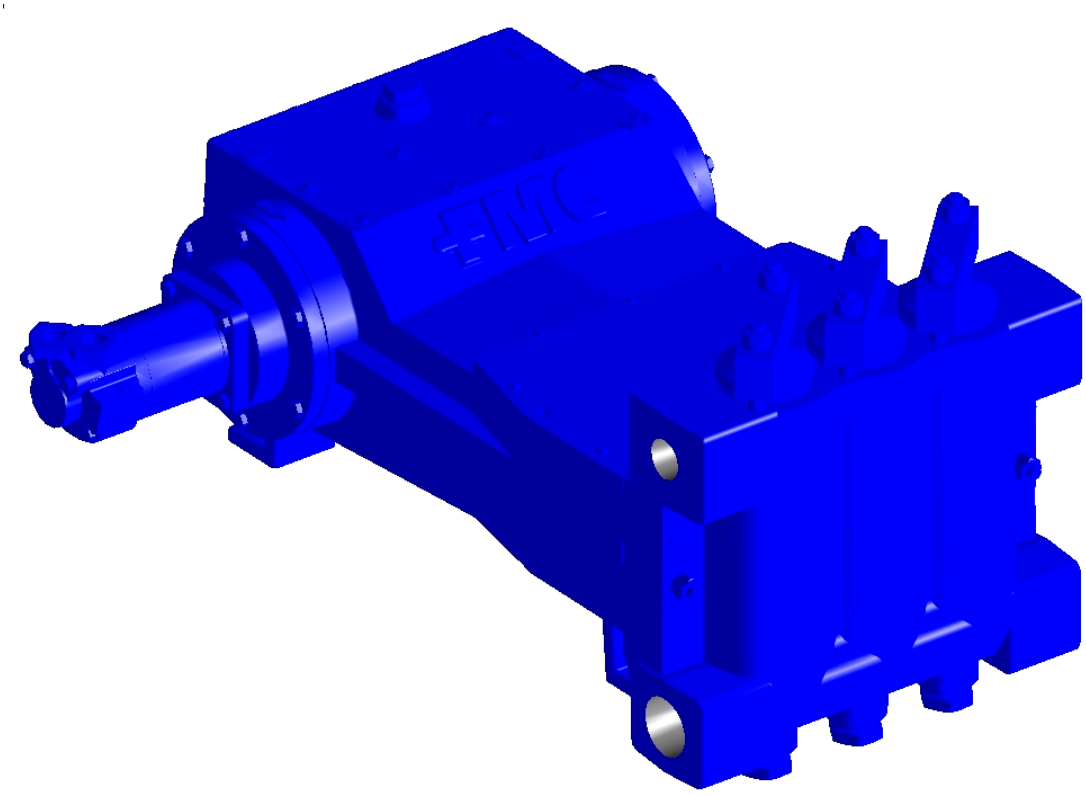
M12-HD

Piston Pump Operation & Maintenance Manual



FMC Safety Instructions

Many accidents occur through the careless operation and maintenance of mechanical equipment. You can avoid hazards associated with the use of high-pressure mechanical equipment provided by FMC by always following the safety precautions listed below. If these warnings are not followed, bodily injury including death could occur to you or other persons. FMC cannot anticipate every possible circumstance that might involve a potential hazard, therefore the warnings listed in this publication are not inclusive. As the user, you must decide if a particular operating mode, repair technique, or tool is safe before performing or using.

The procedures and illustrations provided in this manual are based on the best information available at the time of publication. Procedures, specifications, torque requirements, and other values may be updated at any time. Always contact FMC or your FMC equipment dealer for the most complete and current information before starting any repair job. Contact FMC any time if you are unsure about any procedure involving FMC equipment.

- **Do not perform any operation, maintenance, or lubrication of this equipment until you have read and understood the information provided to you in this manual and any additional information provided by the manufacture of the equipment the pump was supplied with.**
- **Never attempt a service procedure until you are certain all pressure has been removed from the pump and the drive is disengaged and locked out.**
- **Never operate the pump without a relief valve, rupture disk, or other type of overpressure safety device properly installed.**
- **Never exceed the rated pressure or speed of the pump for any reason.**
- **Never operate the pump without proper guards in place for all moving parts.**
- **Use caution when solvents are used to clean or degrease equipment. Most solvents are highly flammable.**

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General Features

The FMC M12-HD pump is a high performance pump specially designed for the demanding duties of horizontal drilling. The M12-HD is a piston style pump that utilizes high performance rubber pistons running in a hardened liner for maximum component life between service. The pump also features abrasive service valve assemblies with a special seating elements designed to seal even when sand and other particulates are present in the fluid.

FMC pumps are extremely flexible. They can be powered by engines, electric or hydraulic motors. FMC supplies many different types of drive connections that allow hydraulic motors to be directly coupled to the pump frame to save space and weight. Some hydraulic motor drives incorporate an external gear reduction system. If your pump is equipped with an external gear reducer, consult the manufacturer for information about operation, service, and maintenance procedures required for the equipment. FMC M12 pumps do not share common oil reservoirs with gear reducers.

Standard M12 pump designs require a liner wash system for proper operation. Some systems are provided directly by FMC, but most are provided by your OEM. Each system is different, but all incorporate a recirculation tank, circulation pump, and an assortment of hoses, tubing and nozzles that direct the wash stream to the back of the piston. Once the wash water has been sprayed on the piston, drain piping collects it and transfers it back to the supply tank.

The purpose of the liner wash is to provide a small amount of water to the back of the piston during operation to cool and lubricate the piston. Without this wash water, friction between the piston and liner generates excessive heat that can cause premature failure of the piston. Never operate your pump without a clean supply of liner wash water to each of the three pistons.

Storage Requirements

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

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, pumps in corrosive fluid applications should drain fluid end, flush with water or other suitable rust preventative, and blow dry using compressed air whenever idle for periods in excess of one (1) week.

Short Term Storage for Severe Environments

Drain any fluid from pump and blow dry with compressed air. Spray a fog of preservative oil into suction and discharge ports of fluid end, then install pipe plugs in 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 (ex. Driveshaft) with a preservative oil. Replace the oil fill cap and breather vent, then cover the entire pump with a weather resistant covering such as a canvas or plastic tarp.

Long Term Storage

Long-term storage is defined as any period when the pump is in storage or idle for periods in excess of six (6) months. Remove the piston cup seals and store them in a separate location with a controlled environment where they are protected from UV exposure. 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.

Drain any remaining oil from the pump power end, then remove the power end cover to expose the drive components. Spray all internal parts with a rust preservative that is soluble in lubricating oil while rotating the driveshaft several turns by hand to insure complete coverage. Replace the power end cover and add a concentrated internal rust inhibitor per manufacturers recommendations.

Spray a rust preventative onto all exterior machined surfaces paying careful attention to any unpainted areas like the crankshaft extension. Remove the power end breather cap and store with the piston cup seals. 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 shelf or pallet that is several inches above ground level. Cover the entire pump with a canvas or plastic tarp. 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, piston cup seals, and any other components that were

removed for storage. Once these steps have been completed, fill with oil and follow normal start-up procedures. Note that FMC can factory prepare units for extended storage for a nominal fee if specified at the time of order.

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 valve seats to insure that all fluid is drained from the pumping chamber between the suction and discharge valves.

As an alternative to the previous procedure, a compatible antifreeze solution can be recirculated through the fluid end. RV antifreeze, propylene glycol, is often used for this purpose.

Lubrication Requirements

FMC pumps are supplied without oil in the crankcase and must be filled with oil prior to startup. The FMC M12-HD pump requires 12 quarts (11.4 liters) of oil. Any anti-wear gear, turbine, or hydraulic oil of the proper viscosity will work. Oils with EP, anti-foaming, or R&O additives work well and are recommended by FMC. Use only high quality oil with a viscosity of SAE 30 weight (ISO 100).

It is critical that condition of the oil be monitored carefully to insure it is at the proper level and has not been contaminated. FMC provides a sight gage mounted at the rear of the pump case that allows easy inspection of oil level and condition. The M12 pump does not require any periodic greasing.

If your pump is equipped with an external gear reducer, consult its manufacturer for oil requirements and service intervals. External gear reducers do not share a common oil reservoir with the pump.

Suction System Information

FMC pumps require a minimum Net Positive Suction Head (NPSH) for proper operation. The calculation of NPSH available for a specific pump system is a function of pump size, speed, fluid temperature, suction pump diameter and length, and a host of other factors. This is a complicated value for the average user to determine, so FMC has provided some general guidelines that will work in the majority of installations.

FMC recommends that suction pipe be as short and directly routed from the source as possible. Always use suction piping at least one pipe size larger than the pump inlet. Use caution with flexible (fire) type hoses that can kink and restrict flow area. FMC also recommends that a booster pump be used on all M12 pump installations. The booster pump should be sized to provide between 20-50 psi AT THE PUMP INLET CONNECTION PORT UNDER ALL OPERATING CONDITIONS AND SPEEDS.

Preventative Maintenance Schedule

Interval	Component	Type of Service	Remarks
First 50 Hours	Crankcase Oil	Change	Clean off any metal attached to the magnetic drain plug before refilling
Daily	Complete Pump	Inspect	Carefully go over the pump and each component of the pump system to insure proper operation
Daily	Discharge Pressure	Inspect	Pressure should be steady. Vibrations or erratic pressure readings are a sign of valve, inlet system, or other system problems that must be addressed
Daily	Piston Seals	Inspect	Check back side of piston seals for signs of excessive leakage. Replace promptly if leakage becomes excessive to avoid additional damage
Daily	Crankcase Oil	Inspect	Check for proper level and for signs of contamination
Daily	Liner Wash System	Change & Inspect	Change the liner wash water and inspect the system for proper operation. Insure sediment has not built up on bottom of wash reservior
Daily	Fluid End	Flush	Flush clean water through the pump at the end of every day of operation to prevent build up of dried mud and polymer on fluid end components
3 Months or 500 Hours	Crankcase Oil	Change	Drain and refill with new oil. Clean debris from magnetic drain plug

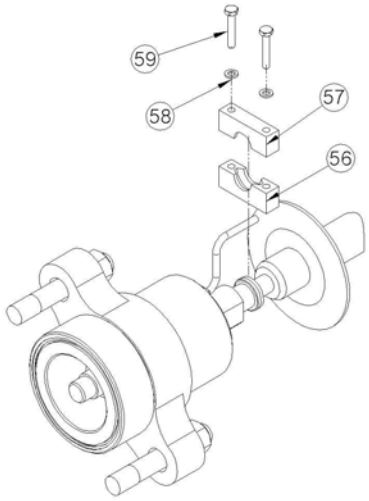
Service Procedures

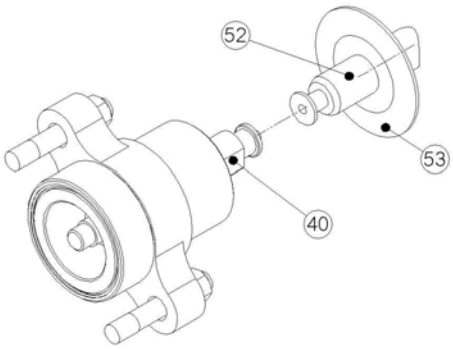
FMC pumps are designed to simplify all required maintenance. In addition to maintaining clean crankcase oil at the proper level, the pistons, valves, and oil seals are all normal expendable items that will eventually wear out and require replacement. Read and understand each section completely before attempting to service the pump. This section covers all normal service procedures on the fluid end of the pump. FMC drive ends do not require routine maintenance and overhaul procedures may require special tools, equipment, or training. If you suspect your pump requires drive end service, contact FMC or your equipment OEM for assistance.

Replacing Piston Cup Seals

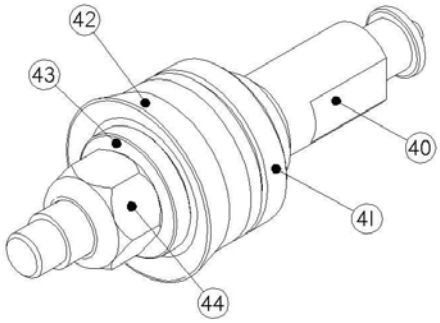
Pistons should be replaced whenever leakage increases to the point it becomes a steady stream, not individual drops. For maximum uptime between service, FMC always recommends that users replace all three pistons when service is required, not just the one that shows signs of leakage.

- Pump several gallons of clean water through the pump before service to remove the majority of mud or polymer from the fluid end components.
- Bleed of all pressure inside pump fluid end. Shut valve on inlet piping if provided to prevent flow of liquid into the pump during service.
- Remove cradle cover to expose the pistons and cylinder liners. If a liner wash system is installed on your pump, remove any piping or nozzles that might interfere with removal of the piston cylinders.
- Use a 3/8” socket wrench to remove the plunger clamp hex bolts (59) and washers (58), then remove the plunger clamp top (57) and bottom (56) from each of the three pump cylinders.
- Slowly rotate the pump crankshaft at least one complete revolution. With the plunger clamps removed, friction between the piston and liner will hold each piston assembly in the full forward (or top dead center) position and provide working clearance for removal of the pistons.



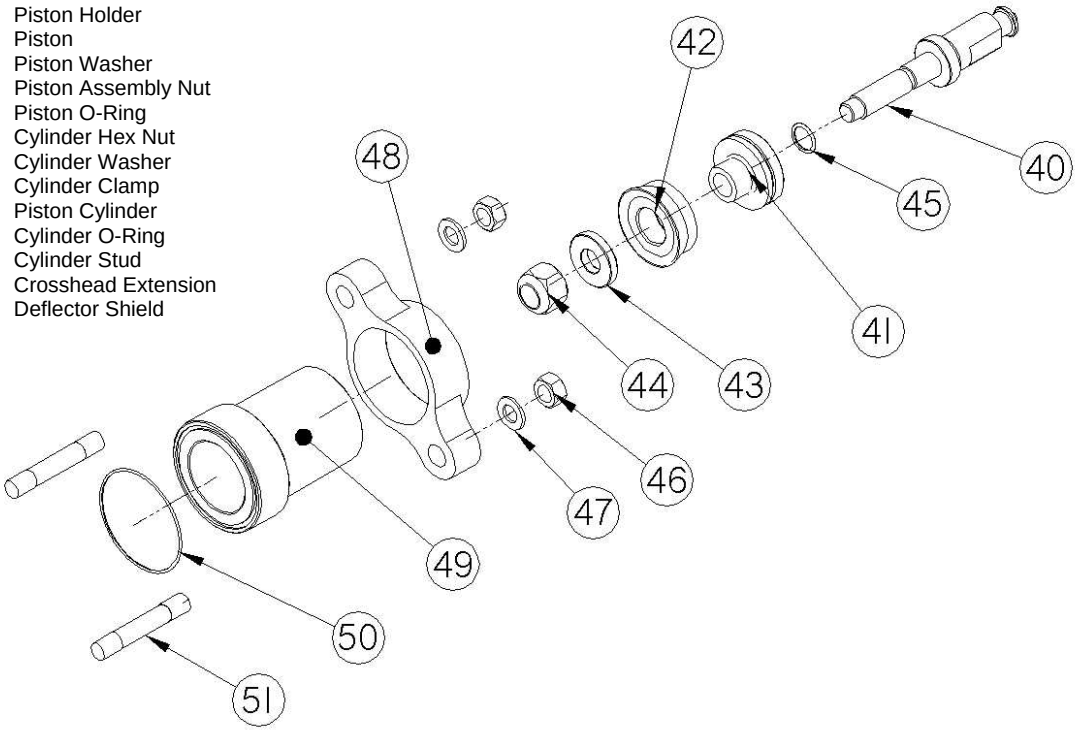


- Use a 1-1/8” socket wrench to remove each of the cylinder clamp hex nuts (46) and washers (47).
- Slide each cylinder clamp (48) out over the end of the cylinder (49) and remove.
- The remaining components of the piston-cylinder assembly can now be removed from the pump and taken to a workbench for further disassembly and inspection. It may be necessary to work the piston-cylinder assembly from side to side while pulling back to free it from the fluid cylinder counterbore if any corrosion has formed between parts. Cylinder o-rings (50) may come out with the assembly or they can often stick in the fluid cylinder counterbore.

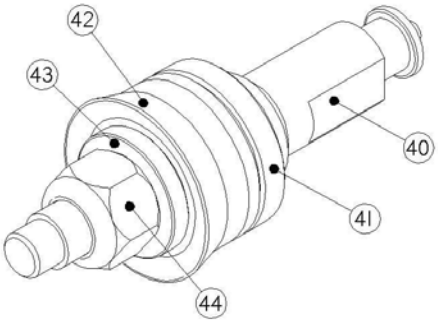


- Push the piston assembly out through the back of the cylinder.
- Place the flats provided on the piston extension (40) in a bench vice. Remove the piston nut (44) and dissemble the remaining components.
- Discard the piston (42), piston o-ring (45), and cylinder o-ring (50). Clean, inspect, and save the remaining components so they can be reinstalled later. Take extra care to inspect the bore of the piston cylinder (49). The ID of the cylinder must be smooth and free of grooves or other defects for maximum service life of the pistons.
- The complete set of piston and cylinder components is shown below.

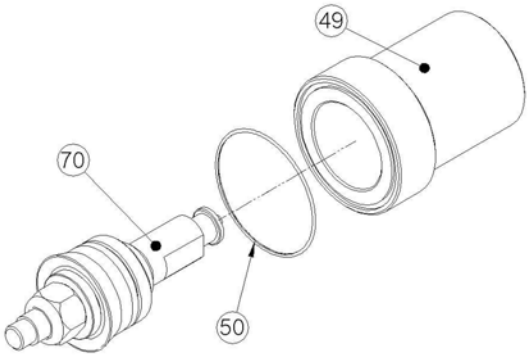
40	Piston Extension Rod
41	Piston Holder
42	Piston
43	Piston Washer
44	Piston Assembly Nut
45	Piston O-Ring
46	Cylinder Hex Nut
47	Cylinder Washer
48	Cylinder Clamp
49	Piston Cylinder
50	Cylinder O-Ring
51	Cylinder Stud
52	Crosshead Extension
53	Deflector Shield



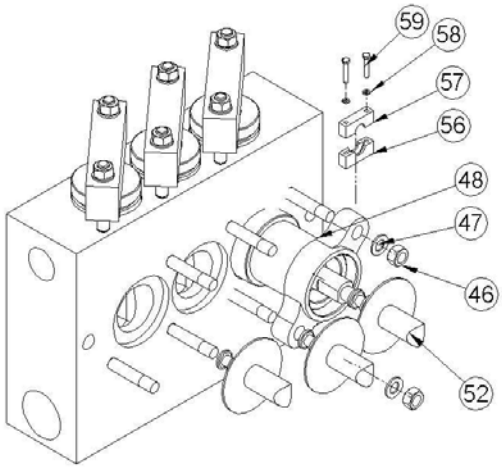
- Install new piston (42) and piston o-ring (45) into the piston sub-assembly as shown (70). Note that the piston o-rings cannot be seen in the assembled view.
- Torque the piston nut (44) to 250 ft-lbs.
- Use a small amount of oil to lubricate the OD of the piston, then insert the piston sub-assembly (70) into the front end of the piston cylinder as shown. Use a press or rubber mallet to drive the piston to the approximate center of the piston cylinder.



- Install new cylinder o-rings (50) in the piston cylinder. Use a dab of grease to hold the o-ring in the groove.
- Place the piston-cylinder assembly into the counterbore of the fluid end and push in firmly until it is seated at the base of the counterbore.
- Slide the cylinder clamp (48) over the cylinder and into position over the cylinder studs.
- Install and tighten the cylinder hex nuts (46) and washers (47). Torque the nuts to 125 ft-lbs in three stages to prevent cocking of the cylinder.



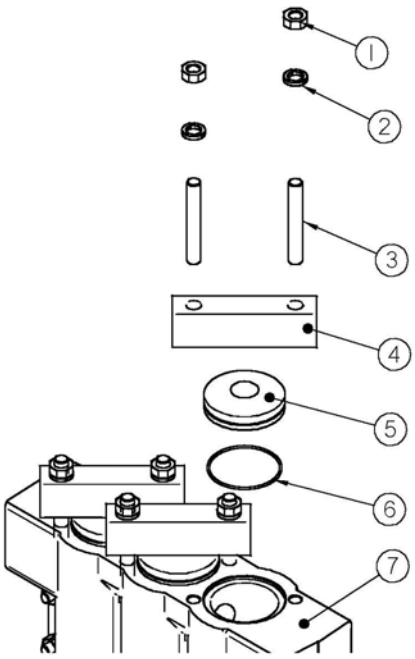
- Use a wrench on the flats of the piston extension (40) to twist and pull it up to proper position in the crosshead extension (52). If the assembly is properly aligned, the quill on the end of the piston extension should easily slide into the bore of the crosshead extension.
- Reconnect the plunger clamp assembly and torque the hex bolts (59) to 5 ft-lbs.
- Reconnect liner wash piping that was removed for service (if equipped) and replace the cradle cover.



Valve Replacement

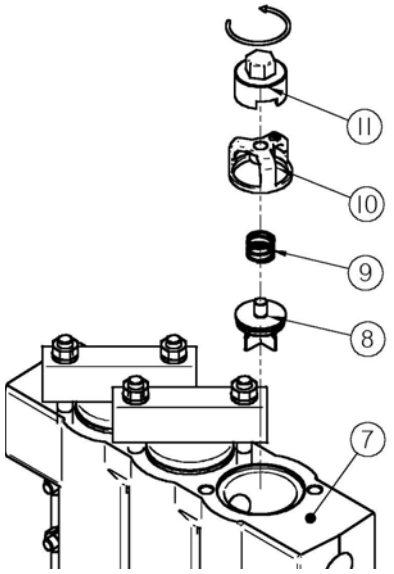
Valves require replacement whenever pump pulsations levels begin to increase resulting in rough, erratic operation. Inability to maintain proper discharge pressure is another sign that valves have worn to the point where they require replacement. For maximum uptime between service, FMC recommends that all 6 complete valve assemblies be replaced whenever this service is performed, not just the valve (or components of the valve) that show visible signs of damage.

- Pump several gallons of clean water through the pump before service to remove the majority of mud or polymer from the fluid end components.
- Bleed of all pressure inside pump fluid end. Shut valve on inlet piping if provided to prevent flow of liquid into the pump during service.
- Remove the valve cover hex nuts (1), washers (2), and valve cover clamp (4). Remove the valve cover (5) and valve cover o-ring (6) from each of the three pump cylinders. It may be necessary to use a pry bar in the groove provided at the base of the valve cover to loosen it from the fluid cylinder.
- Remove the valve cover studs (4) so that the valve puller tools can sit squarely on the top of the fluid cylinder. The tops of the discharge valve cages should now be visible through the valve cover ports at the top of the fluid cylinder.

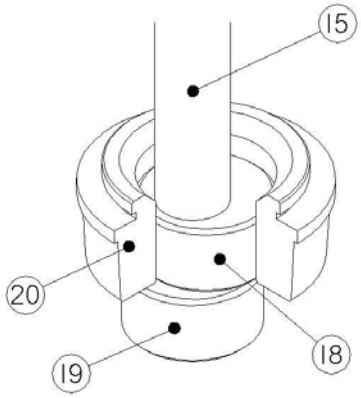


Note: FMC abrasive service (AR) valves are secured to the fluid cylinder using a locking taper mechanism. A valve puller kit is required for the proper removal and replacement of these valves. This kit is available from FMC under part number 5276358. Contact your equipment reseller for this part if required.

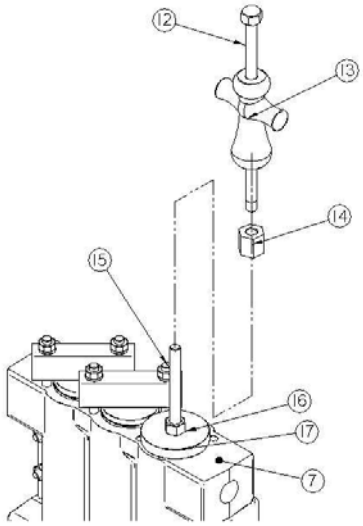
- Use a 1-1/2” socket wrench on the hex of the valve cage tool (11) to unscrew and remove the valve cage (10).
- After the cage has been removed, lift the valve spring (9) and valve (8) out through the valve cover port of the fluid cylinder.
- The FMC valve puller tool must now be used to pull the discharge valve seat free of the fluid cylinder.



- Assemble the puller guide (19) and puller eccentric (18) on one end of the puller stem (15) as shown. There are two guides and two eccentrics provided in the kit. Use the slightly larger diameter ones to remove the discharge valve seats. The smaller diameter components will be used later when removing the suction valve seats.



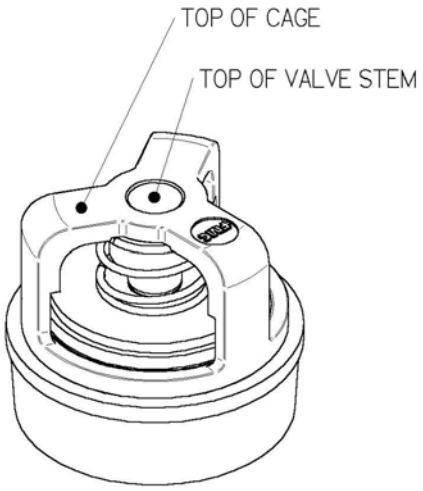
- Insert the end of the puller stem down through the discharge valve seat (20). Work the puller guide (19) through the center of the seat until it sits just underneath the seat. Hold the puller stem firmly in position, then work from side to side until the puller eccentric (18) drops down into the ID of the seat and rests on the top of the guide as shown.
- Hold the puller stem (15) in this position and slide the strongback (17) down over the stem until it rests squarely on the top of the fluid cylinder (7).
- Run the puller nut (16) down the stem until it is hand tight on the top of the strongback. You can now release the puller stem, as the components will not shift position with the nut in place.
- Using a heavy-duty 1-5/8" wrench, tighten the puller nut down against the strongback to apply force to the bottom of the valve seat. Note that up to 800 ft-lbs of torque may be required to free the valve seat from the fluid cylinder. Do not exceed this value.

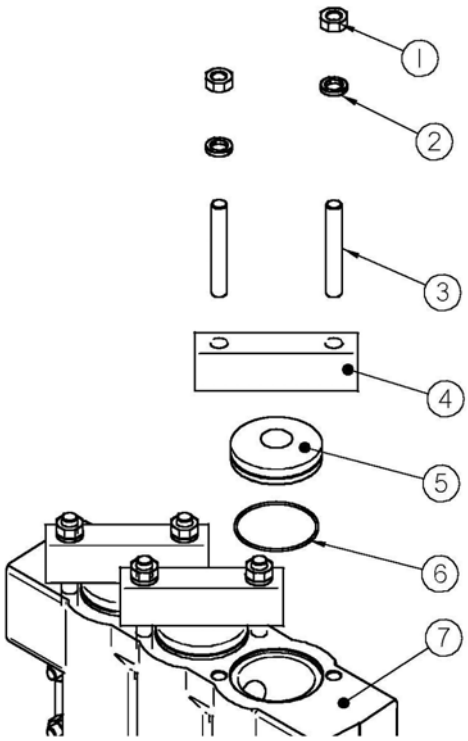


- In many cases, torque alone will be sufficient to free the valve seat. If unsuccessful with torque alone, use the adapter nut (14) to connect the slide hammer (13) and puller bolt (12) to the puller stem (15). Leave the puller nut torqued from the previous step. Drive the slide hammer firmly into the head of the puller bolt to apply extra impact force to free the valve seat and lift out through the valve cover bore in the fluid cylinder.
- Repeat the previous steps to remove the suction valves that are located just below the discharge valves. Replace the puller guide and eccentric with the smaller diameter parts provided in the kit to slide through the smaller bore of the suction valve. It will be necessary to fish out the valve spring and valve from the suction valve using a variety of hooks and loops of string or wire since the are located too deeply in the bore of the fluid cylinder to be removed by hand.
- Remove the suction and discharge valves from the remaining two cylinders.

Note: FMC M12 valves are held in place using a self-locking taper. The tapered portion of the valve seat and the tapered portion of the fluid cylinder must be clean and dry prior to assembly to insure proper operation. Failure to properly clean parts before reassembly could lead to wash out of fluid cylinder or dislodgment of valve assemblies during operation.

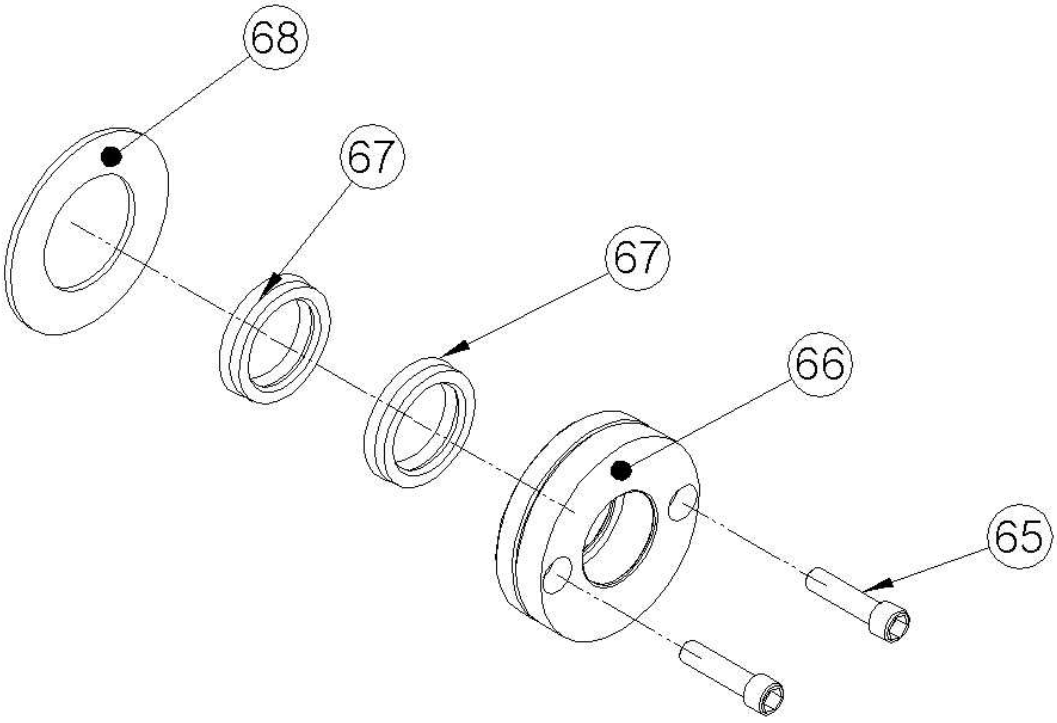
- To reassembly valves, first insure the fluid cylinder and valve seats are clean, dry, and free from oil, rust, or other debris. Use a hose, pressure washer, or scrubbing cloth on the valve bores on the fluid cylinder if necessary to insure proper cleanliness.
- Suction valves must be installed first, followed by discharge valves. Valve assemblies from FMC will arrive properly assembled and torqued direct from the factory. If it is necessary to disassembly new valves (or if you are not sure if they had been previously disassembled) insure that the cage is torqued to the seat to 25 ft-lbs before installation. Use the hex provided on the valve cage tool (11) in the puller kit to torque the cage.
- Lower the suction valve assembly into position on the port taper of the fluid cylinder, lift slightly, then allow to drop straight into the port. If the seat drops straight it will seize in the taper and cannot be removed by hand.
- Drive the valve assembly into the port taper using several sharp blows from a mallet. The valve cage can be bent or damaged if impact forces are applied unequally or to the center of the valve cage. To avoid bending the top of the valve cage, it is advised to seat the valve assembly by driving on the top of the valve stem as shown. If this is not practical, drive on the top of the cage using a device that spreads the force of the impact across the full diameter of the valve cage (such as a wood or bronze bar of the proper diameter). Make sure valves are seated properly or they may dislodge during operation and cause damage to the pump.
- Install the discharge valve assemblies using the same procedures used for the suction valves.
- Install a new o-ring (6) in the valve cover. Use a dab of grease or oil in the groove to help hold the o-ring during assembly.
- Replace the valve cover (5) in the fluid cylinder. Replace the studs (3), valve cover clamp (4), washers (2), and hex nuts (1).
- Torque the valve cover hex nuts (1) to 200 ft-lbs.





Oil Seal Replacement

- Remove the plunger clamp assembly from each of the three pump cylinders as outlined in the previous sections.
- Remove the two socket head cap screws (65) from each of the oil seal holders.
- Gently pull the oil seal holder (66) free from the power end and slide out over the end of the crosshead extension rod.
- Remove the seal gasket (68) from the power end counterbore.
- Use pliers to grip and remove the oil seals (67) from the seal holder. Note the direction of each seal in the holder before removing. Make sure to install new seals in the same direction.
- Replace the gasket (68) and oil seals (67) with new components then reassemble into the pump.
- Torque the seal holder socket head capscrews (65) to 35 ft-lbs.

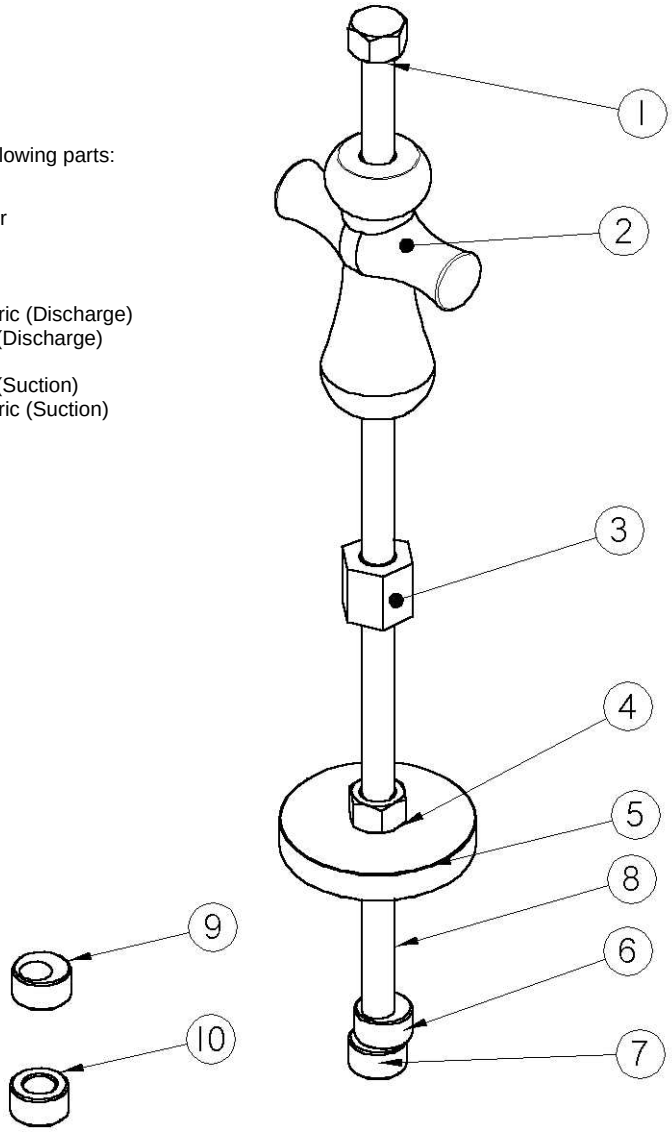


Special Service Tools

FMC AR Valve Puller Tool
Part Number 5276358

Kit Includes the following parts:

1. Puller Bolt
2. Slide Hammer
3. Adapter Nut
4. Puller Nut
5. Strongback
6. Puller Eccentric (Discharge)
7. Puller Guide (Discharge)
8. Puller Stem
9. Puller Guide (Suction)
10. Puller Eccentric (Suction)



Trouble-shooting Guide

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 pump seals

Insufficient flow from pump ONLY
- Pump speed is too slow
- Relief valve improperly adjusted and by-passing fluid
- Worn pump valves
- Excessive leakage from pump seals

Insufficient flow OR pressure AND rough operation
- Valve Problem:
  - Pump valve stuck in open or closed position
  - Valve assembly is damaged or unseated
  - Valve seat is washed out
  - All pump cylinders not primed
  - nlet 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
- 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 piston assembly
- 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 piston cups

Suction pressure fluctuates rapidly
- Pump is cavitating

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 piston seal life
- High abrasive particle content in fluid
- Wrong style or type of piston for service
- Piston liner is damaged
- Pump is cavitating (cylinders may run hot)
- Piston assembly o-ring is damaged
- Poor quality water used
- Pump is allowed to run dry for extended periods of time
- Liner wash 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 do to improper installation techniques
- Poor quality water used
- 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 piston cup 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
- Crosshead extension oil seals are damaged or improperly installed
- Excessive capacity in liner wash system
- Improperly adjusted liner wash nozzle

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