed.

Appendix 7: Troubleshooting Guide

Troubleshooting Guide – Part 1

Problem	Possible Cause	Corrective Action
No discharge	Pump not primed	Verify suction pipe is submerged. Increase suction pressure. Open suction valve.
	Wrong direction of rotation	Reverse motor leads or reverse suction and discharge piping.
	Valves closed	Open all suction and discharge valves.
	Bypass valve open	Close bypass valve.
	Air leak in suction line	Tighten connections. Apply sealant to all threads. Verify suction pipe is submerged.
	Clogged strainer	Clean strainer.
	Pump worn or damaged	Rebuild pump.
Insufficient discharge	Suction pressure too low	Increase suction pressure. Verify suction piping is not too long. Fully open any suction valves.
	Bypass valve open	Close bypass valve.
	Partly clogged strainer	Clean strainer.
	Speed too low	Increase driver speed, if possible. Use larger size pump, if required.
	Pump worn or damaged	Rebuild pump.
Loss of suction after satisfactory operation	Pump not properly primed	Reprime pump.
	Air leaks in suction line	Tighten connections. Apply sealant to all threads. Inspect gaskets, if applicable. Verify suction pipe is submerged.
	Air or vapor pockets in suction line	Rearrange piping as necessary.
	Increase in fluid viscosity	Heat fluid to reduce viscosity. Reduce pump speed.
Excessive power consumption	Fluid viscosity higher than specified	Heat fluid to reduce viscosity. Reduce pump speed. Increase driver horsepower.
	Differential pressure greater than specified	Increase pipe diameter. Decrease pipe run.
	Gear clearances insufficient for fluid viscosity	Purchase gears trimmed for the correct viscosity.
	Plastic gear clearance insufficient for fluid temperature	Purchase plastic gear trimmed for the correct temperature.
	Rotating parts binding or severely worn	Disassemble pump and replace worn parts.

Appendix 7: Troubleshooting Guide (Continued)

Troubleshooting Guide – Part 2

Problem	Possible Cause	Corrective Action
Rapid pump wear	Abrasives in fluid	Install suction strainer. Limit solids concentration. Reduce pump speed or use larger pump running at lower speed.
	Corrosion wear	Use materials of construction that are acceptable for fluid being pumped.
	Extended dry running	Install power sensor to stop pump.
	Discharge pressure too high	Increase pipe diameter. Decrease pipe run.
	Housing stress from piping	Align piping with pump ports. Support piping independently of pump.
	Misalignment (long-coupled pump)	Align pump and motor.
Excessive noise and vibration	Suction and/or discharge piping not anchored or properly supported	Anchor per Hydraulic Institute Standards.
	Base not rigid enough	Tighten hold-down bolts on pump and motor or adjust stilts. Inspect grout and regrout if necessary.
	Worn pump bearings	Replace bearings.
	Worn motor bearings	Replace bearings or motor.
	Pump cavitation	Increase NPSH available.
	Misalignment (long-coupled pump)	Align pump and motor.
Excessive product leakage	Static seal failure caused by chemical incompatibility or thermal breakdown	Use O-rings or gaskets made of material compatible with fluid and temperature of the application.
	Static seal failure caused by improper installation	Install O-rings or gaskets without twisting or bending. Use star-pattern torque sequence on housing bolts during assembly. Allow Teflon O-rings to cold flow and seat during tightening. Torque bolts to specification.
	Dynamic seal worn or damaged	Disassemble and replace seal. Prime pump and avoid dry running.
	Pump port connections not properly sealed	Use Teflon tape or other suitable sealant. Use gaskets compatible with fluid and temperature of the application.
	Crevice corrosion of pump housing material	Only pump chemicals that are compatible with the pump housing material. Decrease temperature to reduce corrosion rate to acceptable value. Flush idle pumps that are used to pump corrosive chemicals. Eliminate contaminants in the fluid that can accelerate corrosion wear.