1st Edition
February, 2006

MULTIPLEX PUMP

MODEL

100T, 250T
200Q, 400Q

OPERATING AND SERVICE MANUAL

S&K SUPPLY
TRIPLEX PUMP

MAINTAIN PUMP RELIABILITY AND PERFORMANCE WITH GENUINE S&K Supply, Inc. PARTS AND SUPPORT SERVICES

S&K Supply Inc.® genuine pump parts are manufactured to design tolerances and are developed for optimum dependability. Design and material innovations are the result of years of experience with hundreds of different pump applications. Reliability in materials and quality assurance is incorporated in our genuine replacement parts.

Your authorized Sales Office offers the entire backup you'll need. Our main facility in Kilgore, Texas maintains a large inventory of genuine parts.

S&K Supply supports your needs with these services:

1. Trained parts specialists to assist you in selecting the correct replacement parts.
2. Repair and maintenance kits designed with the necessary parts to simplify servicing your pump.
3. On site after the sale support

Authorized service technicians are factory trained and skilled in pump maintenance and repair. They are ready to respond and assist you by providing fast, expert maintenance and repair services.

Factory (KILGORE, TEXAS):
S&K SUPPLY, Inc.
316 South Kilgore Street
Kilgore, Texas 75662 USA

Phone: (903) 984 7624
(800) 854 4729

Fax: (903) 984 8906

INSTRUCTIONS FOR ORDERING REPAIR PARTS

When ordering parts, specify Pump MODEL and SERIAL NUMBER (see nameplate on unit). The Serial Number is also stamped into the power end above the main crank bearing housing.

All orders for Parts should be placed with S&K Supply Inc. in Kilgore, Texas.

Where NOT specified, quantity of parts required per pump or unit is one (1); where more than one is required per unit, quantity is indicated in parenthesis. **SPECIFY EXACTLY THE NUMBER OF PARTS REQUIRED.**

FOREWORD

S&K Supply Inc.® pumps are the result of advanced engineering and skilled manufacturing. To be assured of receiving maximum service from this pump the owner must exercise care in its operation and maintenance. This book is written to give the operator and maintenance personnel essential information for day-to-day operation, maintenance and adjustment. Careful adherence to these instructions will result in economical operation and minimal downtime.

DANGER

Danger is used to indicate the presence of a hazard, which will cause severe personal injury; death or substantial property damages if the warning is ignored.

WARNING

Warning is used to indicate the presence of a hazard, which can cause severe personal injury; death or substantial property damage if the warning is ignored.

CAUTION

Caution is used to indicate the presence of a hazard, which will or can cause minor personal injury or property damage if the warning is ignored.

NOTICE

Notice is used to notify people of installation, operation or maintenance information, which is important, but not hazard related.

TABLE OF CONTENTS

INDEX

LIST OF ILLUSTRATIONS

SECTION 1
DANGER NOTICES

DANGER

Read and understand the following DANGER NOTICES before moving or operating the pump or any pump package unit equipment.

Reciprocating pumps are machines capable of producing high fluid pressures and flow rates and are designed to be used with proper care and caution by trained, experienced operators. **TO AVOID PERSONAL INJURY, DEATH AND/OR EQUIPMENT DAMAGE, READ AND THOROUGHLY UNDERSTAND THE FOLLOWING DANGER NOTICES PLUS THE ENTIRE OPERATING AND SERVICE MANUAL BEFORE ATTEMPTING TO MOVE OR OPERATE THE PUMP.** Contact an S&K Supply service representative if you are unable to comply with any of the danger notices or procedures described in these documents.

Closely examine the pump performance data upon pump delivery to become thoroughly familiar with the operating limits for this pump model. **The pump must never be operated at speeds, pressures or power ratings exceeding the maximum values or at speeds below the minimum. Failure to observe the operating limits could result in personal injury, death, and/or equipment damage and will void the warranty.** Alterations to the pump, or application of the pump outside the limits, must not be made without S&K Supply's written approval, together with a new set of performance data, as dangerous operating conditions could result.

Keep in mind that full operator attention and alertness are required when operating high pressure pumping equipment. Operators should not begin or continue operations when tired, distracted or under the influence of alcohol or any type of prescription or nonprescription drugs.

The timely replacement of expendable parts and any other worn or damaged parts can prevent equipment damage and possible injury. The original parts used in S&K Supply Inc. pumps are designed and tested to exacting standards to provide high quality performance and durability. Your best insurance in maintaining these characteristics is to use genuine S&K Supply Inc. replacement parts.

A broad range of danger notices are covered on these pages, however, they cannot substitute for training, experience and common sense in the safe operation of high pressure pumping equipment.

HAMMER LUG FASTENERS

DANGER

On pumps equipped with hammer lug unions and/or hammer lug valve covers the following precautions must be observed to avoid personal injury, death and/or equipment damage due to contact with the hammer, broken parts from the hammer, lugs or other objects propelled by hammer blows. When tightening or loosening hammer lug unions and valve covers, operators or maintenance personnel should:

- Inspect the hammer and hammer lugs to insure they are all in good condition. Replace any of these parts which are cracked, damaged or badly worn.

- Wear safety equipment such as shoes and safety glasses to assure a safe work situation.

- Alert other personnel to move away from the area.
- Check to insure they have safe footing.
- Fully engage the hammer bar, if one is used, to prevent it from disengaging violently from the cover as a blow is struck.
- Wipe their hands and the hammer handle and maintain a firm grip on the handle to avoid losing control of the hammer while swinging and striking.
- Carefully swing the hammer to avoid striking themselves, another person and objects other than the targeted lugs or hammer bar.
- Avoid swinging the hammer above shoulder height.
- Use of a non-sparking is needed is hazardous areas.

VALVE SEAT PULLING (if applicable)

DANGER

The following precautions must be observed by operators and maintenance personnel to avoid personal injury, death and/or equipment damage from contact with the puller, hammer, wedge or broken parts from these components when using either a hydraulic or wedge valve seat puller. Operators or maintenance personnel should:

Hydraulic Seat Puller

- Wear safety shoes and glasses.
- Chain or tie the jack down as it will jump violently when the valve seat disengages from the valve deck.
- Check to insure the pressure applied by the hydraulic pump does not exceed the hydraulic ram maximum pressure rating.

Wedge Seat Puller

- Grind off any mushroomed material from the wedge before use.
- Inspect the hammer and wedge to insure they are in good condition. Replace any of those parts which are cracked, damaged or badly worn.
- Wear safety shoes and goggles.
- Check to insure they have safe footing.
- Fully engage the wedge to prevent it from disengaging violently from the cover as a blow is struck.
- Wipe their hands and the hammer handle and maintain a firm grip on the handle to avoid losing control of the hammer while swinging and striking.

- Carefully swing the hammer to avoid striking themselves, another person and objects other than the targeted wedge.

- Avoid swinging the hammer above shoulder height.

COVERS AND GUARDS

DANGER

Personal injury, death and /or equipment damage can result from contact with moving parts. All moving parts must be equipped with covers and guards. All covers and guards must be securely positioned at all times when the unit is in operation.

Covers and guards are intended to not only protect against personal injury or death, but to also protect the equipment from foreign object damage

EQUIPMENT MOVING AND LIFTING

DANGER

Heavy equipment including pumps, pump packages and components should only be moved or lifted by trained, experienced operators, who are physically and mentally prepared to devote full attention and alertness to the moving and lifting operations. An operator should be fully aware of the use, capability, and condition of both the equipment being moved and the equipment being used to move it.

DANGER

Failure to follow safe and proper pump, pump package or component lifting or moving procedures can lead to personal injury, death and /or equipment damage from shifting, falling or other unexpected or uncontrolled equipment movements.

Make sure the hoist, lift truck, ropes, slings, spreader bar or other lifting equipment you are using is in good condition and has a rated lifting capacity equal to or greater than the weight being lifted. Lifting devices must be checked frequently for condition and continued conformance to rated load capacity. They should then be tagged with the rated capacity together with the date of inspection.

Fully assembled pumps and pump packages are heavy and should only be moved using the specified lifting lugs or attachments.

Individual components may have lifting eyes or lugs which must not be used to lift assemblies, as they are designed to bear the weight of the component only.

Before lifting the individual component, check to insure the lifting attachment is firmly secured to the component, with undamaged, properly torqued fasteners, sound welds, or other secure attachments. Examine the lifting eyes, lugs, slots, holes or other projections to insure they are

not cracked, otherwise damaged or badly worn. The repair of existing or addition of new welded lifting eyes, lugs or other projections should only be performed by experienced, qualified welders.

Package units should be lifted with spreaders connected to the lifting attachments normally built into the package unit support skid. Packages too large to lift as fully assembled should be separated into smaller loads.
For these smaller loads the lifting devices should be fastened to the lifting attachments normally built into the individual motor, engine, pump or transmission / torque converter, or their separate support skids.

When lifting sub-assembled components, for example a suction stabilizer attached to suction piping or a discharge pulsation damper attached to a strainer cross and piping, use special lifting slings designed to safely support the combined weight of the components.

If a crane or hoist is being used to lift large components or assemblies, one or more persons should assist the operator from the ground with guide lines attached to the equipment being moved to properly position it and prevent uncontrolled movement.

When you start to lift a pump, package unit, subassemblies or individual components and you observe the equipment is tilting, or appears unbalanced, lower the equipment and adjust the lifting device to eliminate these improper lifting conditions before proceeding to move the equipment.

It is poor practice and dangerous to allow the equipment to pass over or close to your body or limbs. Be prepared to move quickly out of danger if equipment starts to fall, slip or move unexpectedly toward you.

PRESSURIZED PUMP SYSTEMS

DANGER

Fluids under high pressure can possess sufficient energy to cause personal injury, death and/or equipment damage either through direct contact with escaping fluid streams or by contact with loose objects the pressurized fluid propels.

Operating a pump against a blocked or restricted discharge line can produce excessive pressures in the entire discharge system, which can damage or burst discharge system components.

DANGER

Never operate a pump without a properly sized pressure relief valve or working over-pressure shutdown in the discharge line immediately adjacent to the pump discharge port(s).

The relief valve should be placed in the flowing discharge line and not at the opposite end of the discharge manifold in a dead end connection. The dead end may become clogged with solid material carried in the fluid, which could prevent proper relief valve operation.

DANGER

Never place a shut-off valve or any other component between the pump discharge connection and the pressure relief valve.

Make sure the pressure relief valve is installed so any pressurized relief discharge from the valve is directed away from possible contact with people or equipment. The relief valve must be set to relieve at a pressure equal to or below the maximum pressure values shown on the pump data plate. However, if a component is used in the discharge system with a lower rated pressure capability than that listed on the pump data plate, the pressure relief valve must be set to relieve at a pressure equal to or below the rated capability of the lowest rated component.

Before starting the pump every time, check to insure:

- The pressure relief valve is in good operating condition and has been set to the proper relief pressure.
- Any pipeline used to direct pressurized relief flow to another location, such as a collecting tank, is not blocked.
- The discharge system is not blocked and all the discharge line valves are open.

Check all fluid end discharge system components including pipes, elbows connections, threads, fasteners, hoses, etc., at least once every six months to confirm their structural adequacy. With time, wear corrosion and fatigue can reduce the strength of all components. Magnetic iron and steel components should be checked with magnetic particle or dye penetrant crack detection equipment. Nonmagnetic materials should be checked for cracks with dye penetrants. All metallic components should also be visually checked during these inspections for signs of corrosion. If a component shows evidence of cracking or loss of material due to corrosion it must be replaced with a new part.

Continually monitor suction and discharge hose assemblies when the pump is operating for leakage, kinking, abrasion, corrosion or any other signs of wear or damage.

Worn or damaged hose assemblies should be replaced immediately. At least every six months examine hose assemblies internally for cut or bulged tube, obstructions and cleanliness. For segment style fittings, be sure that the hose butts up against the nipple shoulder, the band and retaining ring are properly set and tight and the segments are properly spaced. Check for proper gap between nut and socket or hex and socket. Nuts should swivel freely. Check the lay-line of the hose to be sure that the assembly is not twisted. Cap the ends of the hose with plastic covers to keep them clean until they are tested or reinstalled on the pump unit. Following this visual examination, the hose assembly should be hydrostatically tested, on test stands having adequate guards to protect the operator, per the hose manufacturer's proof test procedure.

Fluid end component inspections should be performed more frequently than every six months if pressures above 2500 psi are used in the discharge system or if corrosive, abrasive, flammable or hot (over 110º F) fluids are being pumped.

Proper stuffing box packing selection is important for safe pump operation. Contact an S&K Supply service representative for assistance in selecting the proper packing before beginning operation.

Before starting the pump the first time and periodically thereafter, check the pump, suction and discharge system fastener torques versus the values listed on page 35 to insure proper tightness. Over and under torquing can damage threaded pipes, connections and fasteners, which may lead to component damage and/or failure. Replace all components found to be damaged or defective. On pumps equipped with stuffing boxes, the gland must be engaged by at least six (6) threads to hold the discharge pressure of the pump.

DANGER

Do not attempt to service, repair or adjust the plunger packing or other-wise work on the pump while the unit is operating. Shut off the pump drive engine and relieve the fluid pressure in the suction and discharge systems before any work or investigation is performed on the pump or pump systems.

Block the crankshaft from turning and make certain that all pump drive motor or engine start switches or starter controls are clearly tagged with warnings not to start the pump while repair work is in process.

Whenever the pump is operating, continually monitor the entire suction, discharge and pump lubricating systems (if applicable) for leaks. Thoroughly investigate the cause in the event of a leakage and do not operate the pump until the cause of the leak has been corrected. Replace any parts, which are found to be damaged, or defective. When a gasket joint is disassembled for any reason, discard the used gasket and replace it with a new, genuine S&K Supply Inc. gasket before reassembling the joint.

Due to the high working pressures contained by the fluid end, discharge manifold and discharge piping, welding on these components is not recommended. If welding on the discharge system cannot be avoided, only experienced, qualified welders should be used. In addition, the welded part should be hydrostatically proof tested in the shop with water or hydraulic fluid to one and one half times maximum discharge system working pressure, with no observable fluid leakage, before the part is reinstalled in the pump system.

In summary, high-pressure fluid streams can possess sufficient energy to cause personal injury, death and/or equipment damage. These results can occur either through direct contact with the fluid stream or by contact with loose objects the fluid stream has propelled, if the pump system is improperly used, or if the fluid is misdirected, or allowed to escape from defective or improperly maintained equipment.

FLAMMABLE, HOT, COLD OR CORROSIVE FLUID PUMPING

DANGER

Extreme caution must be exercised by trained and experienced operators when flammable, hot, cold or corrosive fluids are being pumped to avoid personal injury, death an/or equipment damage due to explosion, fire, extreme cold or chemical attack.

Never operate a pump, which is pumping hydrocarbons or other flammable, hot, cold, or corrosive fluids when any part of the pump, suction system or discharge system is leaking. Stop the pump immediately if any leakage, other than a few drops per minute of packing weeping, is observed. Keep all flame, sparks, or hot objects away from any part of the pump, suction system, or discharge system. Shield the pump, suction system and discharge system to prevent any flammable, hot, cold or corrosive fluid leakage from dripping or spraying on any components, flame, sparks, hot objects or people. Inspect the plungers, packing, gaskets and seals for fluid leakage frequently and replace all worn or leaking parts.

Selection of the proper gaskets, seals and stuffing box packing is even more critical when flammable, hot, cold or corrosive fluids are being pumped than when other, inherently less dangerous fluids are used. Contact an S&K Supply service representative for assistance in selecting the proper gaskets, seals and packing before beginning operation.

Since some packing weeping into the cradle area is inevitable, the drain placed beneath the bottom of the plunger cradle must be connected to a drain line, which conducts the fluid leakage to a collection container located in a protected area. The entire drain system and container must be constructed of materials resistant to attack from the pumped fluid or from explosion or fire of the pumped fluid.

Before beginning pumping operations or starting the pump power source (whether an engine or electric motor) check the atmosphere all around the pumping site for the presence of flammable or explosive vapors. Do not begin operation and stop ongoing operation if flammable or explosive vapors are detected. Hot surfaces, sparks, electric current or engine exhaust could ignite flammable or explosive vapors. Each engine used as a power source on pumping units where flammable or explosive vapors could form should, be equipped with an air inlet shut-off. If flammable or explosive vapors are present in the pumping site atmosphere, an engine could continue to run on these vapors even after the engine fuel line is shut-off if an air inlet shut-off is not used.

In addition, on pumping units used where flammable or explosive vapors could form, all electric motors used as power sources must be of explosion proof construction and all electrical components and wiring must meet the current National Electrical Code and current local codes for explosive atmospheres.

These precautions must be taken to avoid possible personal injury, death and/or equipment damage from explosion, fire or burns.

SECTION 2
DESIGN, DESCRIPTION AND SPECIFICATIONS

INTRODUCTION

The S&K Supply Inc. reciprocating pumps is are high power, high rod load multi-purpose pumps for various applications such as oil and gas well fracturing and acidizing, salt water disposal, well service and more. Other applications include coiled-tubing and hydro-blasting operations when supplied with specially designed fluid ends**.** The pumps are designed using modern analytical and engineering methods and techniques.

The issue of personnel safety is the most important topic covered in this manual. Therefore, in the beginning of this manual the user is introduced to dangers inherent in the operation of a high-pressure pump. To avoid accidents and injuries, all safety rules listed in this section and also all other applicable safety rules and regulations must be carefully observed.

The sections on Pump Design, Description, and Specifications, describe the pump design, list the pump specifications, and present drawings depicting the pump external views and all essential cross-sectional drawings.

Section 3, "Pump Preparation, Operation, and Maintenance," addresses the issues of preparing the pump for operation after shipping or storage, the lubrication system design and specifications, the new pump run-in procedures, and the periodic routine maintenance schedule. The recommended oils, viscosity data, and crankcase oil temperature requirements are also presented in this section.

Section 4, "Service Procedures," describes the various assembly / disassembly procedures.

Section 5, “Trouble–Shooting,” describes possible problems, causes and solutions related to pump performance.

Section 6, “Rebuilding Data, Recommended Running Clearances and Torques,” presents information useful for pump rebuilding and assembly, including dimensional and tolerance data, running clearances for all bearings, and recommended fastener torques.

PUMP DESIGN

The S&K Supply Inc. pumps use three major assemblies: power end, fluid end, and gear reduction unit (if applicable). The pump is designed with a modular concept. Each assembly is a module that can be assembled, handled, installed, fixed, or transported separately from the rest of the pump. The following is a brief description of the essential design features for each modular assembly.

POWER END (FIGURE 2-1)

The power end is a welded fabrication utilizing high-strength low-alloy frame members, stress relieved and precision machined to provide stability and strength. The crankshaft is one piece, forged alloy, heat-treated and precision ground steel.

FIGURE 2-1 Power End

NOTICE

The recommended direction of rotation is to where the top of the crank moves toward the pump fluid end.

The crankshaft is supported by main roller bearings. The connecting rods are precision machined from high-strength alloy steel castings. Connecting rod bearings are automotive type, with round, grooved sleeve-bearings on the crosshead end. Rod bearings are Babbitt lined bearing bronze. Crossheads are machined from one-piece gray iron castings. The pony rods are steel with a hard metalized and ground surface. The power end must be supplied with lube oil from an external source, supplied by others in well service and slow speed applications. Large drain openings are provided in the bottom of the power end and reducer, and should be connected to an external oil sump (see lubrication section for more details).

SPLASH / GRAVITY FEED LUBRICATION

Pump applications with speeds in excess of 100rpm continuous duty, can rely on splash / gravity feed lubrication. Oil is picked up by the crank and splashed onto an oil tray located over the cross heads and is gravity fed to the bearings and cross heads. Pumps may be run under 100rpm for short periods of time, after a period of running in excess of 150rpm. This assures oil to be present in the oil tray to feed to the bearings and cross heads.

UNDER 100rpm THIS OIL WILL NOT BE REPLENISHED AND WILL RUN OUT THE TROUGH IN APPROXIMATELY ONE (1) MINUTE!

AUXILIARY POWER END LUBRICATION SYSTEM (if applicable)

Both the gear reduction unit (if applicable) and power end are connected to the same lube oil inlets. The power end inlet is located on the sides of the pump. The inlet is a 3/4” NPTF which divides the lube flow between the lube manifold for the crosshead guide and the rotary union. Pressurized lubrication for each crosshead is delivered from the lube manifold through the top of the crosshead guide and is then forced to the wrist pin bearings and cross head slides. The rotary union is attached to the crankshaft. Lubrication for the rod bearings comes from forced lube through the crankshaft. Lube oil from the manifold also lubricates the main bearings. Oil is removed from the power end through a 40# filter strainer in the bottom of the frame near the rear of the power end.

The lube oil is drained from the gear reduction unit from one drain hole, depending on the position of the gear reducer. It is important that the oil sump drain hose size be maintained to the primary external sump and include as few restrictions and direction changes as is practical. Gear unit heating problems are most often related to drain restrictions causing buildup of oil inside the unit, thus generating excessive heat.

NOTICE

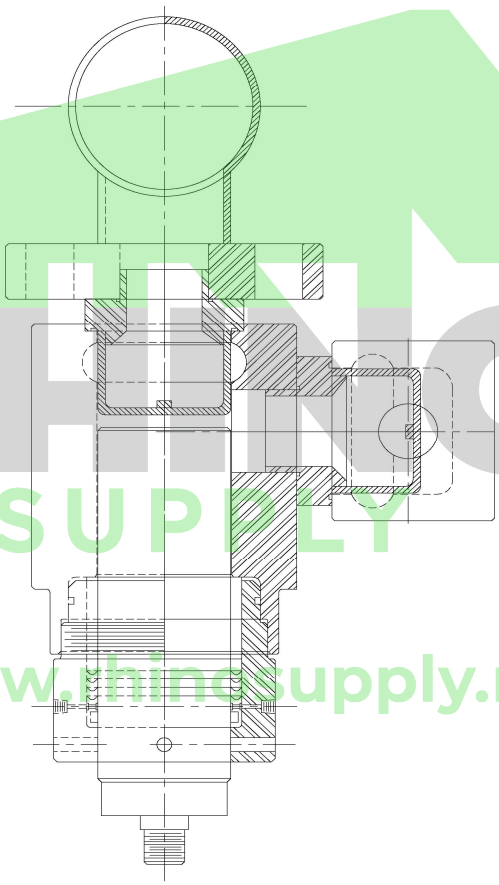
It is also extremely important to maintain some downward slope in the entire lube oil drain system back to the lube reservoir or external sump

FLUID END (FIGURE 2-2)

Three basic fluid end styles are offered on S&K Supply pumps. The standard fluid end is the in line, sandwiched valve type. (Optional styles include valve-over-valve fluid ends and mono block fluid ends). All fluid ends are made from high tensile materials.

The standard fluid end is the in line sandwiched valve type configuration is shown in Figure 2-2. Wing guided type valves and seats with replaceable inserts are standard available. The one-piece plungers are precision ground and polished hard overlaid steel. The stuffing boxes are replaceable for ease of maintenance and repair. Suction manifold is a strait pipe with Victaulic connections on each end. Optional suction and discharge connections are available.

FIGURE 2-2 Fluid End Assembly



GENERAL SPECIFICATIONS

This section presents the pump basic performance for continuous duty. The table presents allowable pressures and flows for various pump plunger sizes at different speeds.

CONTINUOUS DUTY APPLICATION

S&K SUPPLY, Inc. 100T-SW TRIPLEX PUMP

plunger size (In.)	max. pressure (psi)	displace-ment Gal/Rev	displacement volumes (GPM)						
			100rpm	150rpm	200rpm	250rpm	300rpm	350rpm	400rpm
4	580	0.693	69.3	103.9	138.6	173.3	207.9	NR	NR
3 3/4	660	0.609	60.9	91.4	121.8	152.3	182.7	NR	NR
3 1/2	750	0.531	53.1	79.7	106.2	132.8	159.3	185.9	NR
3 1/4	880	0.458	45.8	68.7	91.6	114.5	137.4	160.3	NR
3	1040	0.391	39.1	58.7	78.2	97.8	117.3	136.9	156.4
2 3/4	1230	0.328	32.8	49.2	65.6	82.1	98.4	114.8	131.2
2 1/2	1490	0.271	27.1	40.7	54.2	67.8	81.3	94.9	108.4
2 1/4	1840	0.219	21.9	32.9	43.8	54.8	65.7	76.7	87.6
2	2335	0.173	17.3	25.9	34.6	43.3	51.9	60.6	69.2
1 3/4	3000	0.133	13.3	19.9	26.6	33.3	39.9	46.6	53.2
1 1/2	4000	0.097	9.7	14.6	19.4	24.3	29.1	33.9	38.8

displacement based on 100% volumetric efficiency

S&K SUPPLY, Inc. 250T-SW TRIPLEX PUMP

plunger size (In.)	max. pressure (psi)	displace-ment Gal/Rev	displacement volumes (GPM)					
			100rpm	150rpm	200rpm	250rpm	300rpm	350rpm
4 ½	964	1.239	123.9	185.9	247.8	309.8	371.7	NR
4	1221	0.979	97.9	146.9	195.8	244.8	293.7	NR
3 ½	1716	0.749	74.9	112.4	149.8	187.3	224.7	NR
3	1874	0.551	55.1	82.7	110.2	146.9	176.3	205.7
2 ½	2681	0.382	38.2	57.3	76.4	95.5	114.6	133.7
2	4198	0.244	24.4	36.6	48.8	61.0	73.2	85.4
1 ½	7422	0.138	13.8	20.7	27.6	34.5	41.4	48.3

displacement based on 100% volumetric efficiency

OTHER PLUNGER SIZES AVAILABLE ON REQUEST

S&K SUPPLY, Inc. 200Q-SW TRIPLEX PUMP (continuous duty)

plunger size (In.)	max. pressure (psi)	displace-ment Gal/Rev	displacement volumes (GPM)						
			100rpm	150rpm	200rpm	250rpm	300rpm	350rpm	
4	580	1.16	116	174	232	290	348	NR	
3 3/4	660	1.02	102	153	204	255	306	NR	
3 1/2	750	0.89	89	134	178	223	267	312	
3 1/4	880	0.76	76	114	152	190	228	266	
3	1040	0.65	65	98	130	163	195	228	
2 3/4	1230	0.55	55	83	110	138	165	193	
2 1/2	1490	0.45	45	68	90	113	135	158	
2 1/4	1840	0.37	37	56	74	93	111	130	
2	2335	0.29	29	44	58	73	87	102	
1 3/4	3000	0.22	22	33	44	55	66	77	
1 1/2	4000	0.16	16	24	32	40	48	56	

displacement based on 100% volumetric efficiency

S&K SUPPLY, Inc. 400Q-SW TRIPLEX PUMP (continuous duty)

plunger size (In.)	max. pressure (psi)	displace-ment Gal/Rev	displacement volumes (GPM)						
			100rpm	150rpm	200rpm	250rpm	300rpm	350rpm	
4 ½	964	2.07	207	310	413	518	620	NR	
4	1221	1.63	163	245	326	408	490	NR	
3 ½	1716	1.25	125	188	250	313	375	438	
3	1874	0.92	92	138	184	230	275	322	
2 ½	2681	0.64	64	96	127	160	191	224	
2	4198	0.41	41	61	81	103	122	144	
1 ½	7422	0.23	23	34	46	58	69	81	

displacement based on 100% volumetric efficiency

OTHER PLUNGER SIZES AVAILABLE ON REQUEST

GENERAL SPECIFICATIONS

This section presents the pump basic performance for intermittent duty. The table presents allowable pressures at different flows for various pump plunger sizes at different speeds.

INTERMITTENT DUTY APPLICATION

S&K SUPPLY, Inc. 100T-WS TRIPLEX PUMP

plunger size (In.)	Gal/Rev	displacement volumes (GPM)													
		100rpm		150rpm		200rpm		250rpm		300rpm		350rpm		400rpm	
4	0.693	69.3	2000	103	2000	138	1500	173	1200	207	1000	NR		NR	
3 3/4	0.609	60.9	2000	91.4	2000	121.8	1500	152.3	1200	182.7	1200	NR			
3 1/2	0.531	53.1	2500	79.7	2200	106.2	2000	132.8	1500	159.3	1500	185.9	1200		
3 1/4	0.458	45.8	2500	68.7	2200	91.6	2000	114.5	1500	137.4	1500	160.3	1200		
3	0.391	39.1	2500	58.7	2500	78.2	2200	97.8	2000	117.3	1700	136.9	1500	NR	
2 3/4	0.328	32.8	2500	49.2	2500	65.6	2200	82.1	2000	98.4	1700	114.8	1500	NR	
2 1/2	0.271	27.1	3000	40.7	3000	54.2	2500	67.8	2200	81.3	2000	94.9	1700	108.4	1500
2 1/4	0.219	21.9	3000	32.9	3000	43.8	2500	54.8	2200	65.7	2000	76.7	1700	87.6	1500
2	0.173	17.3	3000	25.9	3000	34.6	3000	43.3	3000	51.9	3000	60.6	3000	69.2	3000
1 3/4	0.133	13.3	3000	19.9	3000	26.6	3000	33.3	3000	39.9	3000	46.6	3000	53.2	3000
1 1/2	0.097	9.7	8000	14.6	6500	19.4	6500	24.3	6000	29.1	6000	33.9	6000	38.8	5000

displacement based on 100% volumetric efficiency

S&K SUPPLY, Inc. 250T-WS TRIPLEX PUMP

plunger size (In.)	Gal/Rev	displacement volumes (GPM)												
		100rpm		150rpm		200rpm		250rpm		300rpm		350rpm		400rpm
4 ½	0.693	124	5000	186	3316	248	2480	310	1990	372	1655	434	1420	NR
4	0.609	98	5000	147	4190	196	3145	245	2518	294	2095	343	1800	NR
3 1/2	0.531	75	5000	112	5000	150	4100	187	3300	225	2740	262	2350	NR
3	0.458	55	5000	83	5000	110	5000	138	4470	165	3735	193	3190	NR

displacement based on 100% volumetric efficiency

SECTION 3
PREPARATION, OPERATION AND MAINTENANCE

DANGER

Read and understand clearly all safety rules and precautions before attempting to operate the pump.

This section deals with pump preparation after shipping and storage of the pump, user built lubrication system and its specifications, pump break in procedures, recommended oils, allowable crankcase operating temperatures, viscosity conversion tables, and routine maintenance schedule.

PREPARATION AFTER SHIPPING AND STORAGE

All pumps are shipped dry and therefore must be flushed with lightweight oil before operating. The flushing must be performed regardless of method or duration of the shipment or type of container the pump was shipped in.

Pumps are not prepared for storage and should be put in service as soon as possible.

If for any reason the pump has to be put into storage after prior use, the following procedure should be followed:

1. Clean and flush the fluid end with a rust preventative.
2. Plug all discharge and suction openings.
3. Drain oil from the power end and the gear reduction unit.
4. Flush the power end with a rust preventative (before flushing make sure that the rust preventative will not clog the oil passages).
5. Remove the breather and either plug or tape the opening.
6. Coat the (gear reducer) input shaft and all exposed bear metal with a heavy rust preventive.
7. Plug drain holes at the bottom of the pump frame, at the rear of the pump, and the gear reducer drain hole.
8. Plug the lube inlets.
9. Store the pump inside in a warm dry place.
10. If the pump is shipped ocean cargo, it must be crated in a water tight container placed below the deck to prevent rusting and salt water contamination.

PUMP MOUNTING INSTRUCTIONS

Follow this procedure to shim the feet of the pump. This will require the use of (4) Grade 8, hex-head screws with lock washers and nuts to secure the pump frame; two for the rear feet and two for the front feet. The fluid end is supported by the power end frame.

1. Set the pump in its location.

2. Install one bolt in each of the two feet at the rear corners of the power frame. Snug but do not tighten these bolts. **Do not remove the lifting equipment before all bolts are secured.**

3. Assure all suction and discharge piping connections are disconnected to allow free movement of the fluid end.

4. Using a feeler gauge, check under the front feet of the power frame. Both feet must be in firm contact with support bracket or skid.

5. Select the proper number and thickness of shims to fill the gap under the high foot.

6. With shims in place (if required), install bolts in the remaining two power frame mounting feet.

7. Tighten all four bolts. Use the appropriate torque for the size of bolts.

8. Connect the suction line to the inlet of the suction manifold, making sure that no strain is placed on the suction manifold.

9. Connect the discharge line with high-pressure hose or high-pressure pipe utilizing swivel joints to allow movement between the pump and the sub-base supporting the discharge line.

10. Vibration isolation connections or tie-downs for the discharge lines are recommended to help reduce vibrations.

AUXILIARY POWER END LUBRICATION SYSTEM

Due to variety of applications and drive arrangements, the power end lubrication pump and applicable auxiliary hydraulic equipment are not furnished with the triplex pump. Therefore, the pump lubrication system is designed and built by individual customers for each particular application.

The lubrication system is very critical to the triplex pump performance and therefore should be professionally designed in accordance with sound engineering practices developed for similar systems, known otherwise as hydraulic power units. The following discussion will re-emphasize some of the good practices used in designing similar systems in the past and comment on the system's critical components.

Lube System Pump

A positive displacement pump must be used. Gear type pumps have demonstrated reliable performance for similar applications in the past. The pump should have the largest suction port available for the selected pump size to minimize losses in the suction piping.

Lube Pump Suction Piping Sizing and Requirements

In the past, failure to meet these requirements has lead to pump damage because of restricted oil flow in the lube pump inlet. Therefore, the following guidelines, developed as a result of long experience, should be adhered to closely.

1. The oil flow velocity through the suction piping should not exceed 2 ft/sec.

2. At maximum operating speed the vacuum reading at the lube pump inlet must be no more than 8" hg or 4psi or 0.28bar.

3. The suction strainer should be sized for oil flow three (3) times larger than the actual flow passing through the strainer at maximum speed.

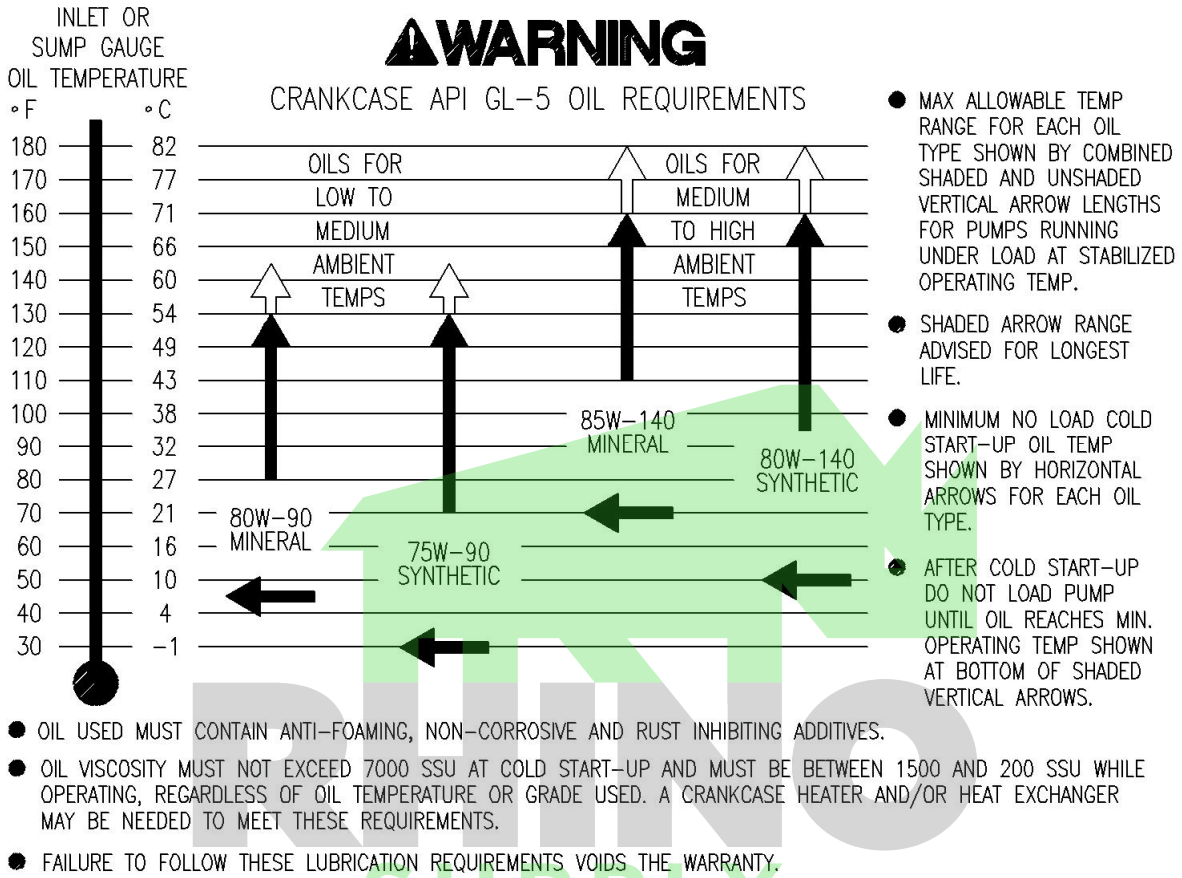
4. The suction pipe should be kept as short as possible and free of bends.

5. Warning devices to monitor lube oil pressure, level and temperatures are highly recommended. The triplex pump operates at very high rod loads and pressures, and malfunction of the lube system may result in serious damage occurring in a very time. Therefore, early warning devices are essential to the successful operation and should be set according to the following operating limits:

NOTICE
Maximum lube system pressure should be set at 120 psi (relief valve setting.) **Minimum lube oil pressure: 40psi** **Normal operating temperature: 150F** **Maximum Operating temperature: 200F** **Minimum lube oil flow is 15gpm for the pump only. Approximate flow is 5gpm to gear reducer. Design Flow: 30gpm.** **Maximum lube system vacuum at lube pump inlet 8 Hg. (4psi /0.28bar)**

FIGURE 3-1 indicates API-GL5 oil grades recommended for use in the pump power end and the gear reducer lube system. Crankcase operating temperature ranges and minimum startup temperatures for each listed grade of oil for various inlet or sump temperature ranges.

FIGURE 3-1 Lubricant Recommendations



PLUNGER / PACKING LUBRICATION

The fluid end plungers are lubricated from a separate lubrication pump through the stuffing box. The lubrication pump, hosing, and check valve to the stuffing box is not provided with the unit.

See "Plunger Packing Lubrication Recommendation Chart," page 20, for a list of lubricants recommended for plunger /packing lubrication.

PISTON / LINER LUBRICATION

Liners and pistons need to be cooled with a water spray. Water soluble oil may be added to improve wear. An auxiliary circulation pump will be needed, circulating the medium thru a separate tank.

STARTUP AND NEW PUMP RUN-IN PROCEDURES – SW PUMPS

A centrifugal charge pump will be required to charge the fluid end suction manifold. The charge pump should be sized according to the volume to be pumped by the triplex pump so that there is no less than 30 - 80psi charge when the triplex pump operates at its maximum flow. Higher pump speeds require higher charge pressures.

The first startup and several hours of the pump run-in are performed at the factory during the acceptance tests as a part of quality assurance procedure. However, the new pump break-in period process may continue for the first 80-100 hours of operation, and therefore it will be each user's responsibility to perform all the tasks related to this critical period. As all moving parts of the pump go through wearing-in process, steel and bronze wear particles are carried by the oil flow in the lubrication system. The resulting contamination of the lubrication system with the wear particles and especially clogging of small passages may cause serious problems. To assist the use the following guidelines are presented for the maintenance personnel to follow during the critical startup and break-in period:

1. Fill the lube oil reservoir with recommended grade of oil. See "Power End Lubrication," and FIGURE 3-1, page 18.

2. Fill the packing lube reservoir with proper oil. See "Plunger/Packing Lubrication Recommendation Chart," page 20, or liner wash tank with water. Start the plunger lube system or liner wash system and check to see whether it is adjusted properly.

3. Remove all inspection covers on the top of the pump frame.

4. Start the driver at the lowest possible RPM and triplex pump at zero (0) psi pressure. Make sure that all roller bearings, crossheads, rod bearings, and crankshaft bearings are properly lubricated by the lube oil coming from the oil tray.

5. Run at low speed to "work out" any trapped air in the fluid cylinder with the charge pump operating.

6. During the operation observe the oil flow and temperature, and entire system for proper operation.

7. Shut the pump down and let it cool thoroughly before starting normal operation of the pump.

8. Change the lube oil and clean the oil stray to get rid of metal particles and any other wear products now present in lube oil system.

9. Change lube oil every 30-45 hours, until it becomes apparent that wear-in process is finished.

10. Tighten all fluid cylinder attachment nuts, procedure listed in "Fluid End Removal and Installation," page 21, after 50-70 hours of pump operation. See FIGURE 4-1, page 22.

11. Follow the routine maintenance schedule described in the next section after completion of the wear-in period.

STARTUP AND NEW PUMP RUN-IN PROCEDURES – WS PUMPS

A centrifugal charge pump will be required to charge the fluid end suction manifold. The charge pump should be sized according to the volume to be pumped by the triplex pump so that there is no less than 30 - 80psi charge when the triplex pump operates at its maximum flow. Higher pump speeds require higher charge pressures.

The first startup and several hours of the pump run-in are performed at the factory during the acceptance tests as a part of quality assurance procedure. However, the new pump break-in period process may continue for the first 80-100 hours of operation, and therefore it will be each user's responsibility to perform all the tasks related to this critical period. As all moving parts of the pump go through wearing-in process, steel and bronze wear particles are carried by the oil flow in the lubrication system. The resulting contamination of the lubrication system with the wear particles and especially clogging of the strainer and the oil filter may cause serious problems. To assist the use the following guidelines are presented for the maintenance personnel to follow during the critical startup and break-in period:

1. Fill the lube oil reservoir with recommended grade of oil. See "Power End Lubrication," and FIGURE 3-1, page 18.

2. Fill the packing lube reservoir with proper oil. See "Plunger/Packing Lubrication Recommendation Chart," page 20, or liner wash tank with water.

3. Remove all inspection covers on the top of the pump frame.

4. Start the engine at the lowest possible RPM and triplex pump at zero (0) psi pressure. Make sure that all roller bearings, crossheads, rod bearings, and crankshaft bearings are properly lubricated.

5. Increase the engine RPM to maximum and check whether the vacuum reading at the lube pump suction inlet is less the 8" Hg or 4 psi or 0.28bar.

6. Check whether the lube system pressure reading is at least 100psi or 7.0bar. Temporary pressure gages should also be checked at this time to make sure that all components of the lube system are working properly.

7. Check to see that oil flow back to the reservoir is normal.

8. Start the plunger lube or liner wash system and check to see whether it is adjusted properly.

9. Run at low speed to "work out" any trapped air in the fluid cylinder with the charge pump operating.

10. Run the pump at 80-90 strokes per minute and 20% of its maximum pressure rating for 30 minutes

11. During this time, observe the suction vacuum gage reading, oil pressure and temperature and check for leaks.

12. Run the pump at 80-90 strokes per min at the following loads:
    40% of full rated load 30 min
    60% of full rated load 30 min
    80% of full rated load 30 min
    100% of full rated load 30 min

13. During the operation observe the oil pressure and temperature, and inlet suction vacuum gage reading, and entire system for proper operation.

14. If the triplex pump is equipped with a transmission, run the pump for 30 min in each gear in the higher gear ranges pulling full horsepower in each gear. Observe closely oil pressures and temperatures, and lube oil suction vacuum.

15. Shut the pump down and let it cool thoroughly before starting normal operation of the pump.

16. During the shutdown, change the oil filter elements and clean the suction strainer.

17. Change the lube oil and clean the reservoir to get rid of metal particles and any other wear products now present in lube oil system.

18. Change filter elements and clean strainer every 10-15 hours, until it becomes apparent that wear-in process is finished.

19. Tighten all fluid cylinder attachment nuts, procedure listed in "Fluid End Removal and Installation," page 21, after 50-70 hours of pump operation. See FIGURE 4-1, page 22.

20. Change the lube oil again, replace the filter elements, and clean the strainer after 80-100 hours of pump operation.

21. Follow the routine maintenance schedule described in the next section after completion of the wear-in period.

PERIODIC ROUTINE MAINTENANCE SCHEDULE

Performance of the periodic routine maintenance tasks, described in this section, will ensure long, economical, and trouble free operation of this pump. It is highly recommended that the customer sets up a maintenance program during the run-in period. The periodic maintenance data should be recorded and kept with other pump documents. The following recommendations, based on previous experience, should serve as a guideline for establishing a good maintenance program. The periodic maintenance schedule is divided into daily, monthly, and quarterly tasks to be performed by the user after the pump has gone through 100 hours of wear-in period. For the tasks performed during the wear-in period, see "Startup and New Pump Run-In Procedures," page 19.

Daily Routine Maintenance Tasks

1. Check the oil level in the lube oil reservoir.

2. Periodically monitor the lube oil operating pressure (WS pumps) and temperature. Minimum oil operating pressure is 40 psi (WS pumps). The maximum oil operating temperature depends on the particular grade of oil used in the pump lube system. (See FIGURE 3-1, page 17).

3. WS pumps: Check the lube pump suction inlet vacuum. A vacuum gage reading higher than 8" Hg or 4 psi or 0.28bar indicates that the suction strainer and/or oil filter element are clogged. The strainer must be cleaned, and the oil filter element replaced as necessary as soon as the pump can be shut down for a short period of time to perform these tasks.

4. Listen for any abnormal noise or rough operation, which may indicate the need for fluid end maintenance such as changing valves and/or valve seats. Due to very high pressures in the triplex pump fluid end, worn valves and seats should be changed as soon as possible to prevent washing them out with the pumped fluid.

5. Check the plunger/packing lubrication pump for proper operation. Insure packing nut is tightened sufficiently into stuffing box. Recheck tightness after extended continuous operation.

Monthly (100 hour) Routine Maintenance Tasks

1. Clean the strainer and replace the oil filter element (WS pumps).
2. Check the entire lube system for leaks and eliminate them.
3. Check all fluid end expendables such as valves, packing, and valve seats and replace them as necessary.
4. Check the extension rod seals and replace them as necessary.

Quarterly (300 hour) Routine Maintenance Tasks

1. Change the lube oil and clean the oil reservoir (WS pumps) and crank case thoroughly.
2. Clean the lube system strainer and replace the oil filter elements (WS pumps).
3. Re-tighten the critical bolt joints following torque specifications given in Section 6.
4. Add grease to all bare metal components to prevent corrosion.
5. Clean or replace the breather cap filter element.
6. Check all pressure, temperature, and vacuum gages for proper operation and replace as necessary.
7. Check all lube system warning and alarm devices for proper operation and replace if found defective.
8. Check supply of on hand expendables such as packing, valves and seats, maintenance items such as seals, O-rings, oil and breather filter elements, and also maintenance tools. Order to replenish supplies as necessary.

The recommended routine periodic maintenance procedures are very simple and can be performed in a short period of time. At the same time, close adherence to these procedures will ensure long, economical, and trouble free operation of the pump.

PLUNGER PACKING
LUBRICATION RECOMMENDATION CHART

ROCK DRILL LUBRICANTS - NORMAL CONDITIONS

Source	Type	Pour Point Maximum
Amoco	Amoco Rock Drill Oil - Light	-20°F
	Amoco Rock Drill Oil - Medium	0°F
Arco	Air Drill #147	0°F
	Arco Trueslide #150	15°F
Chevron Oil U.S.A.	Vistac #68X	10°F
	Vistac #100X	5°F
	Vistac #150X	0°F
Conoco	EP Rockdrill #49, #17, #78	5°F
Gulf Oil (Chevron)	Rockdrill #100	-30°F
	Rockdrill #32	-35°F
Exxon	Arox EP #46	-20°F
	Arox #150	-35°F
Mobil Oil Co.	Almo #525	-20°F
	Almo #527	-20°F
	Almo #529	-10°F
	Almo #532	0°F
Pacer Oil	Rockdrill #150	-10°F
	Rockdrill #600	0°F
Phillips Petroleum	EP #500 (Summer) or EP #300 (Winter)	-10°F
Shell Oil Co.	Torcula Oil #32	-50°F
	Torcula Oil #100	-20°F
	Torcula Oil #150	-15°F
	Torcula Oil #320	-10°F
Sun Oil Co.	Rockdrill 500 (Light)	5°F
	Rockdrill 1000 (Heavy)	5°F
Texaco Oil Co.	Rockdrill Oil XL	-40°F
	Rockdrill Oil XM	0°F
	Rockdrill Oil XH	-10°F
Union Oil of Ca.	Marok 150	------

STEAM CYLINDER OILS - HIGH TEMPERATURE PUMPED FLUIDS

Source	Type
Amoco	Amoco Cylinder Oil 460
Arco	Modco Cylinder Oil 125, 175
Conoco	Inca Cylinder Oil
Exxon	Cylesstic TK-460 or TK-1000
Gulf Oil (Chevron)	Senate #375 Compound
	Security #460 Non-Compound
Mobil Oil Co.	Mobil Cylinder Oil 600W
Pacer Oil	Com-Cyl Oil
Phillips Petroleum	Hector Cylinder Oil
Shell Oil Co.	Valvata J-460
Sun Oil Co.	Occident
	Gear Oil 7-X, Gear Oil 8-C

SECTION 4
SERVICE PROCEDURES

This section describes various assembly and disassembly procedures necessary for pump servicing or parts replacement. The General Requirements and Safety Rules section is a reminder for the maintenance personnel of the critical importance of safety rules and precautions while working on the pump. Notes on dangers and notices specifically related to service procedures are repeated and placed in this section also.

The pump consists of three major modules: the fluid end, the power end, and the gear reduction unit. (See Section 2) (if applicable). The description of service procedures follows the modular concept. Due to many expendable parts, fluid end servicing is rather common in the field and is therefore presented in the very beginning followed by power end and gear reduction unit servicing procedures.

General Requirements and Safety Rules

⚠ **DANGER**
Before any attempt to work on pumps is made, all safety rules and precautions described in this manual must be read and clearly understood.
⚠ **DANGER**
Only qualified and specially trained personnel should be allowed to work on this pump.
⚠ **DANGER**
Proper capacity hoist and lifting devices should be used while working on pump.

FLUID END SERVICE (IN-LINE SANDWICH VALVE STYLE)

This discussion starts with the description of steps necessary for removal and installation of the fluid cylinder assembly and proceeds to the removal and replacement of expendable parts such as valves, valve seats, and packing.

Fluid End Removal

1. Disconnect suction manifold from unit piping and discharge lines at the discharge flanges on the discharge manifold, plunger lubrication lines, and also any accessories such as stroke counters, pressure gages, etc.

2. Unscrew all three plungers, unscrew stuffing boxes and take them out together with the plungers.

3. Connect a hoist to the discharge manifold and tighten the slings until they are snug only. Make sure that hoisting slings are not too tight, because that may cause a strain on the studs and damage threads when removing from the pump. Remove the manifold and lift the manifold off. Remove the valve assemblies.

4. Repeat the above procedure for the suction manifold.

5. Pull the fluid ends one by one in horizontal direction, straight away from the power end until completely free from the stay rods.

6. Move the fluid ends to the service area for service.

NOTICE
The procedure for fluid end installation is presented separately due to the alignment and critical nature of the connection between the power end and the fluid end.

To Reinstall Fluid Ends, proceed as follows:

1. Check all eight stay rods for thread damage. If replacement is required, refer to the Parts List section to order the proper stud for the fluid end.

2. Clean all studs and threads thoroughly, along with the holes in the power frame and the manifolds.

3. Replace fluid ends, valves and manifolds.

4. Lubricate the stud threads with Never-Seize, Dow-Corning 1000 anti-seize or equivalent. Install the heavy-hex nuts by hand.

5. Tighten the studs using a hand-held torque wrench, or hydraulic torque tensioning tool. Refer to the torque section in the manual for proper torques of all fasteners.

6. Re-install the plungers, piping connections and auxiliary equipment.

FLUID END SERVICE (H/V Style Mono-Block Fluid End)

Fluid End Removal

1. Disconnect suction manifold from unit piping and discharge lines at the discharge flanges on the fluid end, plunger lubrication lines, and also any accessories such as stroke counters, pressure gages, etc. from the fluid end

2. Remove all three (3) **S**uction **V**alve Carriers, using the hammer lugs on the S. V. Carriers. By hand, reach in and remove the suction valve stops.

3. Unscrew and remove all three plungers with the plunger removal tool furnished with the pump. (Loosening the stuffing boxes may be helpful on newly packed pumps.)

4. Connect a hoist to the fluid end and tighten the slings until they are snug only. Make sure that hoisting slings are not too tight, because that may cause a strain on the stay rods and damage threads when removing from the pump frame.

5. Remove all heavy-hex nuts utilizing either a hammer wrench, large socket wrench, or hydraulic torque wrench.

6. Pull the fluid end assembly in horizontal direction, straight away from the power end until it is completely free from the studs.

7. Move the fluid end to the service area for changing valves or other service.

NOTICE
The procedure for fluid end installation is presented separately due to the alignment and critical nature of the connection between the power end and the fluid end.

To Reinstall Fluid end proceed as follows:

1. Check all studs for thread damage. If replacement is required, refer to the Parts List section to order the proper stud for the fluid end.

2. See parts list for proper replacements.

3. Clean all studs and threads thoroughly, along with the holes in the power frame, the nose plate, and the fluid cylinder.

4. Lubricate the stud threads with Never-Seize, Dow-Corning 1000 anti-seize or equivalent. Install the heavy-hex nuts by hand.

5. Using a hand-held torque wrench, or hydraulic torque tensioning tool, torque all nuts to the proper torque value.

6. Re-install the plungers, piping connections and auxiliary equipment.

Plunger and Packing Replacement

This service procedure can be performed with the fluid cylinders in place on the pump, and consists of the following steps:

1. Loosen the stuffing box and unscrew the plunger. Remove the plunger and stuffing box.
2. Remove the plunger from the stuffing box and place packing-side up on a work table.
3. Remove all packing and brass from the stuffing box bore.
4. Before repacking the pump, check the plunger, brass, and stuffing box bore for excessive wear or damage.
5. Install packing and brass in the stuffing box with the packing lips facing up (see FIGURE 4-2).
6. Install the plunger in the box using light oil to lubricate.
7. Clean and Anti-Seize the stuffing box threads, check the stuffing box seal, and screw the stuffing box in hand-tight.
8. Reconnect the plunger to the pony rod. Replace the assembly into the pump.

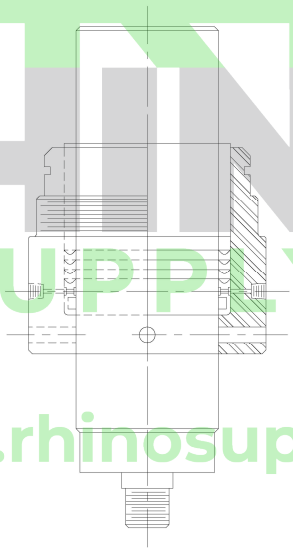


FIGURE 4-2 Packing Assembly

Valve and Seat Replacement (H/V Style Mono-Block Fluid End)

This procedure may be performed with the fluid end on the pump.

> ⚠ **WARNING**
>
> **Never try to remove or cut a valve seat with a torch. Severe damage to the fluid end may occur.**

Before starting, make sure that special tools required for this procedure are available. For part numbers of the tools see the Parts Manual.

1. Remove the discharge valve cover with the tool provided with the pump, or a 10 pound sledge on the hammer lugs.
2. You should now be able to remove the discharge valve and spring by hand.
3. Remove the **S**uction **V**alve **C**over(SVC) taking care not to damage seals.
4. Remove the suction valve and spring.
5. Remove the suction valve stop by hand. (Tap with hammer if it appears stuck.)
6. Remove the suction valve seat or discharge valve seat with a seat puller and a seat puller jack. These tools are available from Gardner Denver.
7. Clean the valve seat deck thoroughly.
8. Be sure the O-ring is installed on the seat and snap the valve seat into the taper by hand to fit tightly.
9. Place the winged valve on the top of the valve seat.
10. Bump the seat into the taper 2-3 times with a heavy bar to make they fit tight.
11. Reinstall the discharge valve and spring, and suction valve stop.
12. Install new seals for the discharge cover and reinstall the cover.
13. To install suction valve and SVC, see the Plunger and Packing Replacement section, steps 4 thru 8.
14. Run the pump at or near maximum discharge pressure to secure the valve seats into the fluid end tapered bores at slow speeds.

POWER END SERVICE

DANGER

Before attempting to service the power end of the pump, the following safety precautions must be observed:

1. **Shift the pump transmission into the neutral gear (if applicable).**
2. **Shut off the pump driver and lock out the unit to prevent starting inadvertently.**

The power end service procedures deal first with major assemblies, namely connecting rods, crossheads, crankshaft, and gear reducer assemblies and then describe how to access all individual parts.

TO REPLACE A ROD BEARING:

1. Disconnect the pump drive and remove the top and rear covers.
2. Remove the rod cap. The rod and cap are match-marked for correct reassembly.
3. With a rubber hammer or wooden hammer handle, tap on the edge of the bearing to remove it.
4. Check the following at reassembly: (a) bearings and crankshaft must be clean and have at least a 16 RMS finish, (b) match marks line up, (c) the rod bearing is free on the crankshaft, and will slide back and forth.

TO REPLACE GEAR REDUCER (if applicable):

1. It is recommended that the gear reducer be removed as a unit.
2. Remove the pump from its mounting.
3. Support the gear reducer with an overhead lift.
4. Remove the gear reducer by disconnecting the lube lines.
5. Using the jack-screw holes, slowly remove the gear reducer assembly from the shaft.
6. Install the new gear reducer on the crankshaft.
7. Re-connect the gear reduce lube line.
8. Rotate the power end slowly, and check to see that all parts are operating and oiling properly, before replacing covers.

TO REPLACE CRANKSHAFT AND MAIN BEARINGS:

1. Remove the gear reducer as described above.
2. Remove the end main bearing housings by means of jack bolts (and center main bearing retainers from the main frame – 250T).
3. With the bearing retainers removed, the crankshaft is now free to SLIDE OUT OF THE FRAME. USE CAUTION TO PREVENT INJURY. Slowly remove crankshaft.
4. Bearings and races are now exposed for removal. Using a torch, rapidly heat the bearings one at a time and remove from the main shaft.
5. The center bearings and races (250T only) will have to be driven from the main-frame using an aluminum or brass bar and hammer.
6. Uniformly heat the bearing races to place on the crankshaft. Secure the inner race bearing retainers to the crankshaft with Spiralock rings. Chill the outer races prior to installation in the main frame and secure with the lock bolts.
7. Insert the crankshaft into the main frame. The axial position of the crankshaft is secured by outer race friction to the bearing housing and needs to be evened out after installation.
8. Place O-rings on the bearing housings and bole these to the main frame assuring main bearings are aligned.

9. After the bearing retainers are in place, rotate the pump to check for free rotation. If the rotation is difficult, use a strong back to push the crank shaft further into the frame.
10. Rotate the power end slowly and check to see that all parts are free.
11. Install the connecting rods and crosshead as described earlier in this section.

TO REPLACE CROSSHEAD AND WRIST PINS AND BEARINGS:

1. Steps 1 thru 3 above.
2. Remove connecting rod and cross head out of the rear of the pump.
3. Place the assembly on its side (pin bore vertical). Quickly heat the small end of the connecting rod to loosen the pin bore (or press pin out).
4. Press in new pin bearings using the new bearing, aligning the oil holes.
5. Chill the pin in dry ice and place it into the cross head and connecting rod.
6. The clearance between the connecting rod bushings and the crosshead pin should be 0.002” to 0.003” on the 100T and 0.003 – 0.005” on the 250T.
7. If the clearance is more than 0.005” replace the bushing and/or wrist pin.

SECTION 5

TROUBLE-SHOOTING

PROBLEM	POSSIBLE CAUSE	SUGGESTED ACTION
Pump Overloads Driver. and/or	1. Excessive pump speed and/or discharge pressure.	1. Reduce pump speed pressure.
	2. Blockage or closed valve in discharge line.	2. clean or open valve.
	3. Incorrect plunger size.	3. Install the correct plunger.
system	4. Improper bypass conditions.	4. See recommended layout, and correct error.
Fluid Not Delivered.	1. Pump not primed.	1. Prime pump.
	2. Air or vapor pocket in suction line.	2. Remove pocket from line.
	3. Clogged suction line.	3. Clean out line.
	4. Suction and/or discharge valves propped open.	4. Remove the obstruction.
Low Discharge Pressure.	1. Worn or fluid cut valve.	1. Replace valve assembly.
	2. Valve propped open.	2. Remove the obstruction.
Knock	3. Pump cavitating.	3. See Cavitation, Fluid or Hammer problem.
	4. Fluid leakage.	4. Replace plungers/packing and/or fluid end seals.
	5. Erroneous gauge reading.	5. Recalibrate or replace gauge(s).
Low Suction Pressure.	1. Low head (NPSH).	1. Raise fluid supply level. Install charging pump.
	2. Insufficient charging pump capacity.	2. Increase charging pump speed or size.
	3. Retarded fluid flow.	3. Remove restrictions from suction line.
	4. Erroneous gauge reading.	4. Recalibrate or replace gauge(s).

PROBLEM	POSSIBLE CAUSE	SUGGESTED ACTION
Cavitation, Fluid Knock or Hammer.	1. Improper suction system layout.	1. See recommended system layout in manual.
	2. Low suction pressure.	2. See Low Suction Pressure problem.
	3. Suction stabilizer and pulsation damper not used.	3. Install suction stabilizer and pulsation damper.
	4. Defective stabilizer or damper.	4. Repair and recharge or replace.
	5. High fluid temperature or viscosity.	5. Reduce pump speed.
	6. Low fluid vapor pressure.	6. Increase NPSH(a).
	7. High acceleration head.	7. Increase supply line size. Decrease supply line length.
	8. Suction valve spring too stiff.	8. Use weaker spring.
	9. Air/Gas in pumped fluid.	9. Allow more settling time in supply tank. Reduce pump speed.
	10. Air entering suction line.	10. Repair suction line.
	11. Air entering charging pump.	11. Tighten or replace shaft packing or seal.
	12. Air entering or charge gas escaping from suction stabilizer.	12. Repair and recharge stabilizer
	13. Multiple pumps operating in	13. Use a suction stabilizer phase on each pump. Separate lines may also be needed.
Suction or Discharge Line Vibration.	1. Line(s) not supported.	1. Install supports or hangers.
	2. Pump cavitating.	2. See Cavitation, Fluid Knock or Hammer problem.
High Crankcase Oil Temperature.	1. High ambient temperature.	1. Use an oil heat exchanger with a circulating pump.
	2. Improper type/grade oil used.	2. Use recommended oil.
	3. Pump overloaded.	3. Reduce pump speed and/or pressure.
	4. Improper clearance in main or rod bearings, crossheads or bushings.	4. Check and adjust clearance. Replace parts as required.

PROBLEM	POSSIBLE CAUSE	SUGGESTED ACTION
Knock In Power End.	1. Improper main bearing clearance.	1. Check and adjust clearances.
	2. Incorrect pump rotation.	2. Reverse rotation.
	3. Loose plunger coupling.	3. Check and tighten. Replace if damaged.
	4. Loose bearing housings/ covers.	4. Check and tighten. Replace if damaged.
	5. Worn crosshead pin.	5. Replace.
	6. Worn crosshead pin bushing.	6. Replace.
	7. Worn connecting rod to journal bearing.	7. Replace.
	8. Worn crankshaft.	8. Replace.
	9. Worn crosshead.	9. Replace.
	10. Worn main bearing.	10. Replace.
	11. Valve noise transmitted to power end.	11. See Excessive Valve Noise problem.
	12. Cavitation noise transmitted to or causing shock loading in power end.	12. See Cavitation, Fluid Knock or Hammer problem.
Excessive Valve Noise.	1. Pump cavitation.	1. See Cavitation, Fluid Knock or Hammer problem.
	2. Seal on inserted valve damaged or missing.	2. Replaced seal or valve.
	3. Broken/weak valve spring(s)	3. Replace spring(s).
Oil Leakage From Stop Head.	1. Worn, damaged or corroded. extension rod.	1. Replace extension rod.
	2. Worn oil stop head seal.	2. Replace seal.
	3. Oil level too high.	3. Reduce oil level.
	4. Excessive crosshead wear.	4. Replace crosshead.
	5. Pressure in crankcase.	5. Clean or replace air breather.
	6. Misalignment in front.	6. Loosen bolts and center. crosshead guide cover.

PROBLEM	POSSIBLE CAUSE	SUGGESTED ACTION
Oil Seal Leakage.	1. Worn sealing lip.	1. Replace seal.
	2. Damaged sealing lip.	2. Replace seal.
	3. Outside diameter not seated.	3. Clean and polish bore of oil seal housing.
	4. Shaft rough at seal lip.	4. Clean and polish shaft or replace wear sleeve.
	5. Pressure in crankcase.	5. Clean or replace air breather.
Stuffing Box Leakage.	1. Short plunger/packing life.	1. See Short plunger/Packing Life problem.
	2. Worn packing rings/metal.	2. Replace packing rings/metal.
	3. Seal leaking at fluid end.	3. Check seal, stuffing box groove and sealing surface.
	4. Corrosion due to wrong stuffing box material for pumped fluid.	4. Determine and install correct stuffing box.
	5. Stuffing box bore worn.	5. Replace stuffing box.
Pumped Fluid In Crankcase.	1. Worn, damaged or corroded extension rod.	1. Replace extension rod.
	2. Worn oil stop head seal.	2. Replace seal.
	3. Stuffing box leakage.	3. See Stuffing Box Leakage problem.
Short Valve Life.	1. Abrasives in pumped fluid.	1. Filter pumped product. Use severe duty valves with insert.
	2. Valve not sealing.	2. Broken valve spring - replace. Worn valve guide - replace. Worn valve/seat - replace.
	3. Pump cavitating.	3. See Cavitation, Fluid Knock or Hammer problem.
	4. Corrosion.	4. Treat pumped fluid. Use different materials for valves/seats. Install sacrificial anodes in suction manifold.

PROBLEM	POSSIBLE CAUSE	SUGGESTED ACTION
Short Plunger/Packing Life.	1. Abrasives in pumped fluid.	1. Consult S&K Supply, Inc. Customer Service for plunger / packing recommendation. Filter pumped fluid.
	2. Excessive plunger/packing friction.	2. Lubricate with rock drill oil. Do not overtighten adjustable packing. Use S&K Supply plungers.
	3. Metal parts or particles wearing plunger.	3. Check stuffing box alignment. Check gland alignment. Check plunger alignment. Check packing for foreign particles. Replace lantern ring.
	4. Wrong plunger/packing for pumping conditions.	4. Consult S&K Supply, Inc. Customer Service.
	5. Wrong size packing.	5. Install correct size packing.
	6. Improper packing installation.	6. Check installation procedure and install correctly.
	7. Excessive crosshead wear.	7. Replace crosshead.
	8. Pump cavitating.	8. See Cavitation, Fluid Knock or Hammer problem.
Catastrophic Failures: Broken Shafts, Bent Rods, etc.	1. Pump overloaded.	1. Reduce pump speed and/or pressure.
	2. Start-up against closed discharge valve.	2. Insure valve is open before starting.
	3. Main bearing failure.	3. Repair or replace.
	4. Plunger striking valve or valve parts.	4. Check valve condition and installation procedure.
	5. Plunger striking cylinder.	5. Check plunger for proper length.
	6. Frozen fluid in cylinder.	6. Do not start pump when pumped fluid is below freezing temperature.
	7. Lube oil pump failure.	7. Replace oil pump.

PROBLEM	POSSIBLE CAUSE	SUGGESTED ACTION
Catastrophic Failures: Broken Shafts, Bent Rods, etc. (continued).	8. Low oil level in sump.	8. Check oil level frequently, and add oil as required.
	9. Contaminated oil in sump.	9. Check oil condition frequently.
	10. Cavitation shock loading.	10. See Cavitation, Fluid Knock or Hammer problem.
Stud Failures.	1. Catastrophic failures.	1. See Catastrophic Failures problem.
	2. Improper nut torquing.	2. Check torque specifications and torque to correct values.
	3. Stud bending due to uneven nut seating.	3. Check nut seat surface for flatness. Rework or replace as required.
	4. Corrosive attack by pumped fluid.	4. Treat fluid or use corrosion resistant studs.
	5. Studs damaged before installation.	5. Check condition before installation, and replace if necessary.
	6. Low strength studs.	6. Use S&K Supply Inc. studs.

SECTION 6
REBUILDING DATA, RECOMMENDED RUNNING CLEARANCES AND TORQUES

REBUILDING DATA FOR 100T and 200Q PUMP (in.)

PUMP STROKE	4.250 Inches
Crankshaft Throw Diameter	3.999 – 4.000
Crankshaft Shaft Diameter at Main Bearing	5.119 – 5.121
Distance Between Main Bearing Centers	7.000
Bore in Frame for Inner Main Bearings	N/A
Bore in Main Bearing Housing	7.874 – 7.875
Connecting Rod Centers	12.000
Connecting Rod Bearing Bore	4.250 – 4.249
Crosshead Guide Bore	6.000 – 6.002
Crosshead	5.995 – 5.997
Wristpin	2.250 – 2.249
Wristpin Bushing Bore	2.252 – 2.255

RECOMMENDED RUNNING CLEARANCES – ACTUAL

	New (in.)	Maximum Allowable Wear Limit (in.)
Connecting Rod Bearing to Crankshaft	.004/.006	.010
Main Bearing Installed Clearance*	.0000” / .0023”	.006
Crosshead to Guide*	0.003	.022
Crankshaft Endplay	.001	.005
Wrist Pin-to-Bearing clearance	.003	.008

* Feeler gauge clearances .001 inch less than actual values.

REBUILDING DATA FOR 250T and 400Q PUMP (in.)

PUMP STROKE	6.000 Inches
Crankshaft Throw Diameter	4.999 – 5.000
Crankshaft Shaft Diameter at Main Bearing	9.451 – 9.450
Crankshaft Shaft Diameter at Main Bearing	5.907 – 5.906
Crankshaft Shaft Diameter at Center Main Bearing	11.502 – 11.504
Distance Between Main Bearing Centers	8.500
Bore in Frame for Inner Main Bearings	15.248 – 15.249
Connecting Rod Centers	16.000
Connecting Rod Bearing Bore	5.004 – 5.006
Crosshead Guide Bore	6.876 – 6.878
Crosshead	6.873 – 6.872
Wristpin	3.000 – 2.999
Wristpin Bushing Bore	3.002 – 3.005

RECOMMENDED RUNNING CLEARANCES – ACTUAL

	New (in.)	Maximum Allowable Wear Limit (in.)
Connecting Rod Bearing to Crankshaft	.006	.012
Main Bearing Installed Clearance*	.0000” / .0023”	.006
Crosshead to Guide*	0.004	.028
Crankshaft Endplay	.001	.005
Wrist Pin-to-Bearing clearance	.003	.008

* Feeler gauge clearances .001 inch less than actual values.

TORQUES

	FOOT-LBS. TORQUE.	
FASTENER	W/LOCTITE	W/ ANTISEIZE

.....	3/8” – 16	19	-
.....	3/8” – 16		16
.....	½” - 14		70
.....	5/8” - 11		95
.....	3/4” - 10		155
.....	.1” - 8		300
.....	1-1/4”- 7		450
.....	1-3/8”- 8		800
.....	1-1/2”- 6		950
.....	1-5/8”- 6		1100
.....	1-3/4”- 6		1600

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