

SPECTRA
WATERMACHINES™

**CLARK PUMP
FIELD REPAIR & REBUILD
MANUAL**



Spectra Watermakers

**20 Mariposa Rd San Rafael CA 94901
Phone 415-526-2780 Fax 415-526-2787
www.spectrawatermakers.com**

Rev 02-15-05

Spectra Clark Pump Re-Manufacturing

This is a list of current standards and recommendations for Clark pump overhaul as of **1-1-05**

If you have an older pump we suggest returning it to the factory for a complete upgrade when it is convenient to your cruising schedule. We charge \$350.00 USD to return your Clark pump in “like new” condition, built to current specifications, and ready for years more service.

Troubleshooting and Repair bulletins for Spectra watermakers are included in the offshore kit and are available for download from our website @ www.spectrawatermakers.com. Before disassembly try to determine the cause of the problem using this information.

Upon disassembly inspect the cylinder walls for deep cracks or blisters. A few scratches will not impair the performance of the systems. Inspect the SS tube fittings for pitting, galling, and corrosion in the threads and seating surfaces. Pitted fittings should be replaced.

It is advisable to remove and replace all of the seals and O-rings. The parts that should be replaced or added if they are not current are as follows,

Center Block and Valve Body *The high pressure inlet and outlet ports have been redesigned from tapered pipe threads to straight threads with O-ring seals. This design change helps prevent cracking due to over tightening. (see next page illustration)*

Annular rings *(the new standard units are gray) We have discovered that a series of the valve block bores were oversized causing some failures of the annular rings. The annular ring should be a press fit into the bore. The standard bore size is 1.248” The standard ring size is 1.250” causing a .002” press fit. The oversized blocks were 1.255”. These blocks should have an annular ring with an OD of 1.258”. These are available from the factory and specified as (Oversized). Annular ring O-rings are now white.*

Reversing valve Spool *(current valve spools are one piece and come with the seals installed. Older three piece spools have threaded holes in each end. These should be replaced if possible)*

Solid brown plastic piston rod *(it is a good idea to replace pistons at this time)*

Check valve springs *(all units now use springs. 7 & 10 % pumps use white plastic springs, 15 & 20% pumps use metal springs.)*

Check valve port o-rings are now white.

Pilot valve spool *(should be white Teflon This **part must be matched to the center block***

Center blocks at 4.00” wide should use a spool 2.10”

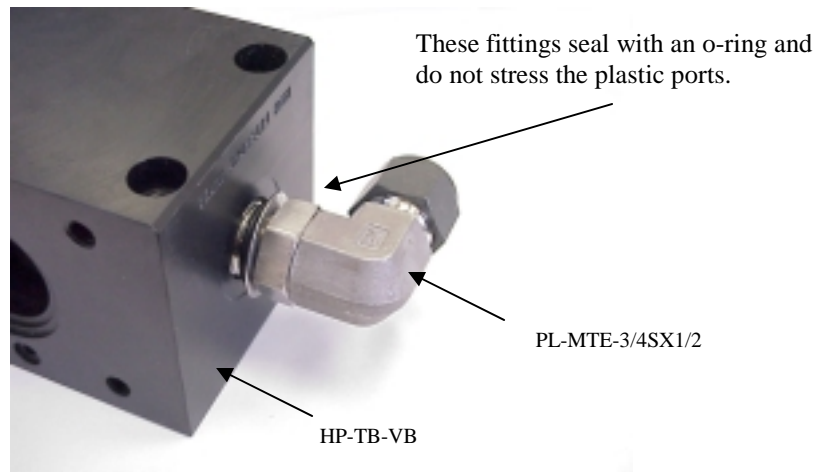
Center blocks at 3.90” wide should use a spool 2.00”)

End Caps *(To avoid cracks developing from over tightening of tapered pipe thread fittings, we recommend all cylinder endcaps be upgraded to the current straight thread, O-ring seal, high pressure fittings and the modified o-ring seal end caps. End caps can be upgraded in the field with our upgrade kit, p/n KIT-HP-ECK).*

Note: If you detect a persistent leak between the cylinder base and the center block after the pump has been reassembled then you may have a crack in the center block between the back lower insert and the high pressure discharge port. This can be confirmed by removing the insert and testing the pump with only three bolts. The leak will be readily apparent. Contact the factory for a modified insert to correct this leak.

Note: If there are rust stains on the fittings it may indicate weeping at the fitting. It may be possible to reseal the tube fitting by backing off the nut and sealing with silicone seal or Teflon tape on the tube ferrule.

All current Clark Pumps have straight thread, O-ring seal, high pressure fittings on the valve body and Center block. This prevents stress on the plastic parts from over tightening of the fittings. We recommend that any pump commanding a complete overhaul be upgraded to these fittings. The blocks must be modified by the factory or select service centers by machining the 3/8 NPT ports into 3/4-16 straight thread..



Emergency Field Repair

Instructions for Field repairs of a variety of problems, including Cracked high pressure ports, Broken spool valves, Cracked annular rings. and others, can be found in the Technical Bulletins included with this manual or available for download at our website.

TABLE OF CONTENTS

INTRODUCTION	page 6
Illustrations	
Function Schematic	page 7
Clark Pump Diagram (front)	page 8
Clark Pump Diagram (rear)	page 8
Reversing Valve End Blocks	page 9
Valve Block	page 9
Center Block	page 10
Cylinder Assembly	page 11
Seal Gauge	page 12
TROUBLESHOOTING GUIDE	page 12
S.S Compression Fitting Leaks	page 13
Pressure Relief Valve Leak	page 13
Shaft Seal Leak	page 13
Worn Spool Piston Seals	page 13
Reversing Valve Spool Seal Leak	page 13-14
Annular Ring Damage	page 14
Annular Ring O-Ring Seal Leak	page 14
Piston Seal Leak	page 14
Piston to Rod Seal Leak	page 15
Check Valve Leak	page 15
Pilot Valve Pin Seal Leak	page 15
Worn Pilot Spool Seals	page 15

(Continued on page 5)

(Continued from page 4)

REBUILD INSTRUCTIONS **page 16**

Disassembly Instructions **page 17**

Reversing Valve Disassembly **page 17**

Annular Ring Removal **page 17**

Cylinder Removal **page 18**

Center Block Disassembly **page 18**

Cylinder Disassembly **page 18**

Assembly Instructions **page 19**

Center Block Assembly **page 19**

Cylinder Assembly **page 20**

Valve Spool Assembly **page 21**

Reversing Valve Assembly **page 21**

Cylinder Installation **page 21**

Final Assembly **page 22**

Testing **page 22**

APPENDICES

Parts Lists 7%

Parts List 10%

Parts List 15%

Parts List 20%

O-ring & Seal Gauge

INTRODUCTION

The **Clark Pump** is the heart of the *Spectra Reverse Osmosis Watermaker*. It is a high tolerance, precision machine, developed after thousands of hours of operation and testing. Troubleshooting, repair and rebuild of this machine may be undertaken by any mechanically-minded technician or boat owner. A willingness to understand the process, acute attention to detail, a clean work area, and careful reading of the instructions are absolutely necessary! One dirty or out of place part could render the **Clark Pump** inoperable.

Refer to the *Function Diagram* on page 5. The **Clark Pump** uses two opposing cylinders with pistons that share a single rod that passes through a center block. A reversing valve, controlled by a pilot valve that is mechanically actuated by the pistons, allows the cylinders to alternate between driving and pressurizing. The driving cylinder has feed pressure pushing on the top of the piston. The driving piston pushes the rod through the center block. The water under the driving piston (brine), that has gone through the membrane on the previous stroke, is discharged overboard. A cylinder starts to pressurize when the rod is forced into it. As the rod pushes the driven piston, it circulates the water on top of the piston through the membrane, back to the reversing valve, which directs it back into the same cylinder under the driven piston where the rod is entering. This creates a closed loop between the cylinder and membrane. The rod displaces water as it enters the cylinder and since the displaced water at this point has no place to go, the pressure instantly rises until there is enough pressure for reverse osmosis to occur in the membrane, allowing the displaced water to be forced out as product. Thus fresh (displaced) water equal to the volume of the rod entering the cylinder is produced on every stroke as the piston circulates the water through the membrane. When the driven piston bottoms out on the center block, it actuates the pilot valve and the process is instantly reversed.

Another perspective on the **Clark Pump** is that it is two devices combined into one. The two opposing cylinders that share a single rod take turns being a “hydraulic ram,” driving the rod into the “circulating pressure intensifier.”

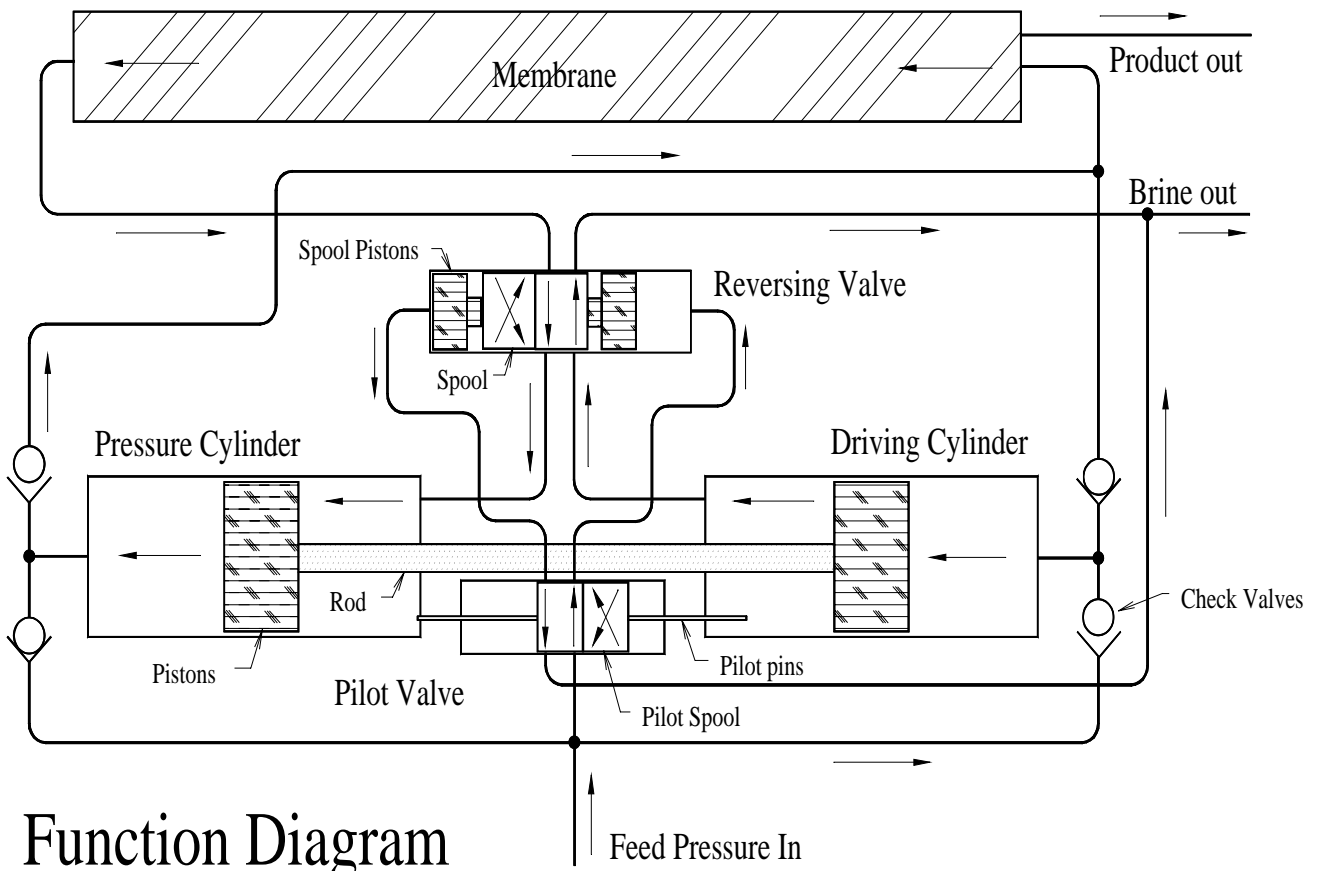
Differences in the flow and pressure gauge readings between “shifts” of the **Clark Pump** (asymmetry) indicate that something is different between the two cylinders. For example, if the right piston seal begins to leak, it would affect the readings when the right cylinder is working hard trying to push the rod into the other cylinder but would have no visible affect as the right cylinder is pressurizing after the “shift.”

On earlier units, a button is provided on the reversing valve to reset the reversing valve if the pilot and the main valves stop at dead center.

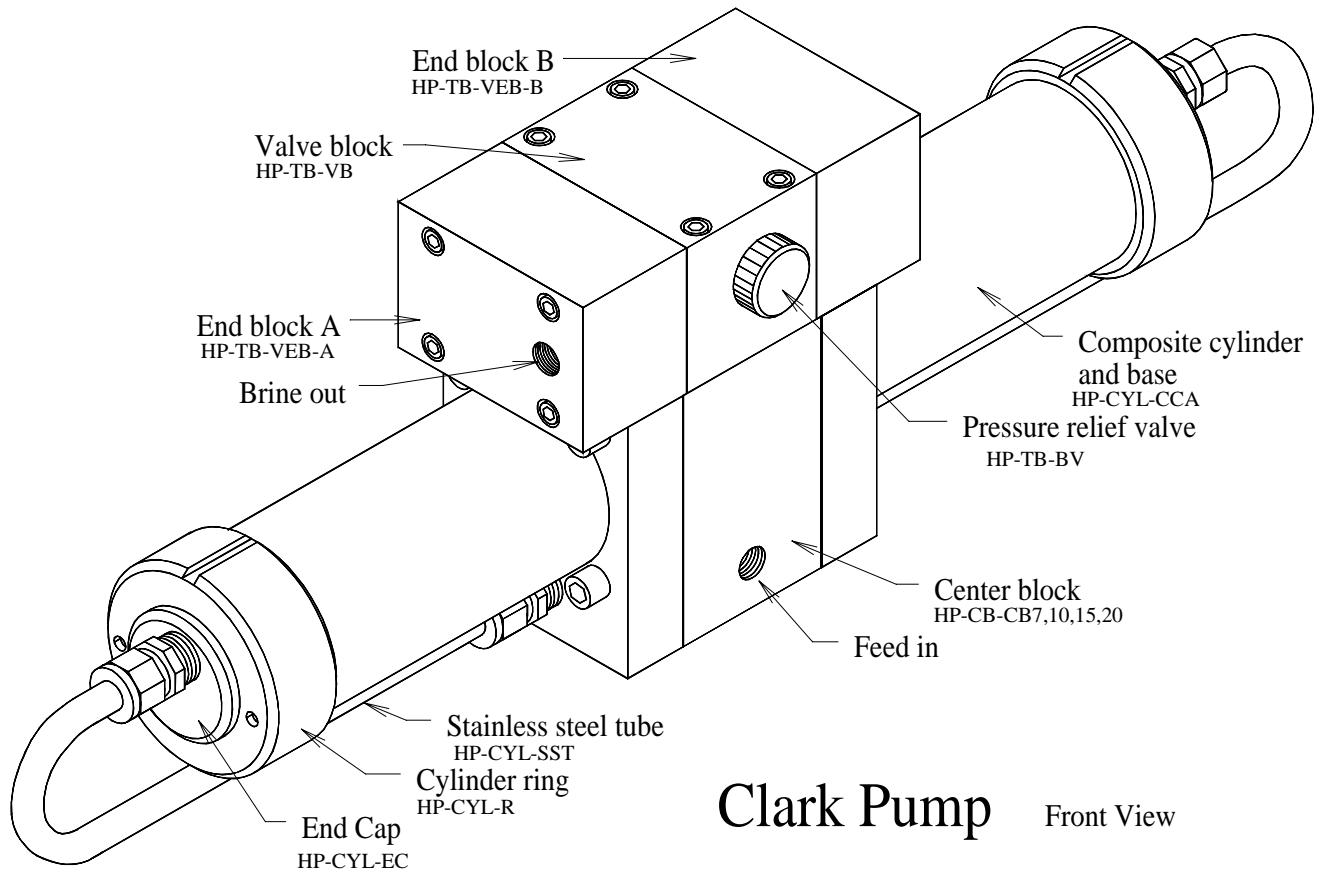
Having a good working knowledge of the **Clark Pump's** internal functions greatly enhances troubleshooting and repair.

If a problem arises, consult the technical bulletins, note the symptoms and call **Spectra Watermakers** or e-mail techsupport@spectrawatermakers.com before disassembly.

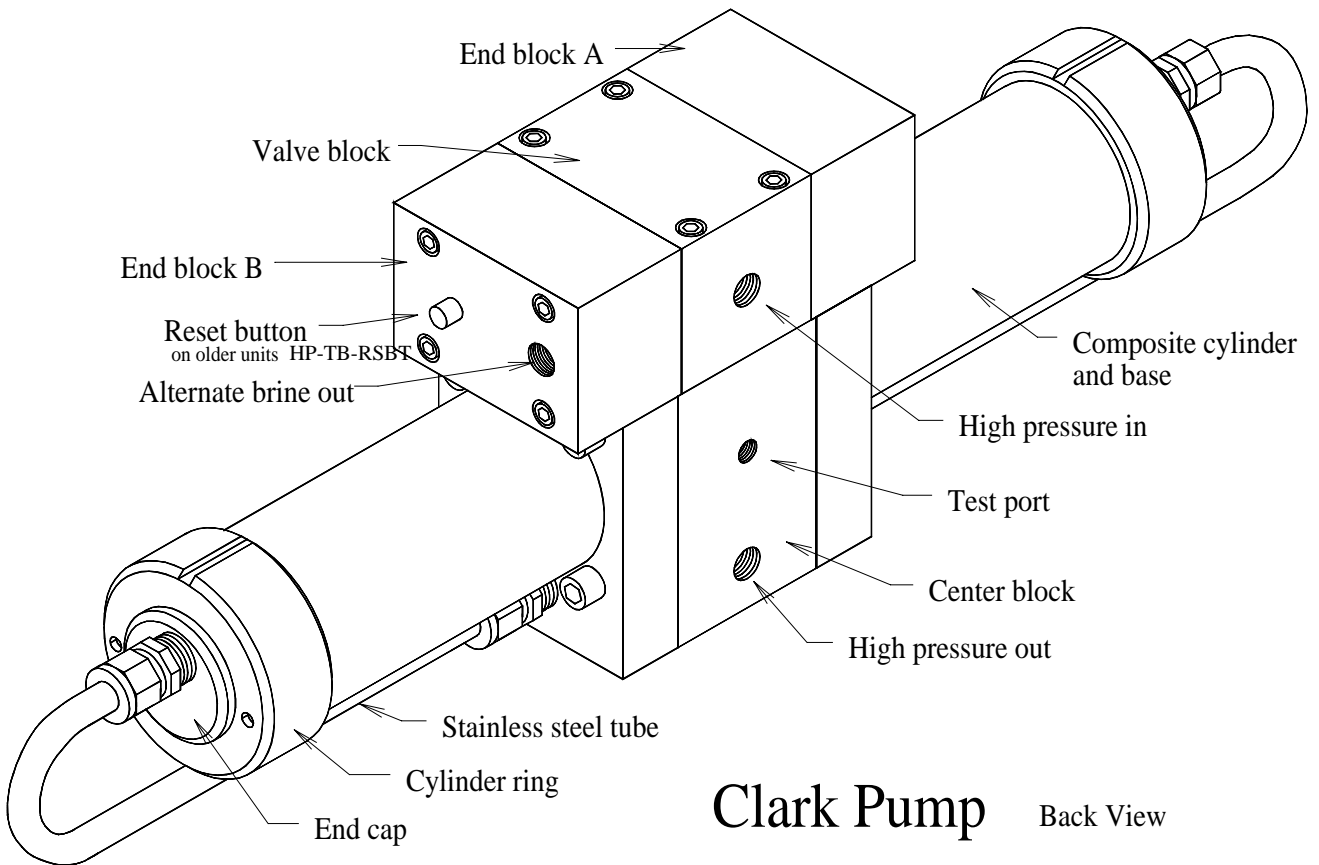
Ventura System



Function Diagram

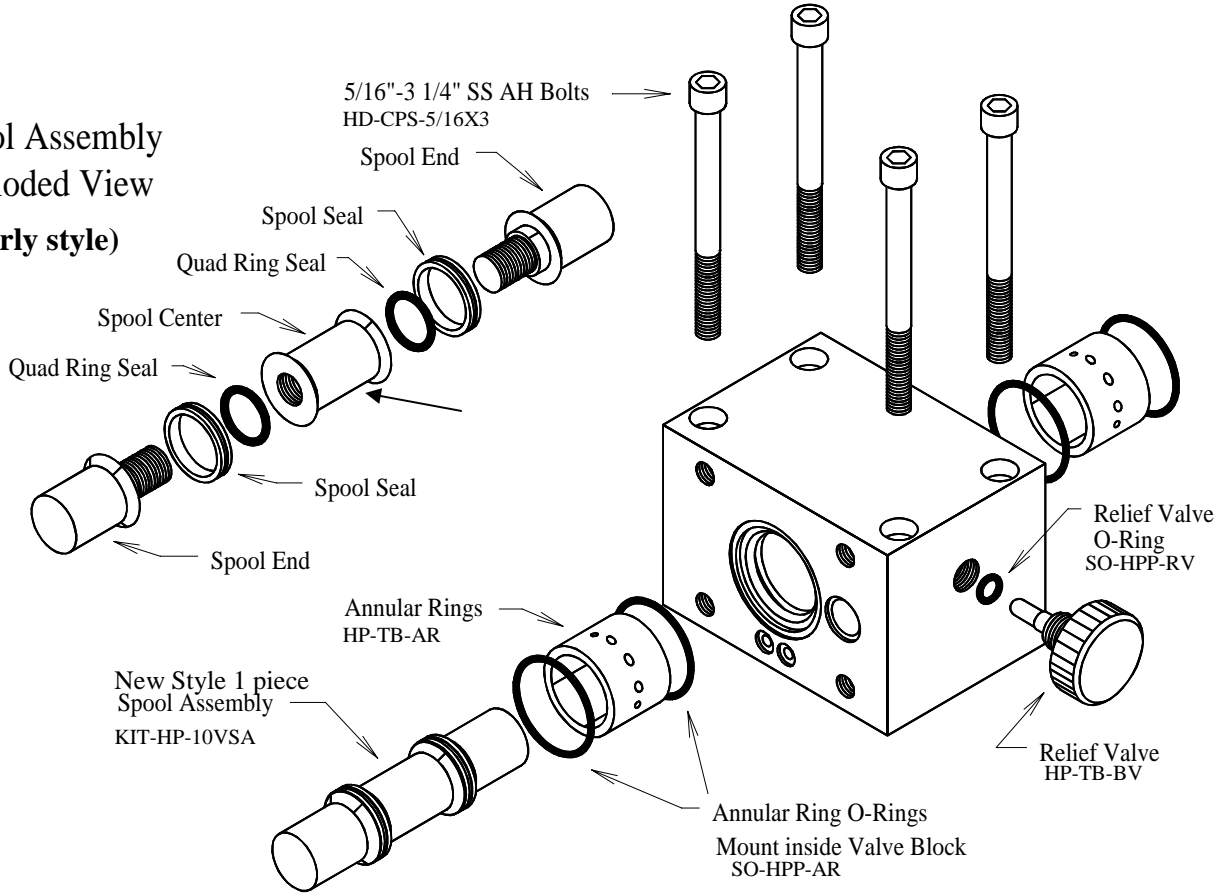


Clark Pump Front View

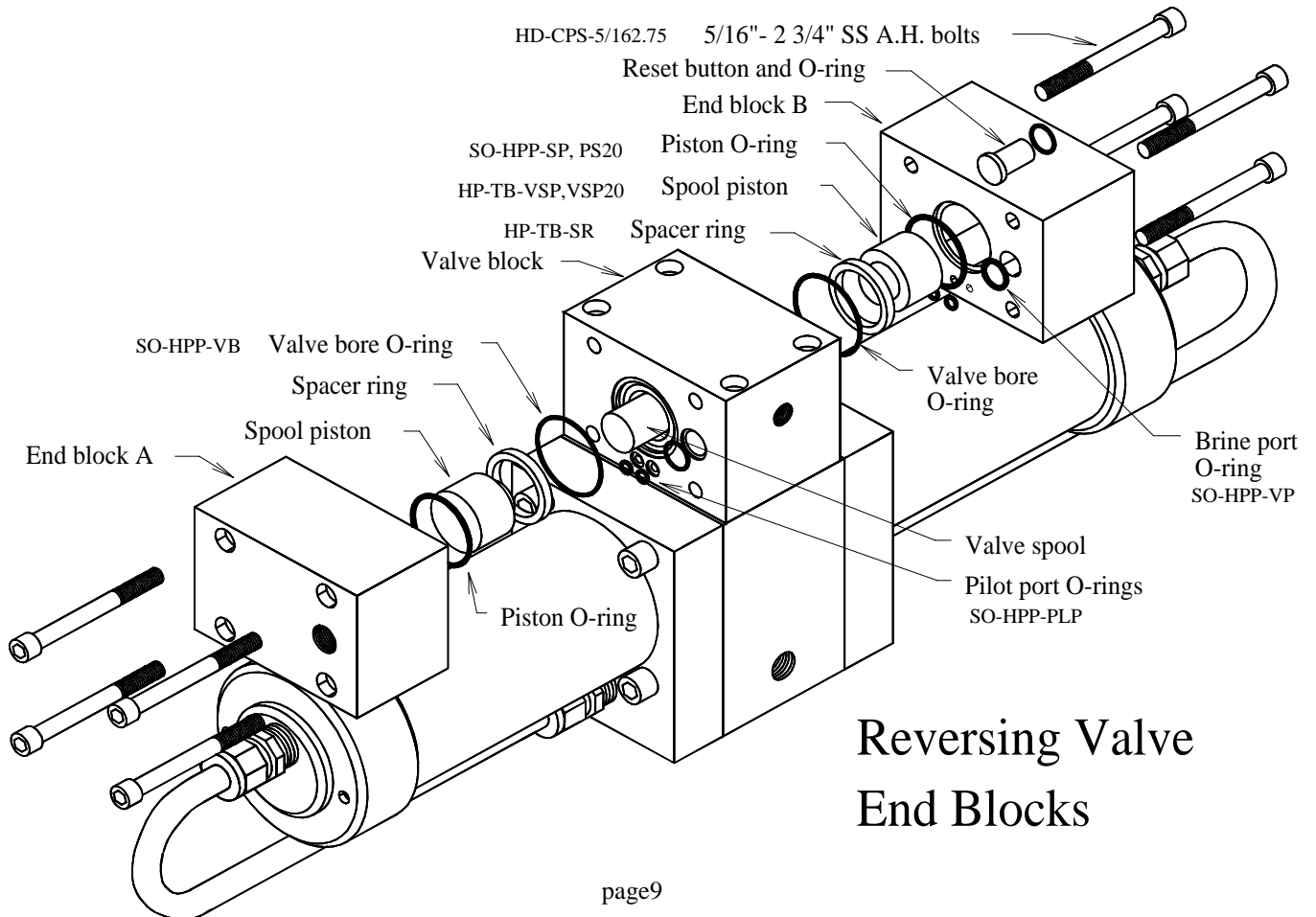


Clark Pump Back View

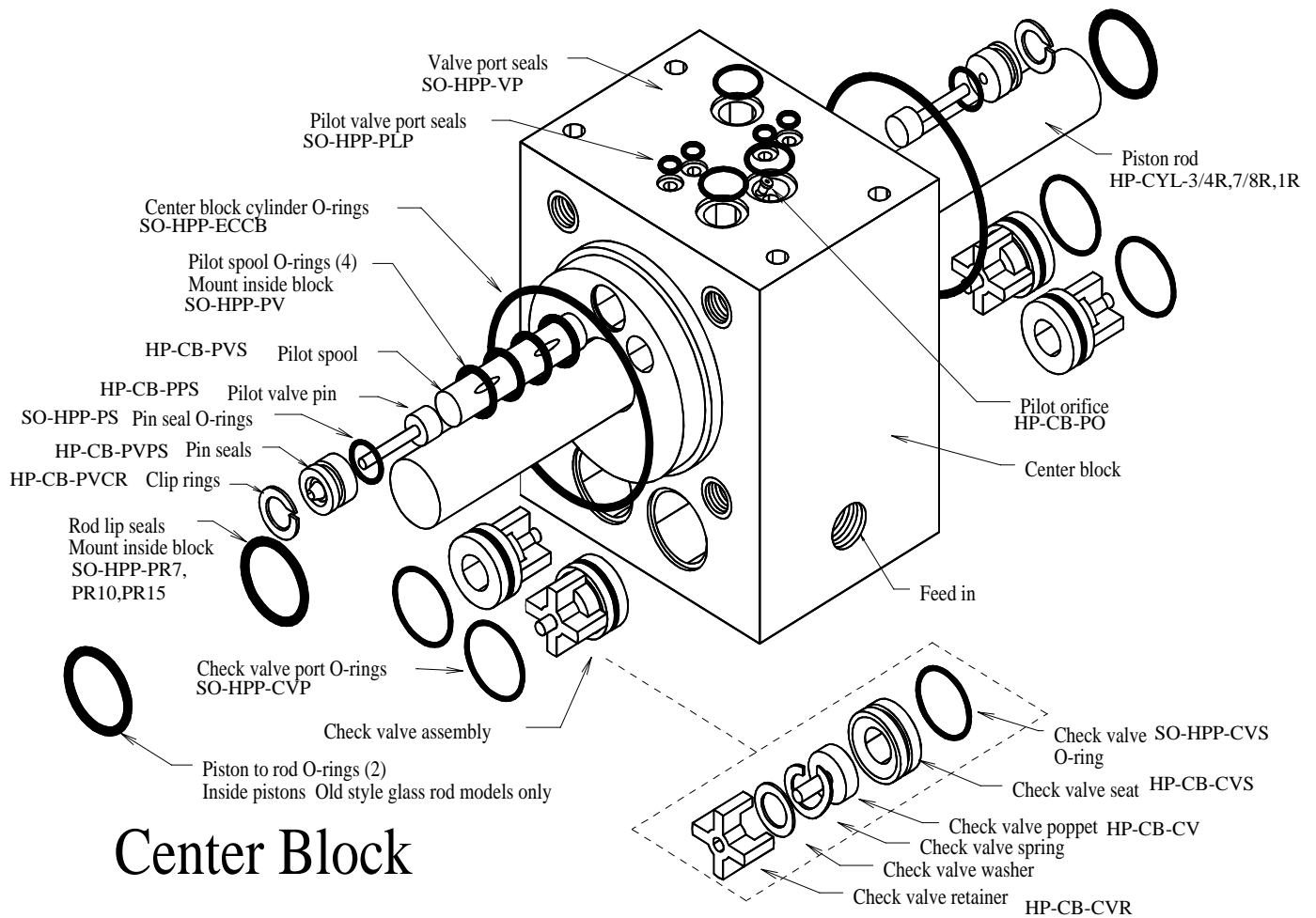
**Spool Assembly
Exploded View
(early style)**



Valve Block



**Reversing Valve
End Blocks**

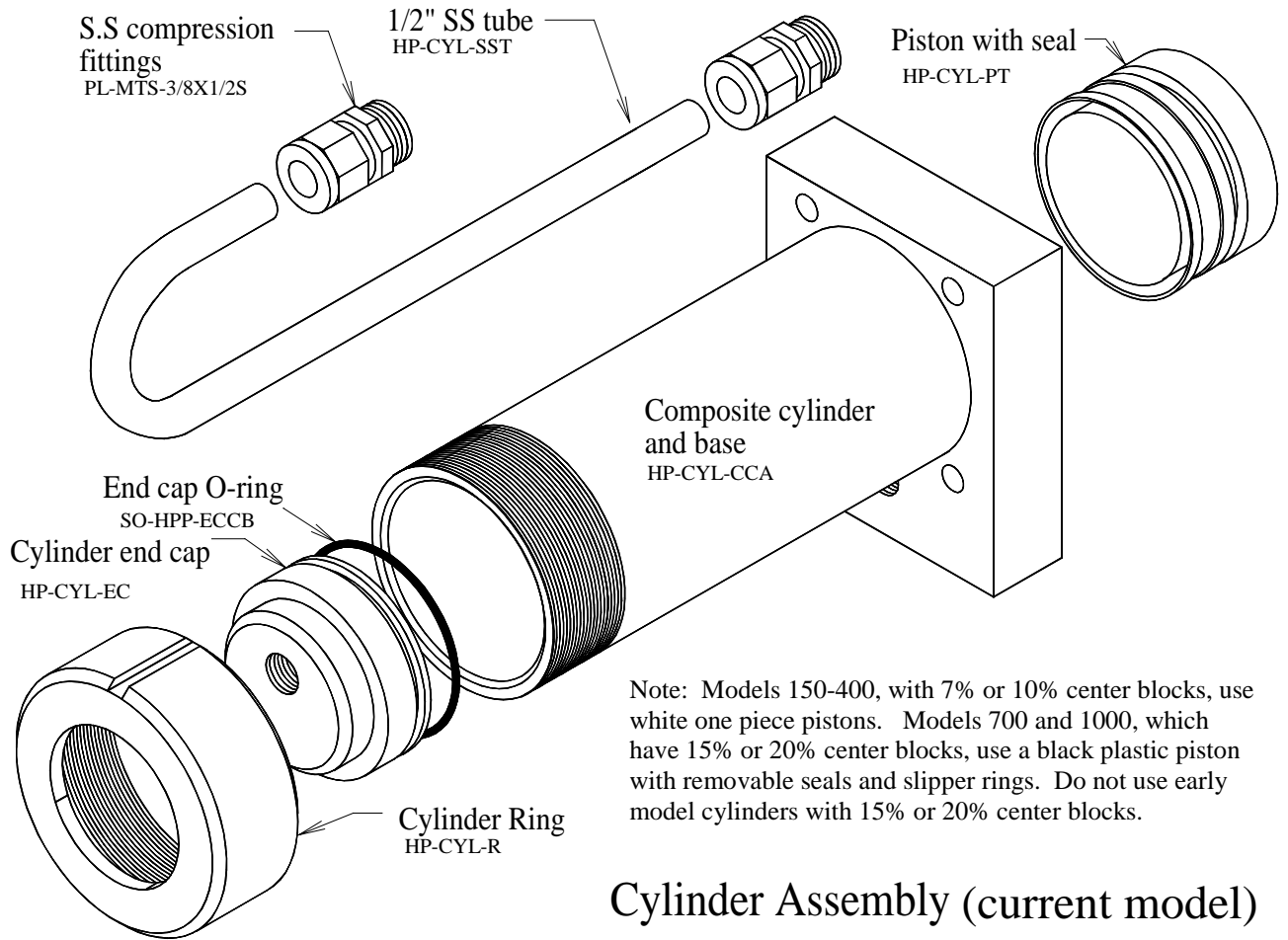


Center Block

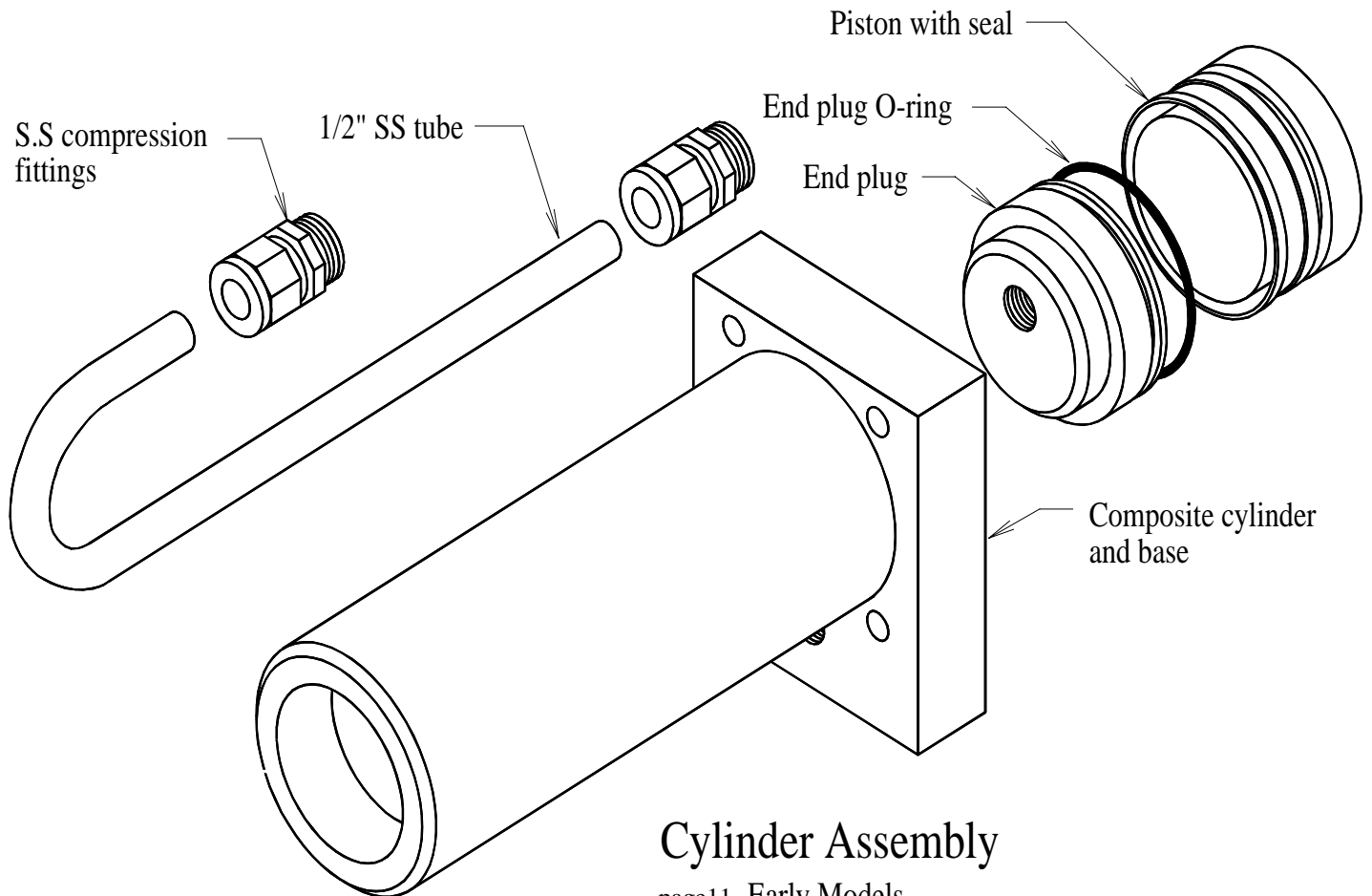
Note: Model 150 watermakers have a “7%” Center Block which uses a 3/4” diameter piston rod and rod seals. 180, 200, 300, 380 and 400 models have a “10%” Center block which uses a 7/8” diameter rod and seals. These models use white plastic valve springs.

Model 700 Watermakers have a “15%” center block using a 1” dia. rod and seals. Model 1000 watermakers use a “20%” Center block which has two rod bores and two 7/8” diameter piston rods, each with two (4 total) lip seals. These models use metal valve springs.

Current Center block serial numbers have four digits followed by a dash, then a one or two digit number. The second number is the center block “percentage:” e.g. 4035-15 would be a fifteen percent center block having a single 1” rod and metal springs.



Cylinder Assembly (current model)



Cylinder Assembly

TROUBLESHOOTING GUIDE & FIELD REPAIR

This section is for troubleshooting and repairing the *Clark Pump* in the field, utilizing the complete Offshore Kit. There are two Offshore Kits, one for 7% and 10% Clark pumps and another for the 15% and 20% versions. If an Offshore Kit is not available, alternative repair instructions are included. If the pump is functional, it is advisable to wait to reach a quiet port before attempting any field service. **Please Note:** The Center and Valve Blocks are constructed from engineered plastic and rely on o-rings for seal to the mating surfaces. Use caution not to scratch or damage the mating surfaces, as it may reduce the ability of the part to seal properly.

Recommended Basic Tools:

- 1/4" and 5/16" Allen wrenches
- End wrench set to 7/8"
- Annular ring tool
- Pliers
- Vise
- Strong angled dental pick with dulled tip and two small sharp dental picks
- Spanner, strap wrench or Oil filter wrench for end cap retaining rings

Before dismantling the Clark pump determine that there are no problems that exist in the rest of the system. Check the feed pump(s) for rated flow and pressure. (see *Troubleshooting* in the Owner's Manual and the Technical Bulletins).

If a *Clark Pump* problem arises, it may be in the form of low or asymmetrical pressure and flow readings, hard or asymmetrical shifting, high feed pressure readings, or a complete stall.

Since there is a set of seals and check valves for each cylinder, a single failure may affect only one cylinder. This will cause the pressures and flows to be different (asymmetrical) from one stroke to the other. Some asymmetry is normal and expected, as it is unlikely that the seals and parts match perfectly from side to side.

Common causes of low or asymmetrical pressure readings, in order of determination:

1. S.S. compression fittings leaking
2. Pressure relief valve leaking
3. Piston Rod lip seal leaking
4. Annular ring damaged or cracked
5. Piston seals leaking
6. Check valves or piston poppet leaking

Shifting problem causes:

1. Worn or sticky valve spool seals
2. Worn spool piston seals
3. Worn or sticky pilot spool seals
4. Foreign material caught in a valve port

Stalling can be:

1. Pin seal failure
2. Excessive piston drag (tight pistons)
3. Broken valve spool

Much more complete troubleshooting and repair info is contained in our technical bulletins. Please consult them before proceeding.

(Continued on page 13)

1. Stainless Steel Compression Fitting Leaks

If a leak develops at a compression fitting, first try tightening the fitting. Use normal size wrenches on the body and the nut and tighten hard. If the leak persists, replace the tube assembly. If a pipe thread is leaking, remove the part, re-wrap with Teflon tape and reinstall. Refer to the Rebuild Instructions for fitting pipe threads into plastic and metal.

2. Pressure Relief Valve High Pressure Seal Leak

This will reduce pressure and product flow. Unscrew the valve and examine the rounded end. Check to see if there is any damage. If the damage is slight it can be dressed with the 800 grit sand paper. Dry out and inspect the bore to see if any foreign material is present. If there is excessive damage in the bore the valve block will have to be replaced. If the plastic is milky and soft, sodium metabisulfite has been used for storage instead of the Spectra SC-1 chemical and other major damage may have occurred.

3. Shaft Seal Leak

One seal leaking will cause asymmetrical product flow. This one is easy to find. On the back side of the center block is a 1/4" pipe plug marked TEST PORT. This plugs an access port to the space between the two high pressure shaft seals. Remove the plug and run the system. If water squirts, sprays or runs out, you have a bad piston rod seal. One or two drops per minute is ok. Follow the Rebuild Instructions for cylinder removal and center block rebuild to replace the seals. If the system is shifting OK, leave the check valves and pilot valve in place.

4. Worn Spool Piston Seals

Worn spool piston seals will cause poor shifting. Remove the end blocks from the reversing valve. Using pliers, remove the white pistons from the end blocks. Examine the pistons for wear and plating of the orange o-ring material onto the surface. This plating can cause the pistons to be sticky and affect shifting. Carefully clean the orange deposits off of the pistons. Avoid scratching the plastic. Remove and replace the o-ring seals using the dull dental pick. Follow the Rebuild Instructions for reassembly.

5. Reversing Valve

A hissing sound from the valve block along with low or no product flow is an indicator of leaking spool seals or a cracked annular ring. A bad spool seal will leak on every stroke. A cracked annular ring will leak on one stroke but may try to pressurize on the next. A spool that has come unthreaded will stall the system. A broken spool will allow the Clark pump to stroke unpressurized but will cause a system stall if the pressure relief valve is closed. Leave the valve on the unit and the hoses connected if possible. Follow the reversing valve disassembly in the Rebuild Instructions to remove and examine the spool. The two end sections thread into the middle. Check for tightness. The spool piston seals can also be checked at this time (see paragraph 4 in this section). Carefully look at the spool seal surfaces to see if they are damaged or worn. The contact area should look polished with minimal scratches, worn evenly, and

(Continued from page 13)

should compress slightly when installed into the valve block. If foreign material has entered the system it will likely cause damage here. Small scratches across the surface are normal, but if any damage is detected or the spool is loose in the annular rings, replace the seals. Compare to a new seal if possible. If no replacements are available, careful sanding of the seal surface is possible. Place 800-grit or finer sandpaper on a smooth flat surface. Lay the complete spool assembly onto the paper, holding it in the center, then pull and rotate the spool along the paper with light pressure. Release and let it roll 1/8 of a turn and repeat. The paper scratches should run around the seal, not across. Done correctly, minor grooves and flat spots can be removed. If the seals are under size heating them in hot water and stretching them may help them reseal. If the damage is too deep, the seals and the rubber quad rings underneath them must be replaced. A broken spool will come out in two or more pieces. See the Technical Bulletins for instructions on temporary repair of a broken valve spool. Current valve spools are one piece and ship with the seals in place. Earlier three piece spools can be disassembled for seal replacement. It is possible to change the seals on a one piece spool by cutting the old ones off with a razor knife and carefully sliding the new quad rings and seals into place.

6. Annular Ring Damage

The two annular rings inside the valve block are subject to wear and scratches if foreign material gets into the system. Wipe away any water and carefully examine the rings with a flashlight. Look for excessive grooves or cracks in the seal contact area across the holes. A crack in a ring will not be visible when installed. If a crack is suspected see the “Reversing Valve Problems” technical bulletin for instructions on temporary repairs. Sanding with 800-grit or finer sandpaper can help clean up any small scratches. Sand along the holes, not across them. The surface must be smooth for proper valve function. If deep grooves are found, remove and replace the bad rings and spool seals following the Rebuild Instructions.

7. Annular Ring O-Ring Seal Leak

Since these are static seals around the outside of the ring, failure here is unlikely. A leak here could be caused by a defective o-ring, or from damage during installation. Check other possibilities before pulling the annular rings. Follow the Rebuild Instructions for the reversing valve.

8. Piston Seal Leak

At this point, the Clark pump should be removed from its mounting, and a work area set up that can handle water spillage. Piston seal failure is unlikely because of the low working pressures. However, to inspect them, begin by removing the reversing valve assembly as a unit. Follow the Rebuild Instructions for cylinder and piston removal. The white pistons in 7% and 10% pumps have integral seals which should have a smooth contact area on the outer surface of the rounded lip. Some small scratching is OK. The piston sides may show deeper scratches, which is normal. Check the pistons carefully for embedded abrasive particles which could scratch the cylinders.

(Continued on page 15)

(Continued from page 14)

9. Piston Poppet (hollow glass piston rod units only)

The piston poppet is in one piston only. If a leak is suspected here, remove the clip-ring and inspect the underside of the poppet and the seat in the piston for foreign material or damage.

10. Check Valve Leak

While the cylinders are off, inspect the *intake* check valves. The retainers and poppet are easily removed. Carefully check the poppets and seats (seats are in the center block). Replace a poppet and/or seat if *any* damage is found. When a cylinder is pressurizing, the intake check valve is closed (the one closest to the feed-in port) and the output check valve is open. Conversely, the other driving cylinders' output check valve is closed. A leak in either one will cause poor performance in the suspect cylinder. If you find a problem in a seat and have an "Easy Out" for a 1/2" hole, remove the seat and repair or replace. If no replacements are available and the damage is slight, the poppet and seat can be "lapped" together using softened wet or dry 800-grit sandpaper in between.

11. Pilot Valve Pin Seal Leak

A leaking pin seal will cause asymmetrical pressures. Unless replacement pins and seals are available, it is not recommended to disassemble the pilot valve assembly without compressed air. Check the system by pushing the extended pin half way in, then using your fingers, pull the pins out as far as they will go. Look at the pin surface for damage. Work the pins in and out, they should feel tight in the seal. If they feel tight and have no external damage they are probably alright. If they seem worn and replacement pins and seals are available, use the sharp dental picks to remove the seal retainer rings, then using pliers, pull on the pin to remove the first seal. When the seal O-ring hits the clip-ring groove, gently pull and partial release to "work" the O-ring over the groove. Use a bolt to push on the spool to remove the other seal and the pilot spool. Refer to the Center Block sections of the Rebuild Instructions.

12. Worn Pilot Spool Seals

Worn pilot spool seals will cause erratic shifting and knocking. Refer to the previous pilot valve pin seals and center block sections in the Rebuild Instructions for field removal of the pilot spool. If the spool is loose in the seals, it is under size or the O-rings are worn. Check the spool for wear and for plating of the seal material onto the spool. If necessary, replace or sand the spool on 800-grit sandpaper placed on a smooth flat surface, sanding and rotating at the same time until smooth and even, then polish with white compound. Follow the Rebuild Instructions for removing the spool O-ring seals with the dull pick, and for reassembly. When reinstalling the spool, insert slowly and feel to make sure that each of the 4 O-ring seals are making good contact on the spool.

REBUILD INSTRUCTIONS

The following instructions are geared for the technician working in a reasonably well-equipped shop with the unit disconnected from the rest of the system. If working conditions are not ideal, refer to the Troubleshooting Guide for alternative procedures. Refer to the exploded view drawings.

Please Note: The center and valve blocks are constructed from engineered plastic and rely on O-rings for seal to the mating surfaces. Use caution not to scratch or damage the mating surfaces, as it may reduce the ability of the parts to seal properly.

Warning: Water will spill from the unit when disassembled. Most of the water can be removed prior to disassembly by connecting the two high pressure ports together and injecting compressed air into the feed in port. Any water inside will spray from the brine discharge port so take precaution.

Use Teflon tape on all pipe threads. For metal-to-plastic or plastic-to-plastic, use at least 4 wraps of Teflon tape. Tighten with a wrench until 1/2 to 2/3 of the fitting thread is buried. **Do not over tighten plastic pipe threads, especially metal into plastic.** If time permits we recommend that center blocks and valve bodies machined to accept tapered thread high pressure fittings be exchanged or returned to the factory for remanufacturing to the current straight thread with O-ring seal style fittings.

Recommended Tools:

- Compressed air with a rubber tip nozzle
- Open end wrench set to 7/8"
- 5/16" and 1/4" ball end Allen wrenches (in offshore kit)
- Annular ring removing tool (in offshore kit)
- Channel locks or pliers and a vice, another set of pliers can substitute for a vice
- Strong angled dental pick with dulled tip
- Two small sharp angled dental picks
- Teflon tape
- "Easy Out" for a 1/2" hole, the tip may have to be ground off
- Mild liquid soap
- 800 grit sandpaper
- White rubbing compound

(Continued on page 17)

DISASSEMBLY INSTRUCTIONS

Reversing Valve Disassembly

Refer to the drawings on pages 8 & 9. Remove the reversing valve block from the center block using the 1/4" Allen wrench. Remove the reversing valve end blocks. Remove the plastic spacer rings and large O-rings. Using compressed air, remove the valve pistons from the end blocks by blowing into the left small port, or pull out with pliers. Remove the piston seals with the dull pick. Push the valve spool out of the valve body by hand. Unscrew the pressure relief valve and remove the O-ring.

Annular Ring Removal

Unless there is visible damage to the wear surface, or you suspect a cracked ring, do not remove the rings. Very small chipping around the holes is OK. Refer to Fig. 1 below. Tilt and slip the ring removal tool through the first ring then turn it upright so it will butt against the second ring. Using a mallet and a wooden or plastic dowel pressed against the remover tool, lightly tap out the ring. If no dowel is handy the spool itself can be used. Re-insert the tool from the other side and repeat for the second ring. If a ring removal tool is not available, a plastic or hardwood punch can be used to carefully work out the ring. The center bore of the valve block is larger than the ring bore, leaving a lip for the punch to catch on. **Caution: If replacement annular rings are not available, it is advised not to remove the rings without an annular ring tool.** The ring and valve body can be easily damaged when the tool is not used.

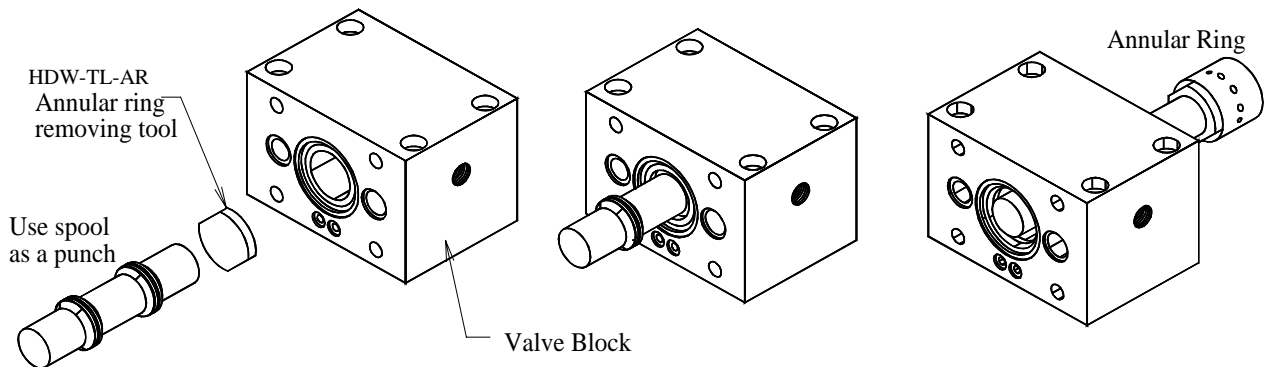


Fig. 1

(Continued on page 18)

Cylinder Removal

The center block has metal threaded inserts that are pressed into the block. They are not glued or pinned. These inserts may spin with the bolts.

To keep the inserts from spinning, loosen one cylinder's base bolt then retighten half-way. Now loosen the opposing bolt on the other base, watching to see if the first bolt starts to turn, then turn it back 1/4 tight. If the first bolt starts to turn, tighten it enough to hold the insert so that you can loosen the opposite bolt. Now go back to the first cylinder and remove the bolt and then the opposite bolt. Repeat on the other three opposing bolt sets. *Note: If a bolt remains stuck in an insert, the cylinder can be removed by pulling out the insert along with the cylinder. After separation, clamp the insert in a vice to loosen the bolt.*

Hold the center block and slide the cylinder away from the center block, **very** gently rocking up and down. Ease-off on the pull as the cylinder begins to move, and go slowly until the cylinder comes free. (If your pump was built before 1/1/2001 it may have a glass piston rod that could shatter if the cylinder is not pulled off gently enough.) Water will now spill out. Pull the cylinder straight out from the center block. If the piston is still on the rod, hold both the rod and piston, then carefully twist and pull the two apart. Remove the rod from the Center block. Store the rod in a safe place. Now remove the other cylinder.

Center Block Disassembly

Note how the check valves are oriented in the block. Remove all the external o-rings and the intake check valve retainers, springs and poppets. Using the "Easy Out," carefully grab the center of the check valve seats and pull them free of the block. Remove the outlet poppets, retainers and springs.

Remove the rod seals with the dull pick. Be careful not to scratch the grooves.

Remove one of the pilot valve pin seal clip rings with the sharp picks. Stick a sharp pick into the plastic ring next to the gap and bend it toward the center. When it clears the groove, use the other pick to reach underneath the end and peel the ring out.

Place a rag in front of the free pin seal. Cover the three pilot ports on the top of the block that are farthest away from the seal, then run compressed air into the closest hole. The seal and pin should shoot into the rag. If no air is available the pin can be pulled out with pliers. This will destroy the pin, so do this only if replacements are on hand. Remove the clip ring from the other side, then use a bolt to push on the pilot spool inside the block to remove both the other seal and pilot spool. Be careful not to catch the pin seal O-ring on the clip ring groove. Remove the four O-ring seals inside the pilot bore with the dull pick.

Cylinder Disassembly (Do not disassemble the cylinder unless there is a problem)

Hold the base of the S.S compression fittings and loosen the nuts to remove the J-tube. Loosen the base fitting first. Use the spanner or a strap wrench, oil filter wrench, or a nonmetal punch in the groove to loosen the aluminum cylinder ring then remove the ring and plastic end cap. Push the piston out of the cylinder. The piston should move easily in the cylinder without being loose. If the piston must be driven out with a mallet and stick it is too tight and must be replaced or turned down on a lathe. Contact the factory for instructions. If the pistons are loose enough to rattle they are too loose and should be replaced in 7% And 10% pumps, or be rebuilt on 15% and 20% pumps.

Earlier model cylinders without the aluminum ring: push the End Plug out through the cylinder base . The piston will come out with it. Remove the compression fittings from the base and end plug only if the fittings and tube are to be replaced.

ASSEMBLY INSTRUCTIONS

Clean the work area before beginning. Inspect all parts and check for any damage and foreign material in the O-ring grooves, ports, and threads. If the black plastic parts are discolored white, or the piston rod is soft enough to easily scratch with a finger nail there has been damage due to improper storage chemicals. Chemically damaged parts will need to be replaced. If possible, replace all the dynamic seals.

Check the pilot spool for indentations and plating from the O-rings. Clean it up with white rubbing compound or replace as necessary. Check the cylinders for damage around the O-ring contact area and for excessive scratching and/or chipping. Thoroughly clean all parts, especially the cylinders. If the piston rod is scratched in the seal contact area, replace it. Dry-fit any new parts together without o-rings to insure proper clearances.

Do not use petroleum based lubrication as the grease can damage the membrane! Have a bucket of clean, mild soapy water handy to rinse the parts just before assembly. The soap will give enough lubrication for easy assembly and will wash away any remaining dirt.

Identify the O-rings by matching them to the life size illustrations on the Seal Gauge.

Center Block Assembly

Double check for debris. ***Refer to the Center Block Drawing on page 10.*** To install the pilot valve o-rings inside the block, first insert the pilot spool into the pilot valve hole from the other side to use as a stop for the O-ring insertion. Rinse the o-rings, then use a small wooden or plastic push rod to push the O-rings into their grooves with the help of the spool. Insert in the closest groove to the top first, and then the next one. Reverse the block and repeat from the other side. Push the pilot into the center of the pilot bore. The spool should have a snug fit in all the O-rings.

Install the O-rings onto the pilot valve pin seals, then insert the valve pins into the seals as shown. Rinse, then hold the pin and push the seals into place, being careful not to catch the seal on the clip ring groove. Install the clip rings.

Install ***one*** of the piston rod seals inside the block with the lip face out. Push the piston rod into the bore from the far side until it is just even with the near side seal groove and push the seal into the groove with your fingers only, making sure it isn't twisted and seats fully. Remove the rod until after the check valves are installed.

Install the O-rings onto the check valve seats and install the check valve components as illustrated. Inlet valves go on the side with the feed water inlet port and are assembled seat first, then poppet, spring, washer, and retainer. It is easier to install the poppet, spring and washer into the retainer and then put the assembly into the center block all at once. (*Note: notice that the old inlet valve retainers have been given small barbs to help hold them in the center block against the force of the spring. Reuse the old retainers if they are serviceable, or barb the new ones in a similar manner using a pair of diagonal cutters.*) The outlet valves go on the side of the center block with the high pressure outlet port and are assembled retainer first and seat last. The O-ring friction between the valve seat and the center block is enough to hold the seat in against the spring force.

Insert the Piston rod into its bore from the side that still doesn't have a seal, pushing it through the installed seal. Then pull it through until the end of the rod just uncovers the empty groove. Install the remaining rod lip seal with the lip pointing toward you, then push the piston rod back in until it is sticking out both sides of the Center Block. If the piston rod is inserted after both seals are in place it can catch on the seal's lip causing it to tear or roll.

(Continued on page 20)

Cylinder Assembly

Refer to the cylinder diagram on page 11 and 12. Later models; Install the S.S. tube fitting into the end cap. If the existing cylinder endcaps use tapered piped threads with Teflon tape sealant, replace them with the new O-ring seal endcaps if available. These are available as a kit, p/n KIT-HP-ECK. Rinse the cap and cylinder then press into the outer end of the cylinder, aligning the fitting port up. Thread on the cylinder ring and tighten. Install the other S.S. fitting body into the cylinder base. If the S.S.tube is new, dry fit it into the fittings on the cylinder. Clean the tube thoroughly. Slip the tube into the fittings and finger tighten the nuts. Start with the bottom fitting. Tighten the nuts 1 1/4 turns while holding the fitting body. If the old tube is used and the fittings have been removed, install the fittings, then dry fit the tube to see if the ferrules contact the fittings at the same time. Adjust by tightening or loosening the cylinder base fitting. Removal and re-Teflon taping of the threads may be necessary. Thoroughly clean the cylinder assembly with soap and water.

15% and 20% pumps replace the white slipper rings and seal and the orange o-ring on the pistons if they are scratched and worn.

7%, 10% & 15% pumps: Rinse the piston, then carefully insert it into the cylinder so that the socket for the piston rod is visible. The bevel in the cylinder edge will help compress the seal lip. Push it in about half way down the cylinder.

20% pumps only: Rinse the piston and insert it into the cylinder about an inch. Note that the piston rod socket must be kept at 90degrees to the long direction of the cylinder base so that the piston rods will be aligned with the rod socket.

Early models; install the O-ring and the S.S. compression fitting body onto the end plug. Rinse the cylinder and end plug and carefully insert the plug into the cylinder, fitting first and towards the top, without pinching the O-ring, then push the plug through the cylinder to the stop ring. The face of the plug should be 1/2" from the end of the cylinder and the fitting is offset to the top. If necessary, align the fitting by tapping the plug back down the cylinder then push on the fitting in the desired direction while tapping the plug back into place.

Early models with hollow rods; install the piston rod O-rings in their grooves inside the pistons. **Important, one piston must have the poppet assembly. If neither piston has the poppet, install a rod O-ring into one piston only. Leave the groove in the other piston empty.** Later models with the solid rods do not need piston O-rings. Note: Hollow glass piston rods cannot be used with the new style pistons. When replacing pistons on units with hollow glass piston rods use a solid piston rod.

(Continued from page 20)

Valve Spool Assembly

Three piece spools should be replaced with current production single piece spools if available. If a three piece spool must be rebuilt refer to the Valve Block Drawing. Place the rubber quad rings onto the spool ends then slip the plastic spool seals over the quad rings. Thread the ends into the spool center. Hand tighten until the ends are bottomed out in the center section then tighten 1/4 turn more with tools holding both ends. It is normal for the plastic seals to have play in the groove.

Reversing Valve Assembly

Refer to the Valve Block and End Cap Drawings. Check the blocks for shavings and clean thoroughly. Install the annular ring O-rings into the valve block. Rinse and push the annular rings in by hand to start. Place the annular ring tool against the rings then tap them into place. Make sure that they end up flush with the valve block surface next to it. Install the port O-rings and the large center bore O-rings onto both sides of the block. Stretch the large O-rings first to help them stay in the grooves if necessary. Install the pressure relief valve O-ring into the valve port, then thread the relief valve in until it stops then open the valve one half turn.

Rinse and install the spool piston O-rings into the end blocks then insert the pistons with the stem facing out. Fit the spacer rings to the end blocks. They should hold there. Carefully install the left end block with the little ports on the bottom and the discharge port on the pressure relief valve side. Watch that the large O-ring stays in place during mating of the parts. Tighten the bolts evenly, but do not over tighten. Hand tightening with a screwdriver-handled tool is all that is necessary.

Push the valve spool into the valve block from the right side. Keeping the spool at 90 degrees to the block will help. The seal rings are slightly oversized and need to be compressed as they slip into the annular rings. The annular ring bores are beveled for this reason. Push it in as far as it will go.

Re-check the large and small port O-rings and spacer ring, then mount the right end block.

Cylinder Installation

Confirm that the check valves are installed correctly and that the cylinder and check valve O-rings are in place. With hollow rod units only, recheck that one of the pistons has a poppet assembly or if not, that only one piston to rod O-ring is installed. Rinse the cylinder O-ring and cylinder then carefully push the a cylinder onto the center block. On single piston rod pumps it is not necessary to try to slip the rods into the pistons; they will seat on start up. However, On 20% pumps having twin piston rods, care must be taken to ensure that the piston rods seat in the piston socket.

Lubricate the bolt threads, install and hand-tighten. Install the other cylinder the same way, but tighten the bolts a little further than the right side. If you have two Allen wrenches tighten the opposing bolts at the same time. If not, alternate tightening the bolts.

Final Assembly

Install the proper O-rings onto the top of the center block. Place the valve assembly onto the center block with the pressure relief valve to the front, feed inlet side, and bolt down evenly. Install the feed inlet fitting into center block and the brine discharge fitting into the left or right discharge port in the reversing valve assembly. Place a 3/8" pipe plug into the unused discharge port. Install the high pressure tube fittings into the high pressure discharge port on the back side of the center block and the high pressure inlet port on the back side of the valve block.

Testing

Bench testing can be accomplished without a membrane by installing a high pressure tube between the high pressure in and out ports. The unit will not run without the high pressure ports connected. Use a spare feed pump drawing from a bucket, or pressure from a garden hose. Open the pressure relief valve before starting, then after the air is purged, slowly turn the relief valve clockwise until pressure builds. When the valve is fully closed the pump should stop under high pressure and have almost no flow out the brine discharge. Check for leaks. Do not close off the pressure relief valve if the feed pressure can go over 120 psi.

If shifting is hard, the possible cause is a poor finish on the annular ring sealing surface.

If nothing happens, check the placement of the check valves or orientation of the center block.

If the unit runs but will not build up pressure and stop when the relief valve is closed, there is internal leakage. Follow the Troubleshooting Instructions to locate the problem.

Check the Test Port: It should be dry or very little water present. One or two drops per minute max. If water is running or spurting from the test port, one of the seals is improperly installed, or may have rolled if the rod was not installed in the proper sequence. If all is OK install the Test Port plug.

7% CLARK PUMP PARTS LIST

PART#	DESCRIPTION	USAGE
HP-CB-CB7	CENTER BLOCK 7%	1
HP-CB-INS	CENTER BLOCK INSERT	4
HP-TB-VB	VALVE BODY	1
HP-TB-BV	BLEED VALVE	1
HP-TB-VEB-A1	VALVE END BLOCK A 1-1/4"	1
HP-TB-VEB-A2	VALVE END BLOCK B 1-1/4"	1
HP-CB-PVPS	PILOT VALVE PIN SEAL	2
HP-CB-PPS	PILOT VALVE PIN	2
HP-CB-PVCR	PILOT VALVE CLIP RING	2
HP-CB-SPRP	CHECK VALVE SPRING PLASTIC (DELRIN)	4
HP-CB-CVSW	CHECK VALVE SPRING WASHER	4
HP-CB-PVS	PILOT VALVE SPOOL	1
HP-CB-CVS	CHECK VALVE SEAT	4
HP-CB-CVR	CHECK VALVE RETAINER	4
HP-CB-CV	CHECK VALVE	4
HP-TB-AR	ANNULAR RING	2
HP-TB-VS10	10% REV. VALVE SPOOL	1
HP-TB-VSS	REV. VALVE SPOOL SEAL	2
HP-TB-VSP	REV. VALVE SPOOL PISTON	2
HP-CYL-EC	CYLINDER END CAP	2
HP-TB-EBP	END BLOCK PLUG	2
HP-CYL-PT	PISTON	2
HP-TB-SR	SPACER RING	2
HP-CYL-SST	STAINLESS TUBE	2
HP-CYL-CC	COMPOSIT CYLINDER	2
HP-CYL-CCB	COMPOSIT CYLINDER BASE	2
HP-CYL-R	CYLINDER END RING	2
HP-CYL-3/4R	3/4" PISTON ROD	1
PL-MTS-3/8X1/2S	3/8"NPT X 1/2" TUBE FITT ST SS.	4
HD-CPS-3/824175	3/8-24X1 3/4 CAP SCREW	8
HD-CPS-5/16X3	5/16-18X3 1/4 CAP SCREW	4
HD-CPS-5/162.75	5/16 X 2 3/4 CAP SCREW	8
HD-WSH-3/8X5/8S	3/8 X 5/8 O.D. SS FLAT WASHER	8
PL-HP-3/8N	GLASS FILLED BLACK NYLON PLUG 3/8"NPT	1
PL-HP-1/4BR	1/4 COUNTER SUNK HEX PLG.	1
PL-MTE-3/4SX1/2	3/4"MPT(ST) X 1/2" TUBE SS FITT. ELL.	2
SO-HPP-PLP	PILOT PORTS	8
SO-HPP-PS	PIN SEALS	2
SO-HPP-VP	VALVE PORTS	6
SO-HPP-CVS	CHK. VALVE SEATS	4
SO-HPP-CVP	CHK. VALVE PORTS	4
SO-HPP-VB	VALVE BORE	2
SO-HPP-ECCB	END CAP & CENTER BLOCK	4
SO-HPP-AR	ANNULAR RING	4
SO-HPP-PV	PILOT VALVE	4
SO-HPP-RV	RELIEVE VALVE	1
SO-HPP-CT	CONNECTOR O-RING	2
SO-HPP-SP	SPOOL PISTON	2
SO-HPP-Q	QUAD SEAL	2
SO-HPP-PR7	7% PISTON ROD SEAL	2

2/11/2005

10% CLARK PUMP PARTS LIST

PART	DESCRIPTION	USAGE
HP-CB-CB10	CENTER BLOCK	1
HP-CB-INS	CENTER BLOCK INSERT	4
HP-TB-VB	VALVE BODY	1
HP-TB-BV	BLEED VALVE	1
HP-TB-VEB-A1	VALVE END BLOCK A 1-1/4"	1
HP-TB-VEB-A2	VALVE END BLOCK B 1-1/4"	1
HP-CB-PVPS	PILOT VALVE PIN SEAL	2
HP-CB-PPS	PILOT VALVE PIN	2
HP-CB-PVCR	PILOT VALVE CLIP RING	2
HP-CB-SPRP	CHECK VALVE SPRING PLASTIC (DELRIN)	4
HP-CB-CVSW	CHECK VALVE SPRING WASHER	4
HP-CB-PVS	PILOT VALVE SPOOL	1
HP-CB-CVS	CHECK VALVE SEAT	4
HP-CB-CVR	CHECK VALVE RETAINER	4
HP-CB-CV	CHECK VALVE	4
HP-TB-AR	ANNULAR RING	2
HP-TB-VS10	10% REV. VALVE SPOOL	1
HP-TB-VSS	REV. VALVE SPOOL SEAL	2
HP-TB-VSP	REV. VALVE SPOOL PISTON	2
HP-CYL-EC	CYLINDER END CAP	2
HP-TB-EBP	END BLOCK PLUG	2
HP-CYL-7/8R	PISTON ROD	1
HP-CYL-PT	PISTON	2
HP-TB-SR	SPACER RING	2
HD-CPS-3/824175	3/8-24X1 3/4 CAP SCREW	8
HD-CPS-5/16X3	5/16-18X3 1/4 CAP SCREW	4
HD-CPS-5/162.75	5/16 X 2 3/4 CAP SCREW	8
HD-WSH-3/8X5/8S	3/8 X 5/8 O.D. SS FLAT WASHER	8
HP-CYL-SST	STAINLESS TUBE	2
PL-MTS-3/8X1/2S	3/8"NPT X 1/2" TUBE FITT ST SS.	4
HP-CYL-CC	COMPOSIT CYLINDER	2
HP-CYL-CCB	COMPOSIT CYLINDER BASE	2
HP-CYL-R	CYLINDER END RING	2
PILOT ORIFICE	PILOT ORIFICE	1
PL-HP-3/8N	GLASS FILLED BLACK NYLON PLUG 3/8"NPT	1
PL-HP-1/4BR	1/4 COUNTER SUNK HEX PLG.	1
PL-MTE-3/4SX1/2	3/4"MPT(ST) X 1/2" TUBE SS FITT. ELL.	2
SO-HPP-PLP	PILOT PORTS	8
SO-HPP-PS	PIN SEALS	2
SO-HPP-VP	VALVE PORTS	6
SO-HPP-CVS	CHK. VALVE SEATS	4
SO-HPP-CVP	CHK. VALVE PORTS	4
SO-HPP-VB	VALVE BORE	2
SO-HPP-ECCB	END CAP & CENTER BLOCK	4
SO-HPP-AR	ANNULAR RING	4
SO-HPP-PV	PILOT VALVE	4
SO-HPP-RV	RELIEVE VALVE	1
SO-HPP-CT	CONNECTOR O-RING	2
SO-HPP-SP1	SPOOL PISTON O-RING 1"	2
SO-HPP-Q	QUAD SEAL	2
SO-HPP-PR10	10%, 20% PISTON ROD	2

2/11/2005

15% CLARK PUMP PARTS LIST

PART#	DESCRIPTION	USAGE
HP-CB-CB15	CENTER BLOCK 15%	1
HP-CYL-1R	PISTON ROD 15%	1
HP-CB-INS	CENTER BLOCK INSERT	4
HP-TB-VB	VALVE BODY	1
HP-TB-BV	BLEED VALVE	1
HP-TB-VEB-A	VALVE END BLOCK A 1"	1
HP-TB-VEB-B	VALVE END BLOCK B 1"	1
HP-CB-PVPS	PILOT VALVE PIN SEAL	2
HP-CB-PPS	PILOT VALVE PIN	2
HP-CB-PVCR	PILOT VALVE CLIP RING	2
HP-CB-CVSW	CHECK VALVE SPRING WASHER	4
HP-CB-SPR	CHECK VALVE SPRING	4
HP-CB-PVS	PILOT VALVE SPOOL	1
HP-CB-CVS	CHECK VALVE SEAT	4
HP-CB-CVR	CHECK VALVE RETAINER	4
HP-CB-CV	CHECK VALVE	4
HP-TB-AR	ANNULAR RING	2
HP-TB-VS20	20% REV. VALVE SPOOL	1
HP-TB-VSS	REV. VALVE SPOOL SEAL	2
HP-TB-VSP1.0	REV. SPOOL PISTON 1"	2
HP-CYL-EC	CYLINDER END CAP	2
HP-TB-EBP	END BLOCK PLUG	2
MC70PT15%	15% PISTON	2
MC-HPP-PTS20	20% PISTON SEAL	2
MC-HPP-PTB20	20% PISTON BUSHING	4
SO-HPP-PT20	20% PISTON O-RING	2
HP-TB-SR	SPACER RING	2
HP-CYL-SST	STAINLESS TUBE	2
HP-CYL-CC	COMPOSIT CYLINDER	2
HP-CYL-CCB	COMPOSIT CYLINDER BASE	2
HP-CYL-R	CYLINDER END RING	2
HP-CB-PO	PILOT ORIFICE	1
HD-CPS-3/824175	3/8-24X1 3/4 CAP SCREW	8
HD-CPS-5/16X3	5/16-18X3 1/4 CAP SCREW	4
HD-CPS-5/162.75	5/16 X 2 3/4 CAP SCREW	8
HD-WSH-3/8X5/8S	3/8 X 5/8 O.D. SS FLAT WASHER	8
PL-MTS-3/8X1/2S	3/8"NPT X 1/2" TUBE FITT ST SS.	4
PL-HP-3/8N	GLASS FILLED BLACK NYLON PLUG 3/8"NPT	1
PL-HP-1/4BR	1/4 COUNTER SUNK HEX PLG.	1
PL-MTE-3/4SX1/2	3/4"MPT(ST) X 1/2" TUBE SS FITT. ELL.	3
SO-HPP-PLP	PILOT PORTS	8
SO-HPP-PS	PIN SEALS	2
SO-HPP-VP	VALVE PORTS	6
SO-HPP-CVS	CHK. VALVE SEATS	4
SO-HPP-CVP	CHK. VALVE PORTS	4
SO-HPP-VB	VALVE BORE	2
SO-HPP-ECCB	END CAP & CENTER BLOCK	4
SO-HPP-AR	ANNULAR RING	4
SO-HPP-PV	PILOT VALVE	4
SO-HPP-RV	RELIEVE VALVE	1
SO-HPP-SP1	SPOOL PISTON O-RING 1"	2
SO-HPP-Q	QUAD SEAL	2
SO-HPP-PR15	15% PISTON ROD	2
SO-HPP-CT	CONNECTOR O-RING	2
PL-HBS-3/8X5/8	3/8NPTX5/8 HOSE BARB	1

2/1/2005

20% CLARK PUMP PARTS LIST

PART#	DESCRIPTION	USAGE
HP-CB-CB20	CENTER BLOCK 20%	1
HP-CB-INS	CENTER BLOCK INSERT	4
HP-TB-VB	VALVE BODY	1
HP-TB-BV	BLEED VALVE	1
HP-TB-VEB-A	VALVE END BLOCK A 1"	1
HP-TB-VEB-B	VALVE END BLOCK B 1"	1
HP-CB-PVPS	PILOT VALVE PIN SEAL	2
HP-CB-PPS	PILOT VALVE PIN	2
HP-CB-PVCR	PILOT VALVE CLIP RING	6
HP-CB-CVSW	CHECK VALVE SPRING WASHER	4
HP-CB-SPR	CHECK VALVE SPRING	4
HP-CB-PVS	PILOT VALVE SPOOL	1
HP-CB-CVS	CHECK VALVE SEAT	4
HP-CB-CVR	CHECK VALVE RETAINER	4
HP-CB-CV	CHECK VALVE	4
HP-TB-AR	ANNULAR RING	2
HP-TB-VS20	20% REV. VALVE SPOOL	1
HP-TB-VSS	REV. VALVE SPOOL SEAL	2
HP-TB-VSP1.O	REV. SPOOL PISTON 1"	2
HP-CYL-EC	CYLINDER END CAP	2
HP-TB-EBP	END BLOCK PLUG	2
HP-CYL-7/8R	PISTON ROD	2
HP-TB-SR	SPACER RING	2
HP-CYL-SST	STAINLESS TUBE	2
HP-CYL-CC	COMPOSIT CYLINDER	2
HP-CYL-CCB	COMPOSIT CYLINDER BASE	2
HP-CYL-R	CYLINDER END RING	2
HP-CB-PO	PILOT ORIFICE	1
MC-HPP-PT20	20% PISTON	2
MC-HPP-PTS20	20% PISTON SEAL	2
MC-HPP-PTB20	20% PISTON BUSHING	4
PL-HP-3/8N	GLASS FILLED BLACK NYLON PLUG 3/8"NPT	1
PL-HP-1/4BR	1/4 COUNTER SUNK HEX PLG.	1
PL-MTE-3/4SX1/2	3/4"MPT(ST) X 1/2" TUBE SS FITT. ELL.	3
PL-HBS-3/8X5/8	3/8NPTX5/8 HOSE BARB	1
HD-CPS-3/824175	3/8-24X1 3/4 CAP SCREW	8
HD-CPS-5/16X3	5/16-18X3 1/4 CAP SCREW	4
HD-CPS-5/162.75	5/16 X 2 3/4 CAP SCREW	8
HD-WSH-3/8X5/8S	3/8 X 5/8 O.D. SS FLAT WASHER	8
PL-MTS-3/8X1/2S	3/8"NPT X 1/2" TUBE FITT ST SS.	4
SO-HPP-PLP	PILOT PORTS	8
SO-HPP-PS	PIN SEALS	2
SO-HPP-VP	VALVE PORTS	6
SO-HPP-CVS	CHK. VALVE SEATS	4
SO-HPP-CVP	CHK. VALVE PORTS	4
SO-HPP-VB	VALVE BORE	2
SO-HPP-ECCB	END CAP & CENTER BLOCK	4
SO-HPP-AR	ANNULAR RING	4
SO-HPP-PV	PILOT VALVE	4
SO-HPP-RV	RELIEVE VALVE	1
SO-HPP-SP1	SPOOL PISTON O-RING 1"	2
SO-HPP-Q	QUAD SEAL	2
SO-HPP-PR10	10%, 20% PISTON ROD	4
SO-HPP-CT	CONNECTOR O-RING	2
SO-HPP-PT20	20% PISTON O-RING	2

2/1/2005