

**OPERATION, MAINTENANCE AND STORAGE MANUAL FOR THE  
Q14 QUINTUPLEX PUMP**

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**Summary:**

This is a manual for an FMC Q14 nominal 100 horsepower quintuplex pump. This pump has five unique pumping cylinders, a 3 ½" stroke and a 6400 pound rod load. It is designed for plungers from 1.00" to 3.25" diameter providing a maximum flow rate of 235 gpm and a maximum pressure of 8100 psi.

## Table of Contents

Section	Title	Page
<b>1.0</b>	<b>Important Safety Instructions.....</b>	<b>5</b>
<b>2.0</b>	<b>Q14 Pump Features.....</b>	<b>6</b>
<b>3.0</b>	<b>Storage Instructions.....</b>	<b>7</b>
3.1	Short Term Storage.....	7
3.2	Short Term Storage for Severe Environments.....	7
3.3	Long Term Storage .....	7
3.4	Precautions during Freezing Weather Conditions .....	8
<b>4.0</b>	<b>Installation Guidelines .....</b>	<b>9</b>
4.1	General Location .....	9
4.2	Mounting Pump to Foundation and Power Source .....	9
4.3	Suction Piping Recommendations.....	9
<b>5.0</b>	<b>Discharge Piping Recommendations .....</b>	<b>11</b>
<b>6.0</b>	<b>Multiple Pump Systems .....</b>	<b>12</b>
<b>7.0</b>	<b>How to Start a Pump .....</b>	<b>13</b>
<b>8.0</b>	<b>Recommended Lubricants .....</b>	<b>14</b>
<b>9.0</b>	<b>Preventative Maintenance Chart.....</b>	<b>15</b>
<b>10.0</b>	<b>Component Parts List .....</b>	<b>16</b>
<b>11.0</b>	<b>Service Procedures.....</b>	<b>20</b>
11.1	Replacing Plunger Packing .....	20
11.2	Removing the Fluid Cylinder .....	22
11.3	Replacing Plunger Rod Oil Seals .....	23
11.4	Replacing Valves.....	25
11.5	Servicing the Power End .....	26
<b>12.0</b>	<b>Fastener Torque Requirements .....</b>	<b>32</b>
<b>13.0</b>	<b>Special Service Tools .....</b>	<b>34</b>
<b>14.0</b>	<b>Trouble-Shooting Pumps.....</b>	<b>35</b>
<b>15.0</b>	<b>Ordering Parts .....</b>	<b>38</b>
<b>16.0</b>	<b>Glossary of Commonly Used Terms.....</b>	<b>39</b>
<b>17.0</b>	<b>Reference Information .....</b>	<b>41</b>

## List of Tables

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<b>Tables</b>	<b>Page</b>
Table 1: Recommended Lubricants .....	14
Table 2: Power End Components (See Figure 3).....	17
Table 3: Fluid End Components (See Figure 4).....	19
Table 4: Fastener Torque .....	32

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## List of Figures

Figures	Page
Figure 1: Q14 Pump Features .....	6
Figure 2: Preventive Maintenance .....	15
Figure 3: Power End Components.....	16
Figure 4: Fluid End Components .....	18
Figure 5: Replacing Plunger Packing.....	21
Figure 6: Fluid Cylinder Removal.....	22
Figure 7: Replacing Plunger Rod Seals .....	24
Figure 8: Removing the Back Cover .....	26
Figure 9: Replacing the Shell Bearings.....	27
Figure 10: Removing Crank Bearings.....	28
Figure 11: Removing the Crank Shaft.....	28
Figure 12: Removing the Cross Head and Con Rods .....	29
Figure 13: Crankshaft Lifting Tool.....	34

## 1.0 Important Safety Instructions



**WARNING:**

Many accidents occur every year through careless use of mechanical equipment. You can avoid hazards associated with high-pressure equipment by always following the safety precautions listed below.

- **SHUT DOWN OR DISENGAGE** the pump and all accessory equipment before attempting any type of service. Failure to do this could cause electrical shock or injury from moving pump parts or components under high pressure.
- **BLEED OFF ALL PRESSURE** to the pump and piping before attempting any maintenance to the pump. Failure to do so may spray water or chemicals at high pressure onto service personnel.
- **NEVER OPERATE THE PUMP WITHOUT A PRESSURE RELIEF VALVE**, burst disc, or other type of properly sized overpressure safety device installed.
- **ALWAYS USE A PRESSURE GAGE** when operating the pump. The pressure must never exceed the maximum pressure rating of the pump or damage may occur. This damage can cause leakage or structural damage resulting in injury to personnel.
- **INSURE THAT NO VALVES ARE PLACED BETWEEN THE PUMP AND PRESSURE RELIEF VALVE.** If the pump is started with a closed or restricted valve in line before the pressure relief valve, the pump may build up pressure in excess of its rated limits and burst causing injury to personnel.
- **USE SHIELDS OR COVERS AROUND PUMPS** when pumping hot water, chemicals, or other hazardous liquids. This precaution can prevent the exposure of service personnel to these fluids should leakage occur.
- **ALWAYS USE GUARDS** on all belt drives and couplings. Guards can prevent personnel from becoming entangled and injured in rotating parts.
- **USE EXTREME CAUTION WITH SOLVENTS** used to clean or degrease equipment. Most solvents are highly flammable. Observe all safety instructions on packaging.
- **NEVER MODIFY THE PUMP TO PERFORM BEYOND ITS RATED SPECIFICATIONS.**

## 2.0 Q14 Pump Features

Exceptional design, workmanship, materials, and over 100 years experience building pumps are features you'll find built into every FMC pump.

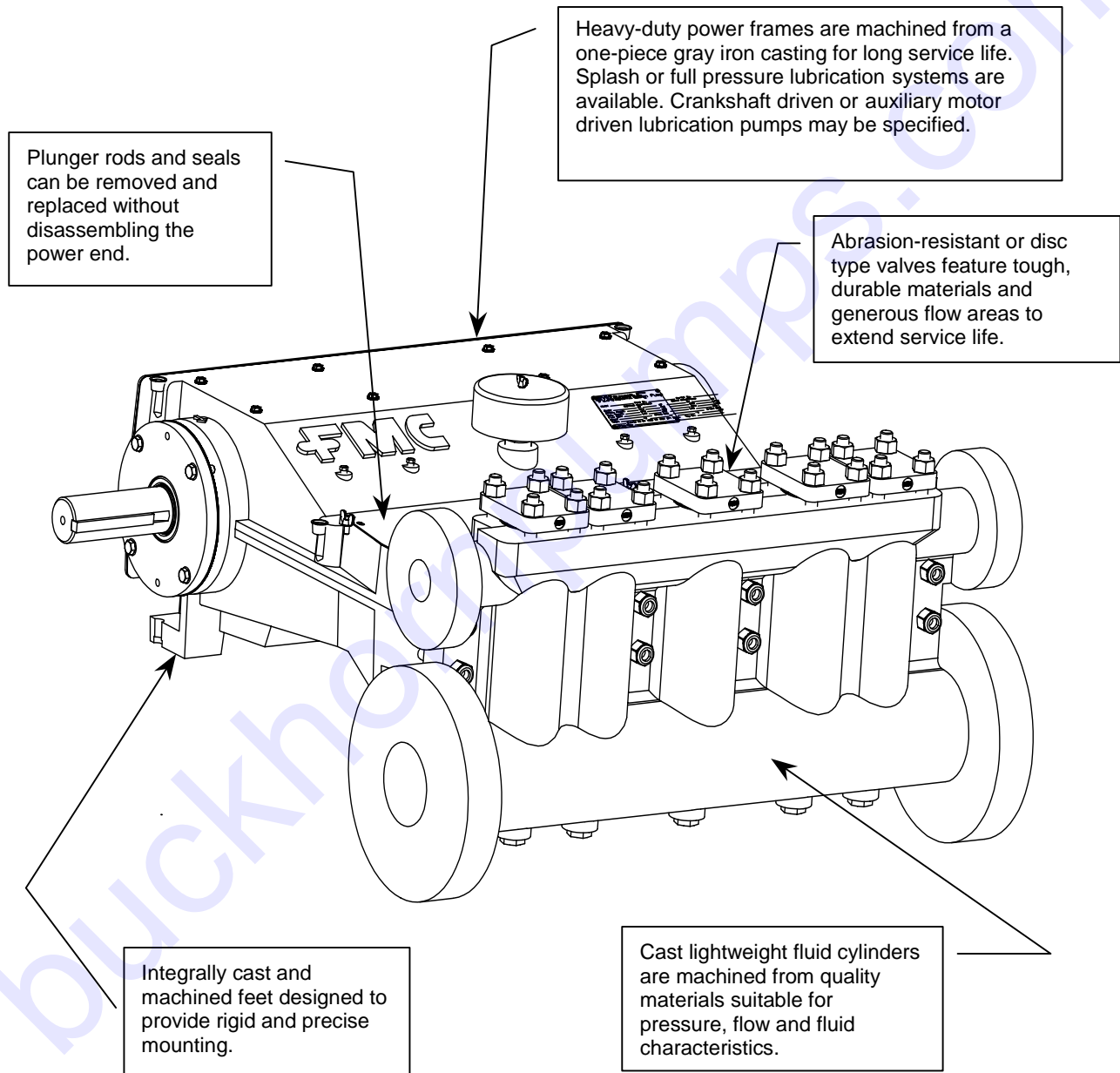


Figure 1: Q14 Pump Features

## 3.0 Storage Instructions

Proper storage of your FMC pump will insure that it is ready for service when needed. Follow the guidelines below that fit the requirements of your application.

FMC pumps come from the factory prepared for storage periods of up to six (6) months in proper environmental conditions. Indoor storage in a dry, temperature-controlled location is always recommended. If pumps are to be stored short term (less than six (6) months) in a severe environment, they should be prepared using the procedures outlined in the “Short Term Storage For Severe Environments” section below. If the pump is to be stored, or is inactive, for periods in excess of six (6) months, it is necessary to prepare the pump as outlined in the “Long Term Storage” section.

### 3.1 Short Term Storage

If the pump is stored in an indoor, temperature controlled environment for less than six (6) months, no special steps are required to prepare it for storage. As a general rule for pumps in corrosive fluid applications, the fluid end should be drained, flushed with water or other non-corrosive cleanser and blown dry using compressed air whenever idle.

### 3.2 Short Term Storage for Severe Environments

Drain any fluid from the pump; flush the fluid end with water to clean out any of the remaining pumpage and blow dry with compressed air. Spray a fog of preservative oil into the suction and discharge ports of fluid end, and then plug those openings. Remove the oil fill cap (or plug) and the power end breather vent. Spray a heavy fog of preservative oil into the oil fill hole until it can be seen coming out of the breather opening. Coat all exposed, unpainted metal surfaces (for example, the drive shaft) with a preservative oil. Replace the oil fill cap and breather vent with a solid plug to prevent ingress of moisture.

### 3.3 Long Term Storage

Long-term storage is defined as any period when the pump is in storage or idle in excess of six (6) months. If the pump has been in service, flush the fluid end with water to clean out any of the remaining pumpage, then blow the fluid end dry using compressed air.

Plungers and packing should be removed from the stuffing boxes and securely packaged for shipment and storage.

Drain all remaining oil from the pump power end. Remove the rear cover to expose the drive components. Spray all internal parts with a rust preservative that is soluble in lubricating oil while rotating the drive shaft several turns by hand to insure complete coverage. Replace the rear cover and add a concentrated internal rust inhibitor per recommendations (see Recommended Lubricant Chart, Section 8).

Spray a rust preventative onto all exterior machined surfaces paying careful attention to any unpainted areas like the crankshaft extension and plunger rods. Remove the power end breather cap and store in a dry place. Cap the breather opening with a plug or

other suitable means in order to keep the preservative atmosphere sealed inside the power frame.

Never store the pump on the floor or ground. Always place it on a pallet or blocks so that it is several inches above ground level. Periodically inspect the unit and rotate the crankshaft by hand several turns during each inspection. Drain and replace the rust inhibitor after every six (6) months of storage.

Before operating the pump, drain the preservative and lubricating oil mixture from the power end. Reinstall the drain plug, breather/filler cap, plungers and packing, and any other components that were removed for storage. Once these steps have been completed, follow the normal pump start up procedures outlined in this manual. Note that FMC can prepare units for extended storage for a nominal fee if specified at the time of order.

### **3.4 Precautions during Freezing Weather Conditions**

Freezing weather can cause problems for equipment when pumping water based fluids that expand in volume when changing from a liquid to a frozen solid state. For example, when water is left in a pump fluid end and exposed to freezing temperatures, the expansion of the water as it freezes can rupture the fluid cylinder of the pump and cause permanent equipment damage or personal injury.

Whenever the pump is stored or idle in conditions that are near or below freezing, any water based fluids should be removed from the pump. The best way to do this is to run the pump for a few seconds with the suction and discharge lines disconnected or open to atmosphere. This will clear the majority of the fluid from the pumping chamber as well as the suction and discharge manifolds. After the run, blow compressed air through the fluid end to remove all traces of fluid. If possible, lift up the suction valves to insure that all fluid is drained from the pumping chamber between the suction and discharge valves.

## 4.0 Installation Guidelines

A proper installation is the key to optimum performance, longer service life, and reduced maintenance requirements. Take time to thoroughly plan all aspects of your installation.

### 4.1 General Location

It is important to position the pump on a flat, level surface. The operation of the lubrication system may be affected if the pump is not near level. Whenever possible, the pump should be mounted in a clean, dry location with sufficient lighting and adequate space for easy inspection and maintenance. Locate the pump as close to the suction source as possible to allow for the shortest and most direct routing of the inlet piping.

### 4.2 Mounting Pump to Foundation and Power Source

The Q14 pump must be mounted in a horizontal position only. Secure the pump to the mounting surface using the four (4) holes provided in the pump base. Check motor or engine rotation direction to insure that the top of the pump drive shaft rotates towards the pump fluid end when in operation.

For units that are V-belt driven, check the alignment of the sheaves after the unit is installed on its permanent mounting. Tighten belts to the proper tension as recommended by the belt manufacturer. Verify that the sheaves are in line and running parallel to each other with a straight edge or other device. Never operate the pump without the belt guard securely in place.

For direct-coupled units, insure that the shafts are properly aligned according to the coupling manufacturer's recommendation. Never operate the pump without a shaft guard securely in place.

### 4.3 Suction Piping Recommendations

Poor suction piping practices are a very common source of pump problems. To insure proper operation it is very important to follow good design practice in the installation of the suction system before the pump is operated. A small amount of extra time and money invested in the piping system usually provides for better pump performance and longer periods between service requirements. It is difficult to diagnose many pump problems without the aid of a suction pressure gage. For this reason, FMC recommends that a gage always be installed in the suction line directly before it enters the pump.

The suction line from the fluid source to pump should be as short and direct as possible. Use rigid piping, non-collapsible hose or a combination of both as circumstances warrant in your installation. The suction pipe size should be at least equal to or one size larger than the pump inlet. Long piping runs, low suction heads, or indirect pipe routing may require even greater oversizing of the suction line for proper operation of the pump. In some cases it may be necessary to install a booster pump in the suction line of the pump to obtain sufficient pressure for the pump to operate successfully.

The suction line must be laid out so that there are no high spots in the line where gas or air pockets could collect. These pockets can make the pump difficult to prime and cause rough, erratic operation. A drain valve or plug should be installed at the low point of the suction line to allow for drainage during freezing conditions and for maintenance.

FMC recommends that all piping be supported independently of the pump. By supporting the piping this way, vibrations are reduced and stress on the pump is kept to a minimum. The use of elbows, nipples, unions, or other fittings should be minimized. Make sure that all joints and connections are airtight. Air leaks reduce the capacity of the pump and can result in cavitation, rough operation, and/or loss of prime. To help isolate mechanical and hydraulic vibrations, FMC recommends the use of flexible hose connections between the pump and any rigid piping.

Always insure that calculated system net positive suction head available (NPSHa) exceeds pump net positive suction head required (NPSHr) by at least 5 feet (1.5 meters) of water for proper operation of the pump. NPSH requirements for each pump model are provided on the product data sheets available through FMC or your authorized FMC reseller. FMC does not recommend using the pump in static lift conditions without prior approval.

## 5.0 Discharge Piping Recommendations

Route the discharge piping in as short and direct a route as possible. Use the same pipe size as the outlet of the pump. In installations where the discharge piping is in excess of 150 feet (50 meters), it is suggested to use the next larger size pipe to minimize friction losses downstream of the pump. Always use pipe or hose that is designed for your particular pressure requirements. Inadequate pressure ratings can allow hose or pipe to fail resulting in personal injuries or equipment damage. Normal hose pressure ratings are clearly marked on the outer surface of the hose. Working pressure ratings for pipe, flanges, and fittings can be obtained from the manufacturer or reference material.

Always use a pressure gage in the pump discharge line. A properly functioning gage mounted at the pump (and before any valves) is required to accurately determine the operating pressure of a pump.

A properly adjusted pressure relief valve or rupture disc must be installed directly downstream of the pump to prevent damage or injuries resulting from over pressure or deadhead conditions. The relief valve by-pass line must be as large as the pipe outlet of the relief valve. Never install valves in the by-pass line or between the pump and the pressure relief device. FMC recommends that the by-pass be returned to the suction tank or drain, not back into the pump suction line.

Insure that all piping is supported independently of the pump to reduce vibrations and strain on the pump itself. The use of elbows, nipples, unions, or other fittings should be kept to an absolute minimum. Avoid short radius 90° elbows; use two long radius 45° elbows instead. To help isolate mechanical and hydraulic vibrations, FMC recommends the use of flexible hose connections between the pump and any rigid piping or the use of pulsation dampeners.

## 6.0 Multiple Pump Systems

Special consideration must be taken to avoid vibration and pulsation problems when operating multiple reciprocating pumps using common suction and discharge piping headers. It is recommended that the user contact FMC or other experienced industry consultants for assistance with the design of the system and pump in these situations.

## 7.0 How to Start a Pump

Always take special precautions when starting a pump for the first time or after any extended shutdown. Never assume that someone else has properly prepared the pump and system for operation. Always check each component of the system prior to every start-up.

The checklist that follows is intended to be a general guide for starting a pump in a typical installation. Every installation is different, and each will have different requirements to insure safe and successful operation. It is the responsibility of the operator to determine the correct start-up procedure for each installation.

1. Insure that the drain plugs on the bottom of the pump crankcase have been installed and are tight. Insure that the oil level sightglass has been properly installed.
2. Check the oil level to insure that the pump is properly filled and that the oil has not been contaminated with water or other liquids. FMC pumps are not shipped with oil in the power frame and must be filled with the proper grade of oil prior to start-up. The Q14 pump requires 7.9 gallons (29.9 liters) of oil. Use the chart provided in Section 8.0 for assistance in selecting the correct type of oil for your service.
3. Insure that the pressure relief valve and all accessory equipment have been installed and properly adjusted. Verify that all joints are pressure tight.
4. Open the suction line valve to allow fluid to enter pump.
5. Check to insure that power is locked out, and then turn the pump over by hand if possible to insure free, unobstructed operation.
6. Make sure that all guards are in place and secure. Verify that all personnel are in safe positions and that system conditions are acceptable for operation.
7. Start the pump. Whenever possible, use a bypass line for the flow to allow the pump to start in an unloaded condition (no discharge pressure). Slowly close the bypass line to bring the pump into full load conditions. Shut down immediately if the flow becomes unsteady, pressure fluctuates or if unusual sounds or vibrations are noted.

## 8.0 Recommended Lubricants

Few factors can influence the life of a pump more than the power end lubricant. Careful selection of the right type of oil for your particular application will help insure optimal performance from your pump.

The intent of this section is to state the general lubrication requirements for FMC pumps. Several manufacturers products are listed by name in the table below in order to aid the customer in locating suitable products. The following listing is not exclusive, nor an endorsement of any particular product or manufacturer. Consult FMC for lubrication recommendations for applications that fall outside of the conditions listed below.

Table 1: Recommended Lubricants

Recommended Lubricant Chart						
Type of Service	Ambient Temperature	ISO Grade (cSt)	AGMA Number	SAE Weight	SSU Viscosity	Brand Names
General Service	0 - 95° F	100	3	30	550	Texaco Meropa 100 Shell Omala 100 Shell Rotella T SAE 30 Exxon XD-3 30 wt Mobil Trans HD-30
High Ambient Temperatures	95 - 120° F	220	5	50	1165	Texaco Meropa 220 Shell Omala 220 Shell Rotella T SAE 50 Exxon HD-3 50 wt Mobil Trans HD-50
Cold Ambient Temperatures	-30 - 60° F	68	2	20	350	Texaco Meropa 68 Shell Omala 68 Shell Rotella T SAE 20 Exxon HD-3 20 wt Mobil Trans HD-20
Frequent Start-Stop Cycles		150	4	40	775	Texaco Meropa 150
<b>Specialty Items</b>						
Internal Rust Inhibitor						Cortec VCI 329
External Rust Preventative						Texaco Metal Protective Oil L
Packing Lubrication		Rock Drill Oils			Exxon Arox 150 Shell Toreula 150 Mobil Almo 529	

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## 9.0 Preventative Maintenance Chart

Routine maintenance is an essential part of any successful pump installation. Properly maintained FMC pumps are designed to offer years of trouble-free service.

Regular maintenance and inspection will keep your pump operating at peak performance. FMC pumps have been carefully engineered to minimize maintenance requirements and simplify these tasks when they are required. Regular inspections allow operators to become familiar with normal pump operation so they can recognize the signals of potential problems and schedule maintenance. The chart shown below should be used as a guideline only. Many applications will require adjustment of the intervals shown in this chart for severe or unusual operating conditions.

Interval	Component	Service	Remarks
Break In Period	Crankcase Oil	Change	Drain and refill with new oil after first 50 hours of operation. Insure that magnetic drain plugs are cleaned of debris
	Inlet Strainer	Inspect	Clean if required. The amount of material in the strainer will determine the interval of cleaning
Daily	Complete Pump	Inspect	General inspection of pump and system to check for proper operation of equipment
	Packing Sets	Inspect	Check the stuffing box area of the pump for signs of leakage. Replace packing if leakage becomes excessive.
	Pump System	Flush	Required for shutdown when pumping fluids that may harden or corrode pump if left inside once stopped.
	Crankcase Oil	Inspect	Insure that oil is at proper level and has not been contaminated by pumpage or condensation.
3 Months/2,000 Hours	Crankcase Oil	Change	Drain and refill with new oil. Clean magnetic drain plugs.

Figure 2: Preventive Maintenance

## 10.0 Component Parts List

A typical Q14 pump configuration is shown below in Figures 3 and 4 for general reference purposes and for service procedures outlined in the following sections. Actual pumps supplied by FMC may use slightly different components or configurations. To order service parts or see exact component configurations for your particular pump, refer to the cross section drawing in the literature kit supplied with the pump. Contact your OEM reseller or FMC if you do not have this information.

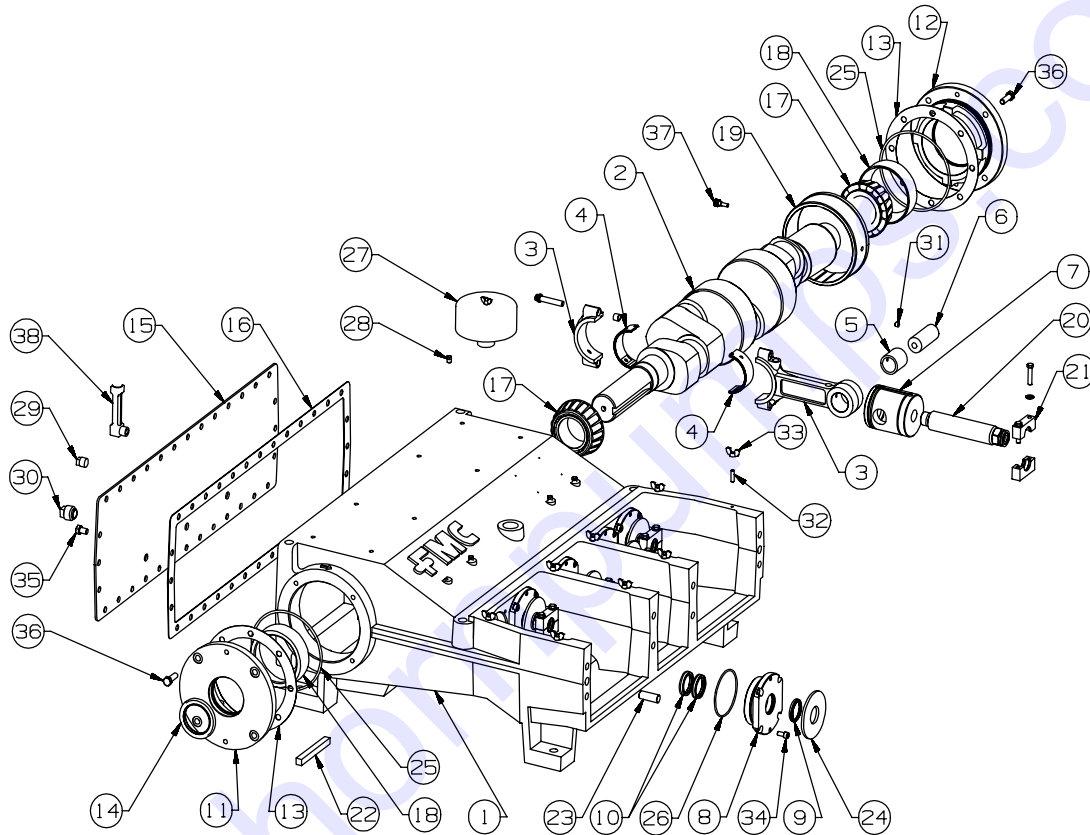


Figure 3: Power End Components

Table 2: Power End Components (See Figure 3)

Item Number	Description	Quantity Required
1	Power Frame	1
2	Crankshaft	1
3	Connecting Rod Assembly	5
4	Rod Shell Bearing	10
5	Con Rod Bushing	5
6	Wrist Pin	5
7	Crosshead	5
8	Seal Housing	5
9	Wiper Ring (Extension Rod)	5
10	U Cup Seal	10
11	Bearing Housing Drive Side	1
12	Bearing Housing (Blind)	1
13	Shim	As needed
14	Oil Seal	1
15	Back Cover	1
16	Back Cover Gasket	1
17	Bearing Cone	2
18	Bearing Cup	2
19	Center Bearing	2
20	Extension Rod	5
21	Plunger Clamp Assembly	5
22	Key	1
23	Dowel Pin	2
24	Deflector Shield	5
25	O-ring (Bearing Housing)	2
26	O-ring (Seal Housing)	5
27	Filler /Breather Assy.	1
28	Pipe Plug 1/8 NPT	4
29	Pipe Plug 1/2 NPT	2
30	Magnetic Pipe Plug	2
31	Set Screw (Cross Head)	5
32	Stud (Cradle Cover)	8
33	Wing Nut	8
34	Cap Screw (Seal Housing)	20
35	Cap Screw (Back Cover)	30
36	Cap Screw (Bearing Housing)	8
37	Lock Screw	2
38	Liquid Level Gage	1

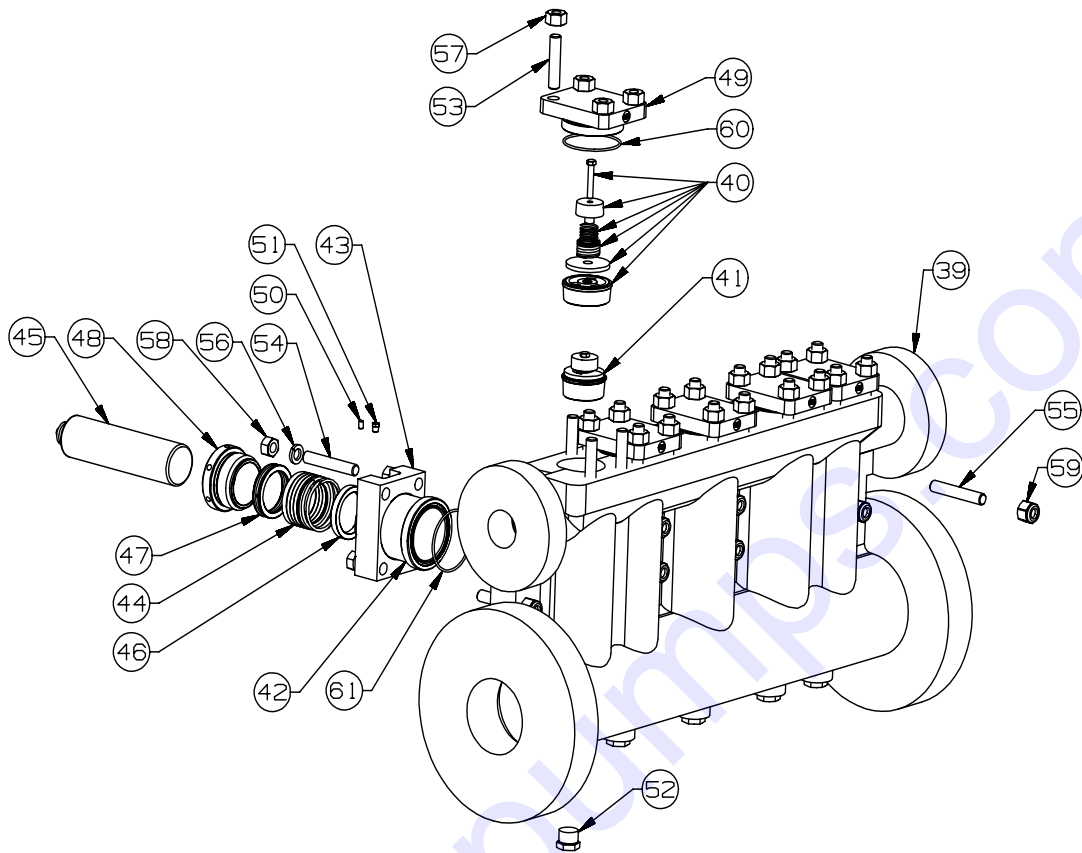


Figure 4: Fluid End Components

The illustrations above (Figure 4) depict a typical Q14 fluid end assembly with a cast fluid cylinder and disc type valves. The service procedures outlined in this manual are specific to this type of pump, however other configurations and minor design differences may have been supplied with your product. Some procedures may require slight adaptations as a result.

Table 3: Fluid End Components (See Figure 4)

Item Number	Description	Quantity Required
39	Fluid Cylinder	1
40	Discharge Valve Assembly	5
41	Suction Valve Assembly	5
42	Stuffing Box	5
43	Stuffing Box Clamp	5
44	Plunger Packing	5
45	Plunger	5
46	Throat Bushing	5
47	Lantern Ring	5
48	Adjusting Nut	5
49	Valve Cover	5
50	Set Screw (Nylon Tipped)	5
51	Pipe Plug (Stuffing Box)	5
52	Pipe Plug (Fluid Cylinder Drain)	5
53	Stud (Valve Cover)	20
54	Stud (Stuffing Box Clamp)	20
55	Stud (Fluid Cylinder)	8
56	Lock Washer (Stuffing Box Clamp)	20
57	Hex Nut (Valve Cover)	20
58	Hex Nut (Stuffing Box Clamp)	20
59	Lock Nut	8
60	O-ring (Valve Cover)	5
61	O-ring (Stuffing Box)	5

## 11.0 Service Procedures

FMC pumps are designed to simplify all required maintenance. The following sections illustrate a step-by-step procedure for performing most common service needs of a pump. Read and understand each section completely before attempting to service the pump.

### 11.1 Replacing Plunger Packing

1. Before starting any maintenance procedure that requires opening the fluid end, close the block valves on both the inlet and discharge side of the pump. **Make sure that the power to the pump driver is locked-out.** Relieve any pressure that might be in the fluid end. Remove one of the drain plugs from the bottom of the inlet manifold and allow all fluid to drain from the manifold. Remove the remaining plugs from the manifold. Use a bar or rod to reach through the inlet manifold and lift the suction valves to drain the individual pumping chambers. All fluid drained from the pump must be contained and properly disposed.
2. Unbolt the plunger clamps (21) and remove them from the plunger (45) and extension rod (20). Remove the nuts (58) holding the stuffing box clamps (43) to the fluid cylinder (39) and remove the stuffing box clamps (43). See Figure 5.
3. Rotate the crankshaft by hand until one of the extension rod (20) is fully retracted from the plunger (45). Slide the plunger and stuffing box out of the cradle of the pump as a single unit. Repeat this procedure for the other four plunger stuffing box assemblies. See Figure 5.
4. Loosen the set screw (50) locking the threads on the adjusting nut (48) and unscrew the adjusting nut. Use caution because the plunger packing (44) is sometimes spring loaded. Pull the plunger (45) from the assembly and remove the plunger packing (44). See Figure 5.

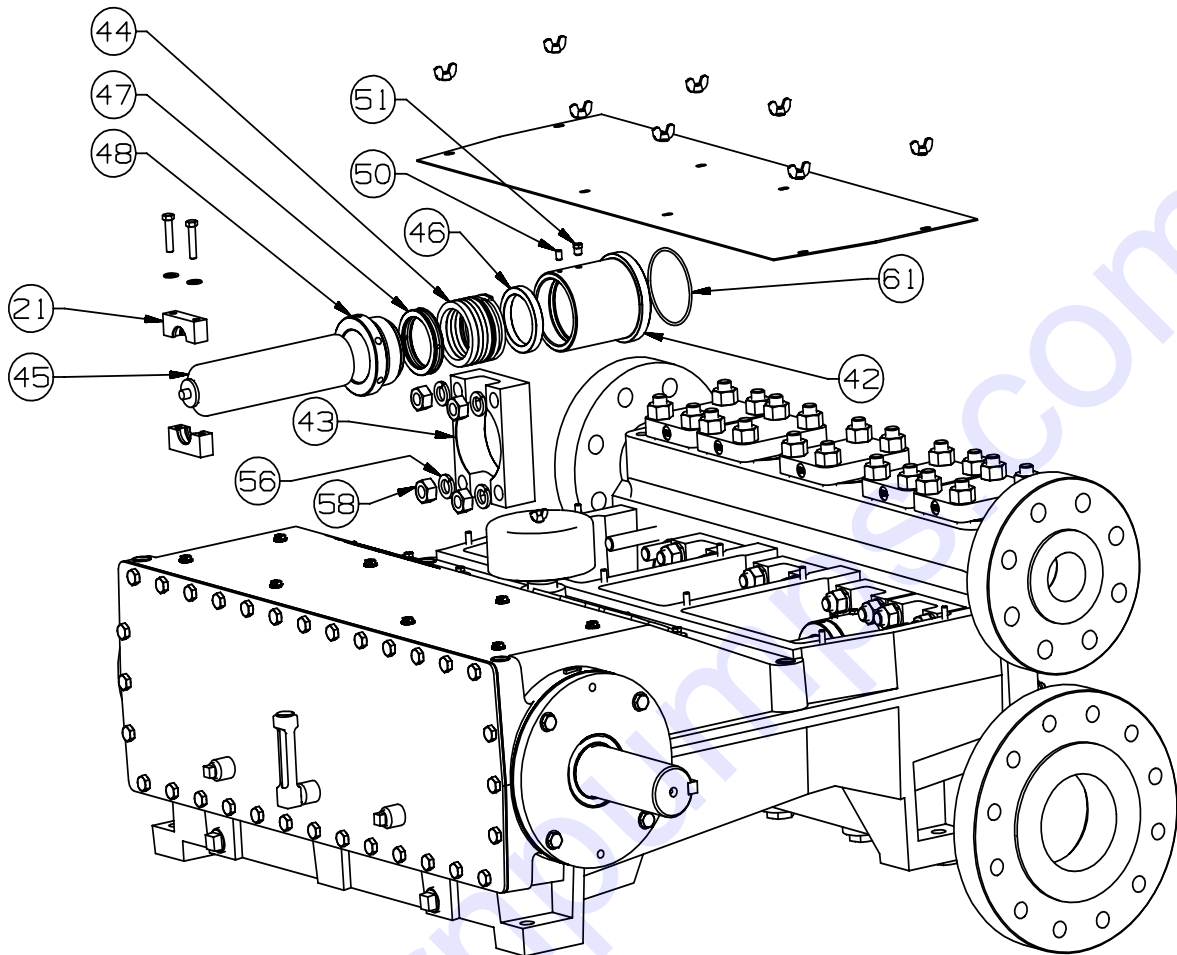


Figure 5: Replacing Plunger Packing

5. Inspect all parts for damage or unusual wear patterns and replace any components that appear damaged. Insure that the plungers are smooth and free of cracks, scores and grooves. New packing will fail prematurely if used with plungers that have damaged or rough surfaces. FMC recommends that all packing sets be replaced, not just those that show signs of leakage, whenever this type of service is performed. This will help insure maximum operation time between service intervals.
6. Reverse the previous steps to rebuild the pump after worn or damaged components have been replaced. FMC recommends that all seals or gaskets that are disturbed during a service procedure be replaced. This includes the stuffing box (42) face seal o-ring (61) and valve cover o-rings (60). Insure that all fasteners are tightened to the values specified in the Fastener Torque Requirements section of this manual.

## 11.2 Removing the Fluid Cylinder

1. Before starting any maintenance procedure that requires opening the fluid end close the block valves on both the inlet and discharge side of the pump. **Make sure that the power to the pump driver is locked-out.** Relieve any pressure that might be in the fluid end. Remove one of the drain plugs from the bottom of the inlet manifold and allow all fluid to drain from the manifold. Remove the remaining plugs from the manifold. Use a bar or rod to reach through the inlet manifold and lift the suction valves to drain the individual pumping chambers. All fluid drained from the pump must be contained and properly disposed of.
2. Unbolt the plunger clamps (21) and remove them from the plunger (45) and extension rod (20). Slide all of the plungers forward as far as possible. See Figure 6.
3. Disconnect the suction and discharge piping.
4. Remove the lock nuts (59) holding the fluid cylinder assembly on to the power frame (1). Support the weight of the fluid cylinder assembly and slide the assembly away from the power frame (1). See Figure 6.
5. Installation will be the reverse of this procedure. Torque all fasteners as outlined in the Fastener Torque Requirements section of this manual. Please note that if the lock nuts (59) on the fluid cylinder studs (55) are not adequately torqued a failure is highly likely.

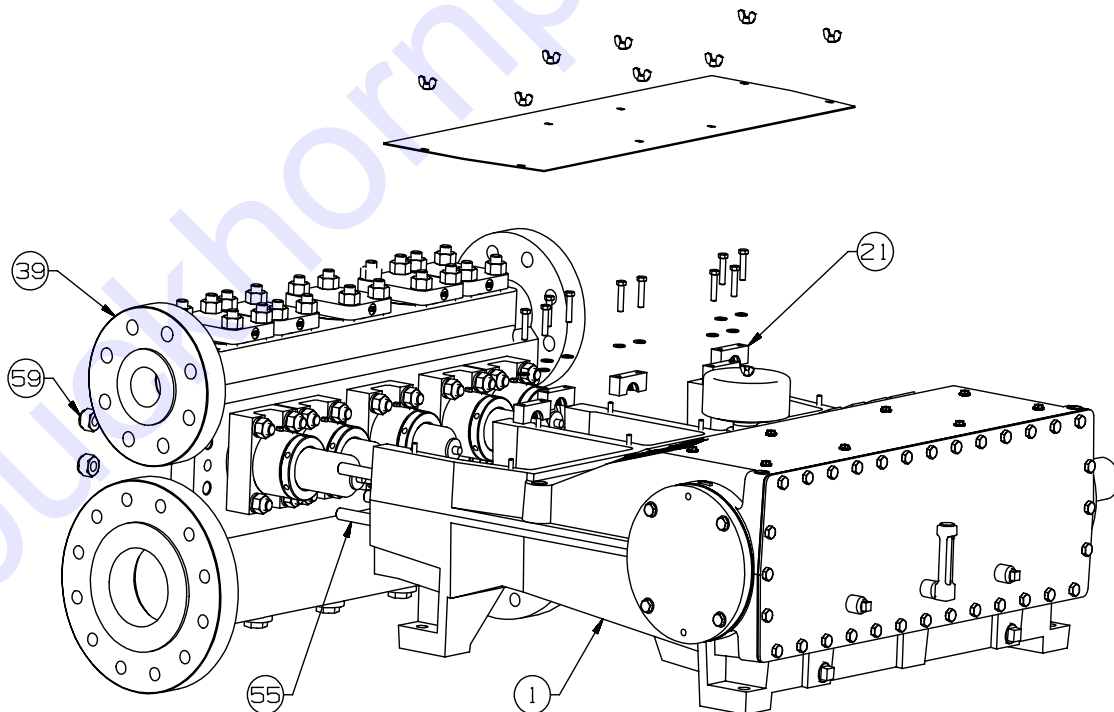


Figure 6: Fluid Cylinder Removal

### 11.3 Replacing Plunger Rod Oil Seals

1. The plunger rod oil seals retain oil in the power frame (1) and prevent dirt, water, or other contaminants from entering the power frame (1) by way of the plunger rods. The fluid end need not be disturbed to perform this procedure.
2. Bleed off all pressure inside pump fluid end before starting any service work.  
**CHECK TO INSURE THAT THE POWER IS LOCKED OUT.**
3. Unbolt the plunger clamps (21) and remove them from the plunger (45) and extension rod (20). See Figure 7.
4. Rotate the crankshaft (2) by hand until one of the plunger (45) is moved fully forward, toward the fluid cylinder (39), and the extension rod (20) is fully retracted.
5. Slide the deflector shield (24) off the end of the extension rod (20).
6. Unbolt the four cap screws (34) holding the plunger rod seal housing (8) to the power frame (1). Pull the seal housing (8) over the end of the plunger rod and out of the cradle. If the seal housing (8) is difficult to remove, threaded holes in the housing are provided to jack the housing away from the power frame (1) using the bolts holding the seal housing (8) in place. Repeat these three steps for the other seal housings (8). See Figure 7.
7. Remove the cup seals (10), wiper ring (9) and the o-ring (26) from the seal housing (8). Note the orientation of each seal prior to removing it. See Figure 7.
8. Inspect the extension rod (20) at this time. If it is scored or damaged in any way it must be removed. To remove the extension rod (20) unscrew it from the crosshead (7). A new extension rod (20) is screwed into the crosshead (7) and torqued per the Fastener Torque Requirements section of this manual.
9. Install a new o-ring (26) and new seals (10) in the seal housing (8) in the same orientation that they were originally.
10. Replace the seal housing (8) in the power frame cradle over the plunger rod and into position in the counterbore. Tap into position using a rubber mallet. The four cap screws (34) can be used to evenly draw the seal housing (8) into place. Take care to avoid folding the seal lips back when they are pushed over the plunger rod when the seal housing (8) is installed in the power frame (1). A small amount of motor oil on the plunger rod and the seal bore in the power frame (1) will aid this process and provide lubrication to the seals (10) during start-up.

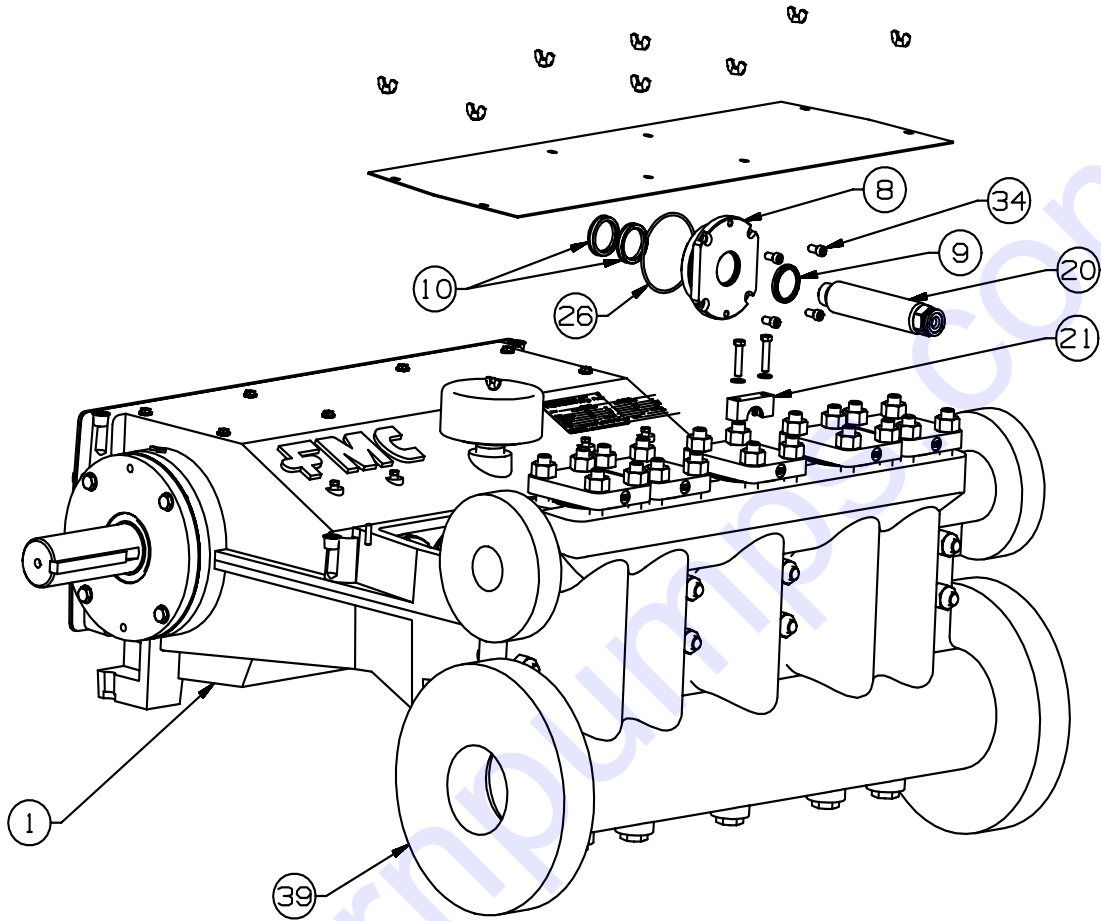


Figure 7: Replacing Plunger Rod Seals

## 11.4 Replacing Valves

1. Two types of valves may be supplied with a Q14 pump. They are disc type valves and AR style valves. The next steps must be performed for either type of valve.
2. Adequate clearance is required above, below, and in front of the pump fluid cylinder to allow valve service without removal of the fluid end. If sufficient clearance is not available, the fluid end must be removed as outlined in other sections and taken to a workshop for valve service. The following procedures are written under the assumption that sufficient clearance exists.
3. Loosen the hex nuts (57) that retain the five valve covers (49) on the top of the fluid cylinder. Remove the covers (49).
4. For AR type valves refer to MSP500000080. This document describes the methods for removing and installing the AR valves.
5. For disc type valves refer to MSP500000081. This document describes the methods for removing and installing disc valves.
6. After the valves have been replaced, inspect the o-ring (60) on the valve cover (49). FMC recommends that the valve cover o-rings (60) be replaced at this service interval even if they do not appear damaged. Fit the valve cover (49) with the o-ring (60) in place over the studs (53). Replace the valve cover hex nuts (57). Torque the cover hex nuts (57) to the recommend values listed in the Fastener Torque Requirements, Section 12.0, of this manual.

## 11.5 Servicing the Power End

1. Disconnect the driver from the pump and insure that suction and discharge lines are disconnected or blocked and have no pressure applied. Removal of the fluid cylinder simplifies most power end service procedures.
2. Remove magnetic pipe plugs (30) from bottom of pump and allow all oil to drain from crankcase. The magnetic elements will hold iron wear debris generated by the breaking in of the crossheads in their bores. This debris should be wiped or blown off the magnets before reinstallation. See Figure 8.
3. Remove the 32 rear cover cap screws (35). Remove the back cover (15) and back cover gasket (16) from the power frame. See Figure 8.

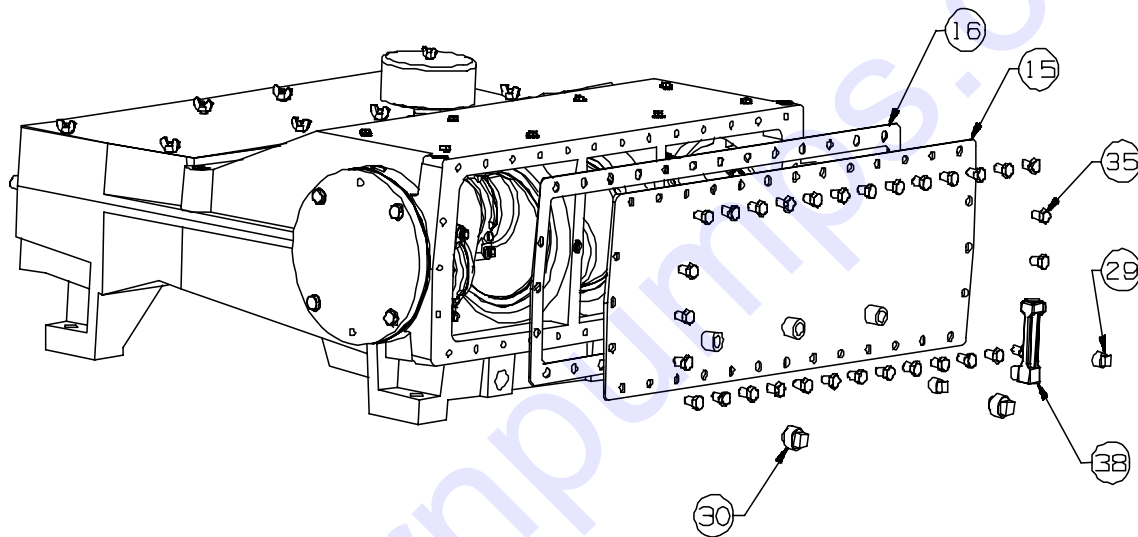


Figure 8: Removing the Back Cover

4. Remove the end cap of the connecting rod (3) by unscrewing the two cap screws that hold each cap to the rod body. See Figure 9.
5. Slide the rod bearings (4) from the connecting rods and rod caps. Note that these parts sometimes adhere the crankshaft pins. See Figure 9.

6. Connecting rods and caps are matched sets and must always be reassembled with their original mate and in the same orientation. Note the numbered codes stamped on each half of the connecting rod assemblies and make certain they are installed as matched set and in the same orientation when re-assembling the pump.
7. Unbolt the four cap screws (34) holding the plunger rod seal housing (8) to the power frame (1). Pull the seal housing over the end of the extension rod (20) and out of the cradle. See Figure 9.
8. Push the connecting rods (3) and crossheads (7) as far forward into the power frame (1) as possible to provide clearance for the crankshaft (2). This will provide additional clearance when removing the crankshaft.
9. Using a feeler gage check the clearance between the center bearings (19) and the crankshaft (2). If the clearance is more than .010" the bearing must be replaced. Detailed instructions about this will follow below.

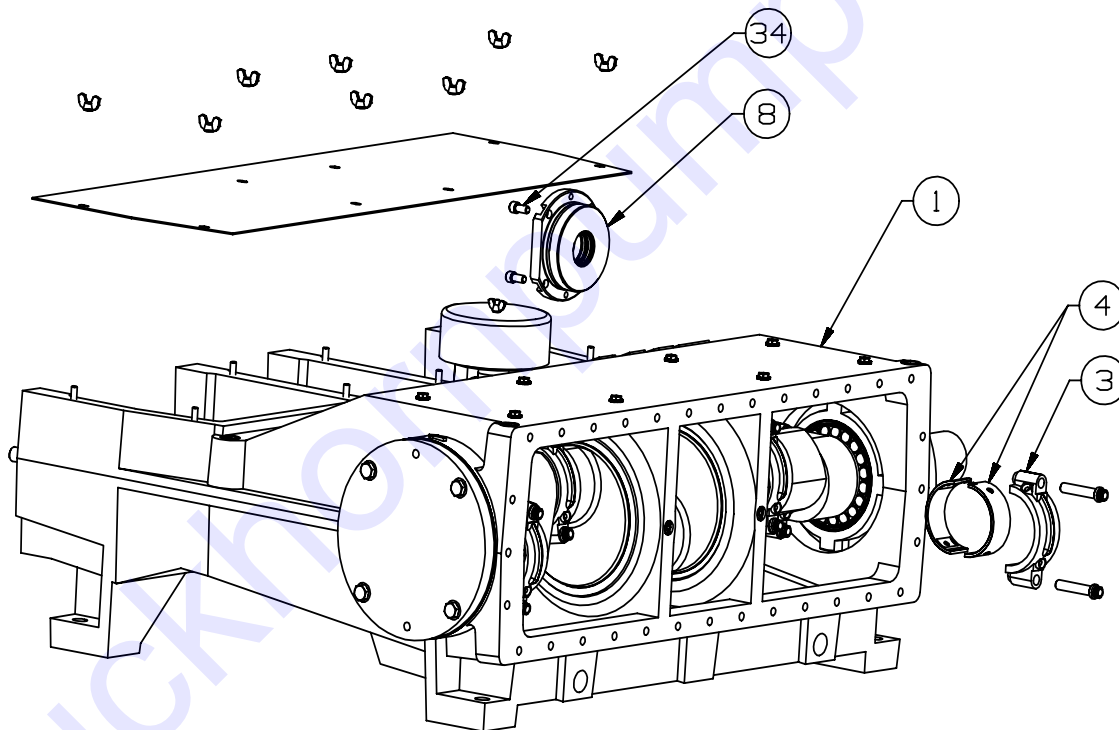


Figure 9: Replacing the Shell Bearings

10. Remove bearing housings (11 & 12), hex head cap screws (36) and shims (13). Note that the bearing cups (18) and crankshaft oil seal (14) will remain attached to the bearing housings (11 & 12). It may be necessary to tap on the housing with a rubber mallet to free it from the power frame (1) after the hex head cap screws (36) have been removed. If that is not adequate, tapped jack screw holes which are the same size as the cap screws (36) holding the housings in place have

been provided in each bearing housing to help remove stuck housings. See Figure 10.

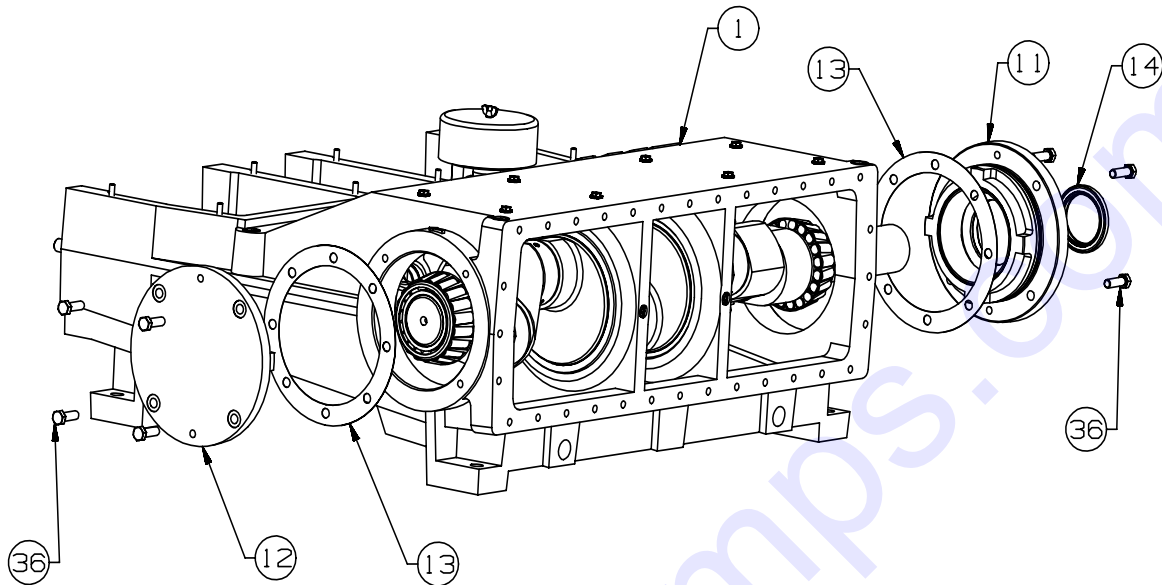


Figure 10: Removing Crank Bearings

11. To remove the crankshaft (2) work it through one side of the bearing housing opening in power frame (1). The throws may have to be rotated as the crank is removed to clear the connecting rods. The crankshaft should be handled very carefully to prevent the critical bearing surfaces from being scratched or damaged. See Figure 11. See Section 13.0 for a tool to lift the crankshaft.

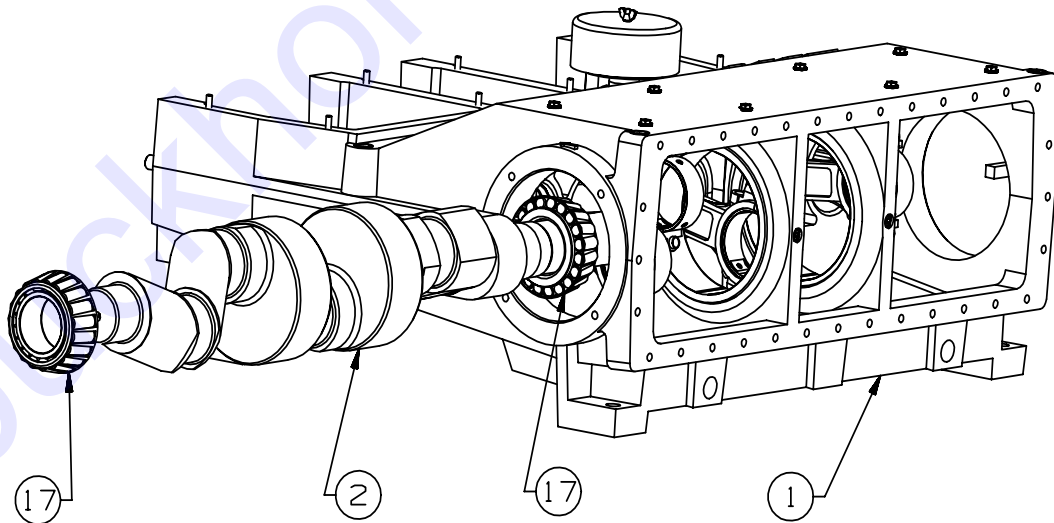


Figure 11: Removing the Crank Shaft

12. Bearings cones (17) can be removed from the crankshaft using an automotive type bearing puller. Bearing cups (18) can be removed from the bearing housings (11 & 12) using a puller if a sufficient lip is available for the puller arms to grab. An alternate procedure involves running a weld bead around the inside surface of the cup. When cool, this will reduce the interference between the cup and bearing housing enough to free the cup. Always replace with new bearing cups and cones.
13. Pull connecting rod and crosshead assemblies from the power frame (1). Take care to insure they are reassembled into the same bore from which they were removed. See Figure 12.
14. Inspect all components for signs of wear or damage and replace if required. Carefully check the crankshaft bearing surfaces for pits, scratches or other signs of wear. If any of the bearings are damaged and must be replaced. FMC recommends that all bearings be replaced even though some may not show visible signs of damage.

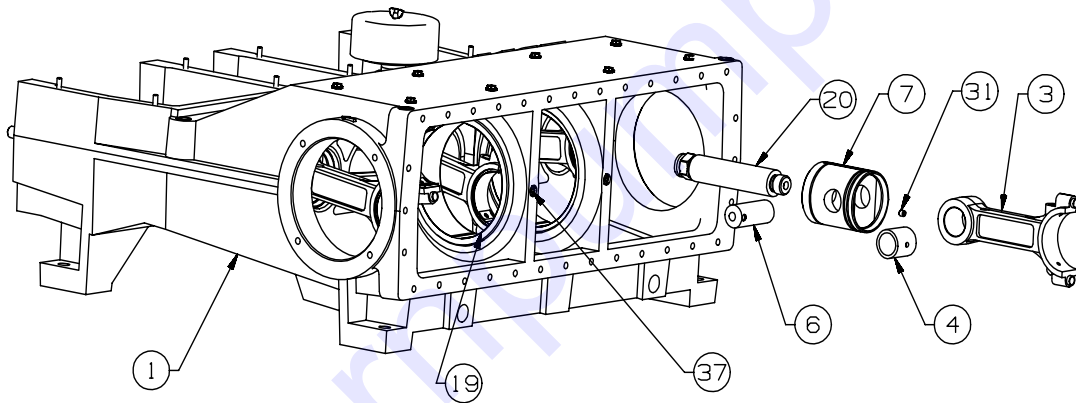


Figure 12: Removing the Cross Head and Con Rods

15. If the center bearings (19) require replacement remove the lock screw (37) from the power frame (1). The bearings may be driven out of the power frame by pressing or tapping away from the center of the pump. See Figure 12 for the location of these parts.
16. Thoroughly clean all parts with solvent and apply a thin coat of oil before reassembly.
17. Tapered roller bearing cones must be heated to aid in assembly to the shaft. Always observe proper safety procedures and use heat resistant tools and gloves when handling hot parts. There are a number of recommended methods for heating bearings. Electric ovens or electrically heated oil baths may be used, but only when accompanied by proper thermostatic control.
18. To replace the crankshaft (2) tapered roller bearings, heat the bearing cones to a maximum of 300° F and slide down the shaft unit it is full seated against shoulder.

The hot bearing cone (17) may pull away from the cold shoulder unless it is held in position until it cools enough to grab the shaft. Use a .001" thick feeler gauge to verify that the bearing cone (17) is fully seated against the shoulder of the crank after parts have cooled.

19. Use a press to seat the new cups (18) in the bearing housing (11 & 12). Never use new bearing cones (17) with old bearing cups (18).
20. If new center bearings (19) were required install them at this time. The bearings must be pressed or tapped into the power frame (1). They have an alignment hole on the outside that needs to line up with the lock screw (37). Use care when installing these. After the lock screw (37) is installed check the inside diameter of the bearing (19) to verify that there is no bulge where the lock screw (37) engages the bearing (19). Torque the lock screw (37) per Section 12.
21. Reassemble the crossheads (7) and connecting rods (3). Install new rod bearing inserts (4). Insure that the set screw (31) retaining the wrist pin (4) is in place if it was removed for repair or inspection of the wrist pin bushing. See Figure 12.
22. Push the crosshead assemblies fully forward in power frame (1) to provide maximum clearance for the crankshaft (2). Insure crossheads (7) are replaced in same orientation and in the same cylinder bore they were originally. The oil cup pocket feeding lubricant to the wrist pin bushing is on the top of the connecting rod (3) and should be in the up position. The cross heads have an oil reservoir which must be on the top.
23. Slide the crankshaft (2) with the bearing cones installed into the power frame (1) using the tool if available.
24. Reinstall the shims (13) and bearing housing (11 & 12). As a starting point, install the same number of shims (13) that the pump originally had prior to service. Inspect the o-rings (25) that seal the bearing housing (11 & 12) and replace if damaged.
25. Replace the rod bearings (4) in the connecting rod caps. Insure that rod caps are assembled with their mating connecting rod. Torque the cap screws holding the end caps to the mating rod per the values given in the Fastener Torque Requirements section of this manual. After the cap screws are torqued, striking the cap with a rubber hammer will help properly seat the rod bearings. See Figure 9.
26. A dial indicator must be used to properly adjust the endplay of the crankshaft (2). Improper adjustment may result in excessive temperature, noise, and reduced bearing life. FMC recommends between .000"-.002" of internal axial clearance (end play) when properly assembled. The final adjustment must be verified using a dial indicator.
27. Turn the crankshaft (2) more than two complete revolutions to insure the connecting rods are loose, there is no binding in the rod bearings, the wrist pin joints are free and the crossheads move freely in the power frame (1).

28. Mount a dial indicator base on back of power frame (1) with the indicator tip on a shoulder of the crankshaft (2) and the axis of the indicator parallel to the crankshaft (2).
29. Move the crankshaft (2) to one side of the power frame (1) using a light tap from a rubber mallet or a pry bar.
30. Set the dial indicator to zero.
31. Move the crankshaft (2) back over to the opposite side and read bearing endplay as total indicator movement. Remove or add shims as necessary to achieve proper endplay (.000" to .002"). Distribute shims equally on both bearing housings (11 & 12). Verify the endplay with the dial indicator per the procedure described before final assembly.
32. Install the oil seal (14) into the bearing housing (11). The oil seal can be installed over the end of the crank shaft (2) and seated in the bearing housing (11) with light hammer blows. When properly seated it will be flush with the face of the bearing housing (11). See Figure 9.
33. Install all of the plunger rod seal housings (8) in the power frame (1). The crankshaft should turn freely.
34. Complete reassembly of pump. Torque all fasteners as outlined in the Fastener Torque Requirements section of this manual.

## 12.0 Fastener Torque Requirements

No pump service procedure is complete without insuring that the fasteners have been properly torqued. Failure to properly tighten the pump bolting could cause the pump to leak or even allow the bolts to fail. Always use a calibrated torque wrench during the installation of all critical fasteners listed below. Values are in FT-LBS and Newton meters. Typical sizes are shown; other sizes may be used depending on application.

Table 4: Fastener Torque

		<b>Power End</b>					
<i>Item</i>			<i>Typical</i>	<i>Torque</i>			
<i>Number</i>	<i>Description</i>	<i>Size</i>	<i>Material</i>	<i>Ft-lbs</i>	<i>N-m</i>		
(35)	Back Cover Bolts	0.500-13 UNC	GR-5	40	54		
(36)	Bearing Housing Bolts	0.500-13 UNC	GR-5	40	54		
(3)	Connecting Rod Bolts	0.500-13 UNC	Alloy	65	88		
(31)	Cross Head Set Screw	0.375-16 UNC	Alloy	20	27		
(37)	Lock Screw	0.375-16 UNC	Alloy	20	27		
(33)	Cradle Cover Wing Nut	0.375-16 UNC	GR-2	10	14		
(7 & 20)	Extension Rod to Crosshead	1.250-8 UN	17-4 SST	350	475		
(34)	Seal Holder Cap Screw	0.375-16 UNC	A193-B7	25	34		
(21)	Plunger Clamp	0.375-16 UNC	18-8 SST	10	14		
		<b>Fluid End</b>				Xylan Coated	
<i>Item</i>			<i>Typical</i>	<i>Torque</i>		<i>Torque</i>	
<i>Number</i>	<i>Description</i>	<i>Size</i>	<i>Material</i>	<i>Ft-lbs</i>	<i>N-m</i>	<i>Ft-lbs</i>	<i>N-m</i>
(55)	Attachment to Power End	0.750-10 UNC	A193-B7	250	340	175	237
Valve Cover Clamps							
(53)	Q1408-Q1410	0.750-10 UNC	A193-B7	250	340	175	237
(53)	Q1412	0.750-10 UNC	A193-B7	250	340	175	237
(53)	Q1414-Q1418	0.750-10 UNC	A193-B7	250	340	175	237
(53)	Q1420-Q1426	0.750-10 UNC	A193-B7	250	340	175	237
Stuffing Box Clamps							
(54)	Q1408-Q1410	0.750-10 UNC	A193-B7	250	340	175	237
(54)	Q1412	0.750-10 UNC	A193-B7	250	340	175	237
(54)	Q1414-Q1418	0.750-10 UNC	A193-B7	250	340	175	237
(54)	Q1420-Q1426	0.750-10 UNC	A193-B7	250	340	175	237

Refer to Figure 3 and Figure 4 for item numbers.

The section for the fluid end components includes torques for the fasteners coated with Xylan. Xylan is a flouropolymer coating applied to components to provide corrosion resistance and lower coefficient of friction. Xylan fasteners are typically colored blue or red.

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### 13.0 Special Service Tools

The items listed below are special tools available from FMC to help aid in key service procedures. They are referenced in several of the proceeding maintenance procedures.

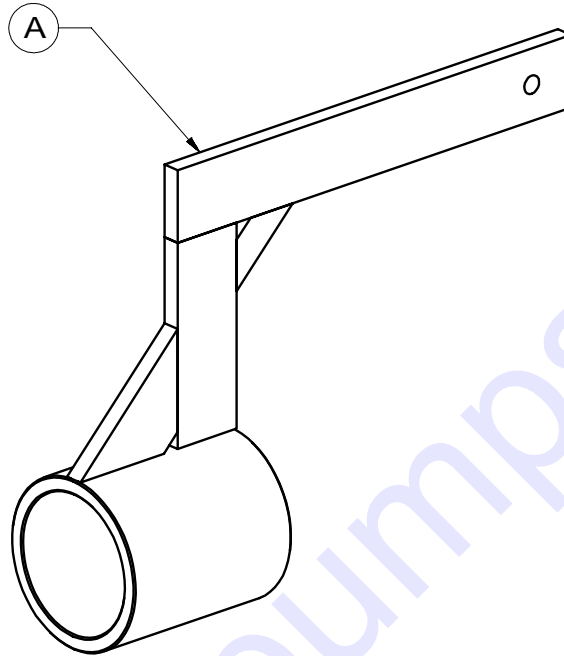


Figure 13: Crankshaft Lifting Tool

Crank Shaft Lifting Tool: No part number has been established for the crankshaft lifting tool. Contact FMC Engineering for tool details if required.

Valve Removal kits:

Pump Models	AR Style	Disc Style	Valve Series
Q1408 – Q1412	5276357	5263974	3
Q1414 – Q1418	No numbers assigned.		6
Q1420 – Q1426	5276358	3268171	7

## 14.0 Trouble-Shooting Pumps

This chart is designed to aid in the solution of pump and pump system problems. Once the problem has been identified, work through the possible causes and solutions until the problem has been corrected.

### No flow from pump

- Tank is empty
- Inlet valve is closed
- Inlet strainer is clogged with debris
- Crankshaft is not turning

### Insufficient pressure from pump ONLY

- Pump speed is too slow
- Relief valve improperly adjusted and by-passing fluid
- Oversize or worn nozzle on equipment
- Worn pump valves
- Excessive leakage from plunger packing

### Insufficient flow from pump ONLY

- Pump speed is too slow
- Relief valve improperly adjusted and by-passing fluid
- Worn pump valves
- Excessive leakage from plunger packing

### Insufficient flow OR pressure AND rough operation

- Valve problem:
  - Valve is stuck in the open or closed position
  - Valve assembly is damaged or unseated
  - Valve seat is washed out
- All pump cylinders not primed
- Inlet strainer is clogged with debris
- Excessive gas in liquid due to:
  - Air leaks in suction line or fittings
  - High spots in suction line that allow formation of gas pockets
  - Vortex in tank near inlet pipe opening
  - Insufficient NPSHa
- Pump is cavitating due to:
  - Insufficient NPSHa (tank head or charge pressure)
  - Fluid viscosity is too high
  - Inlet line is too long and/or too small diameter

### Pump runs rough, knocks, or vibrates ONLY

- Loose plunger
- Valve assembly is damaged or has unseated
- Pump is cavitating due to:
  - Insufficient NPSHa (tank head or charge pressure)
  - Fluid viscosity is too high
  - Inlet line is too long and/or too small diameter
- Worn or damaged power frame components
- Pump is sucking air across worn plunger packing during suction stroke (usually only observed on pumps that do not have a booster pump)

### Suction pressure fluctuates rapidly

- Pump is cavitating
- Air is entering into the suction piping

### Fluid leaking from pump

- Piston cups are wearing and about to fail
- Fluid cylinder bolts are not properly tightened
- Fluid cylinder o-rings (or gaskets) are damaged
- Piston assembly o-rings are damaged

### Short Plunger Packing life

- High abrasive particle content in fluid
- Wrong style or type of packing for service
- Plunger is damaged
- Pump is cavitating
- Pump is allowed to run dry for extended periods of time
- Packing Lube system not properly maintained (if equipped)

### Short valve life

- High abrasive particle content in fluid
- Valve assemblies only partially rebuilt during previous service
- Valve assemblies damaged due to improper installation techniques
- Pump is cavitating

### Cracked fluid cylinder

- Discharge pressure too high
- Pump exposed to freezing conditions without properly draining
- Hydraulic shock resulting from cavitation or entrained air
- Discharge valve is stuck shut
- Material or manufacturing defect

### Crankshaft jerks or starts and stops rotation

- V-belts are loose and slipping (if equipped)
- Hydraulic system relief valve is chattering (if equipped):
- Attempting to operate pump at excessively high discharge pressure
- Discharge line is blocked or partially obstructed

### Power end overheats (in excess of 180° F)

- Discharge pressure too high
- Low oil level
- Improper oil viscosity
- Contaminated power end oil
- Pump speed is too fast
- Pump is running backwards
- Couplings are misaligned
- V-belt drive tension is too tight
- Pump located too close to heat source
- Worn or damaged power frame bearings

### Broken crankshaft or connecting rod

- Pump exposed to freezing conditions without proper draining
- Discharge pressure too high
- Suction pressure too high
- Hydraulic shock due to cavitation
- Material or manufacturing defect

### Broken Fluid End Bolts

- Bolt or nut not properly torqued
- Discharge pressure too high
- Excessive piping loads on fluid end

### Power end oil is contaminated

- Pump has been operated with failed plunger packing for extended periods of time
- Use of high-pressure wash wand to clean near breather or oil seal areas
- Deflector shields are missing or damaged
- Extension rod oil seals are damaged or improperly installed

## 15.0 Ordering Parts

Service parts are available through FMC's worldwide network of distributors, or from the original supplier for the equipment that the pump is used on. If unsure where to purchase parts, contact FMC customer service for the location of an authorized parts retailer in your area. Always insist on genuine FMC replacement parts.

Use the assembly drawing and bill of materials included with this manual to determine the components and corresponding part numbers required to service the pump. Make sure that the part number on the drawing or bill of materials matches the part number of the pump requiring parts. When ordering parts, always reference the part number and serial number of the pump with the order. These numbers can be found stamped on the metal nametag affixed to the power end of every pump. By referencing these numbers you can insure that the components you receive work as intended with your pump.

Be sure to inquire about any special service tools or complete maintenance kits.

## 16.0 Glossary of Commonly Used Terms

CAPACITY	The total volume throughput per unit of time at suction conditions. It includes both liquid and any dissolved or entrained gases. For all practical purposes this can be considered the volume flow rate in the suction pipe. The standard unit of pump capacity is U.S. gallons per minute (GPM).
CAVITATION	The state where fluid pressure drops below vapor pressure, causing the liquid to begin to change from a liquid to a gas and boil. Usually occurs in the chamber between the suction and discharge valves during the suction stroke, and often sounds like a mechanical knock. Cavitation results in the formation of gas bubbles, or cavities, in the fluid that cause vibration and damage when they are collapsed by the increased fluid pressure on the discharge stroke.
DAMPENER	A device that reduces pressure pulsations in the suction or discharge piping. May be referred to as a suction stabilizer, accumulator, or surge suppressor.
DISPLACEMENT	The volume swept by all pistons or plungers per unit time. This term is typically expressed as gallons per revolution.
POWER END	The portion of the pump that converts supplied rotary motion into linear motion used by the Fluid End to move the pumpage.
EFFICIENCY	Mechanical efficiency is the ratio, expressed as a percentage, of pump power output to the pump power input. The mechanical efficiency of reciprocating pumps is very high, typically in excess of 90%. Volumetric efficiency is the ratio of actual pump capacity to theoretical displacement
FLOODED SUCTION	Implies that the level of liquid in the suction vessel is above the centerline of the suction port of the pump.
FLUID END	The portion of the pump that converts the linear motion supplied by the power end into fluid flow at pressure. May also be called Liquid End.
NPSHA	An abbreviation that stands for Net Positive Suction Head Available. NPSHA is the total suction pressure, including allowance for acceleration head, available from the system at the pump suction connection, minus the vapor pressure of the liquid at actual

	pumping temperature. NPSHA for a reciprocating pump is normally expressed in units of feet of water.
N P S H R	An abbreviation that stands for “Net Positive Suction Head Required”. This is the minimum total inlet pressure required by the pump for proper operation. This value is a function of pump design and speed and is determined by the pump manufacturer through a specific NPSH test.
P I S T O N	A type of power pump that uses a cylindrical seal (piston) mounted on a holder to drive fluid through the valves. The piston seal reciprocates within a stationary cylinder.
P L U N G E R	A type of power pump that uses a cylindrical plunger to drive fluid through the valves. The plunger reciprocates through a stationary set of seals known as packing.
P O W E R P U M P	A reciprocating pump that drives the pumping element(s) using a slider crank mechanism. Power pumps are piston, plunger, or diaphragm type. All require a driver with a rotating shaft, such as a motor or engine, as a power source.
P O W E R F R A M E	The major portion of a power pump that encloses and supports all other components of the power (or drive) end.
S T R O K E L E N G T H	The length of one complete, unidirectional motion of the piston or plunger. Stroke length is usually expressed in inches.
V A L V E	A component that allows unidirectional flow of liquid. FMC pumps have a series of two valves, one inlet and one discharge, per pumping cylinder.

## 17.0 Reference Information

Use the following section to record key information about your specific pump model. Information such as part and serial numbers will be needed when ordering service parts. This data may be found stamped on the metal nameplate located on the pump power frame. This area may also be used to make notations about special parts, procedures, phone numbers, or other important information related to your pump.

- Pump Model
- Part Number
- Serial Number
- Rated Pressure
- Rated Capacity
- Rated Speed

Notes: