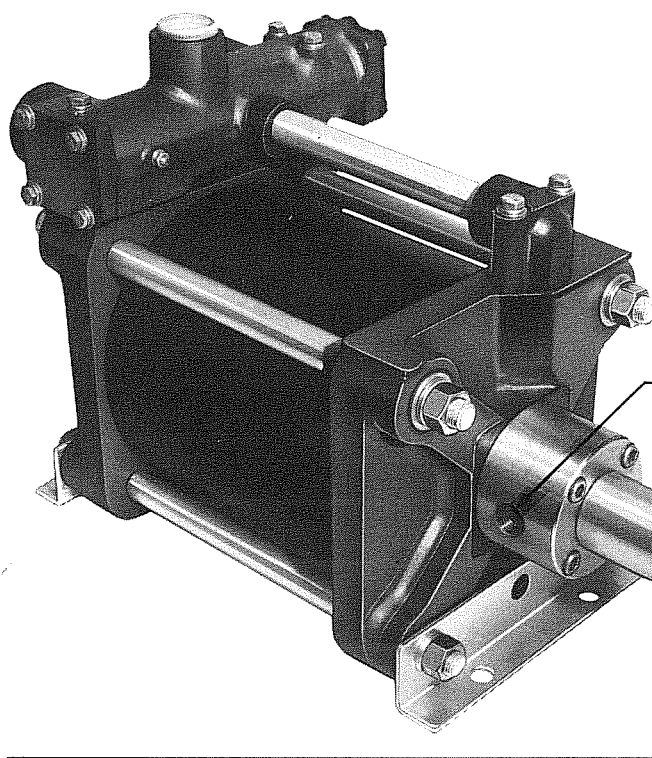


HANDBOOK

OPERATION AND MAINTENANCE

AND INCLUDES

ILLUSTRATED PARTS BREAKDOWN (IPB)



MODELS S-218-GJC-45 and S-218-GJC-65

AIR-DRIVEN HYDRAULIC PUMPS

LIQUID OUTLET
PORT- $\frac{1}{2}$ " NPT

LIQUID INLET
PORT-1" NPT

**CURTISS
WRIGHT**

Flow Control Corporation

Sprague Products

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Brecksville, OH 44141
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INTRODUCTION

This handbook provides the necessary information to install, operate, maintain and overhaul the air-driven hydraulic pumps, TSE models S-218-GJC-45 and S-218-GJC-65.

1.0 INSTALLATION

- 1.1 The S-218 series pump requires only bolt attachment to a base plate and plumbing connection of three lines:
- From driving air source to pump air inlet port.
 - From fluid source to pump liquid inlet port.
 - From pump liquid outlet port to working system.

To obtain effective liquid sealing at the inlet and outlet ports and air sealing at the air inlet port the NPT male threads on the lines connecting to and from the pump should each be wrapped with two wraps of teflon tape. Note: tape to within one or two threads of the end of the fitting, NOT to the end.

Do not use pipe dope.

No special tools are required to install or overhaul the pump.

- 1.2 LOCATION—For maximum performance, the pump's liquid inlet port should be level with or below the liquid reservoir or liquid source. The pump will perform satisfactorily in any location or position.

- 1.3 MOUNTING—Two $\frac{17}{32}$ dia. mounting holes are provided in each of the two mounting brackets on the underside of the pump's air motor for attachment to a base plate or platform. See Figure 1-1 for installation and clearance dimensions.

- 1.4 PLUMBING—All plumbing must be rated to maximum operating pressures.

- Connect driving air supply line to pump air inlet port.
- Connect liquid supply line from reservoir to pump inlet port.
- Connect system liquid line to pump outlet port.

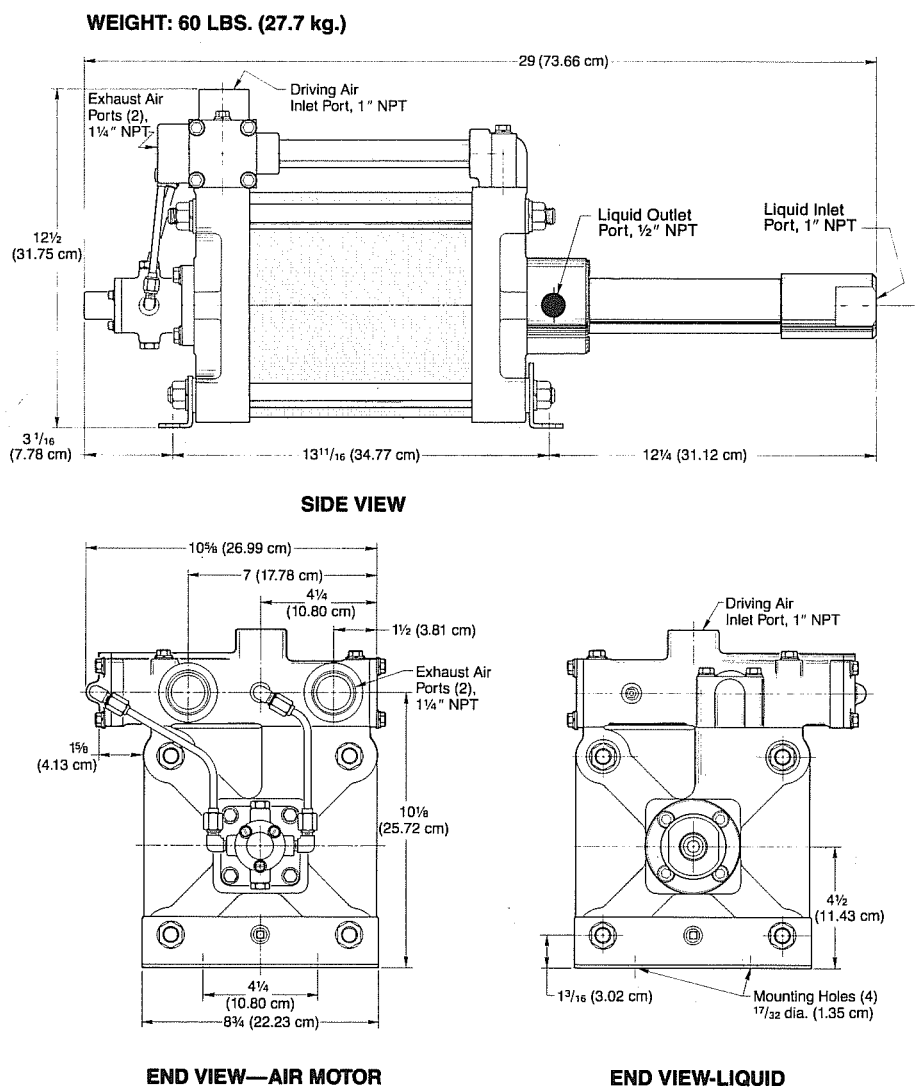


Figure 1-1, Pump installation and clearance dimensions.

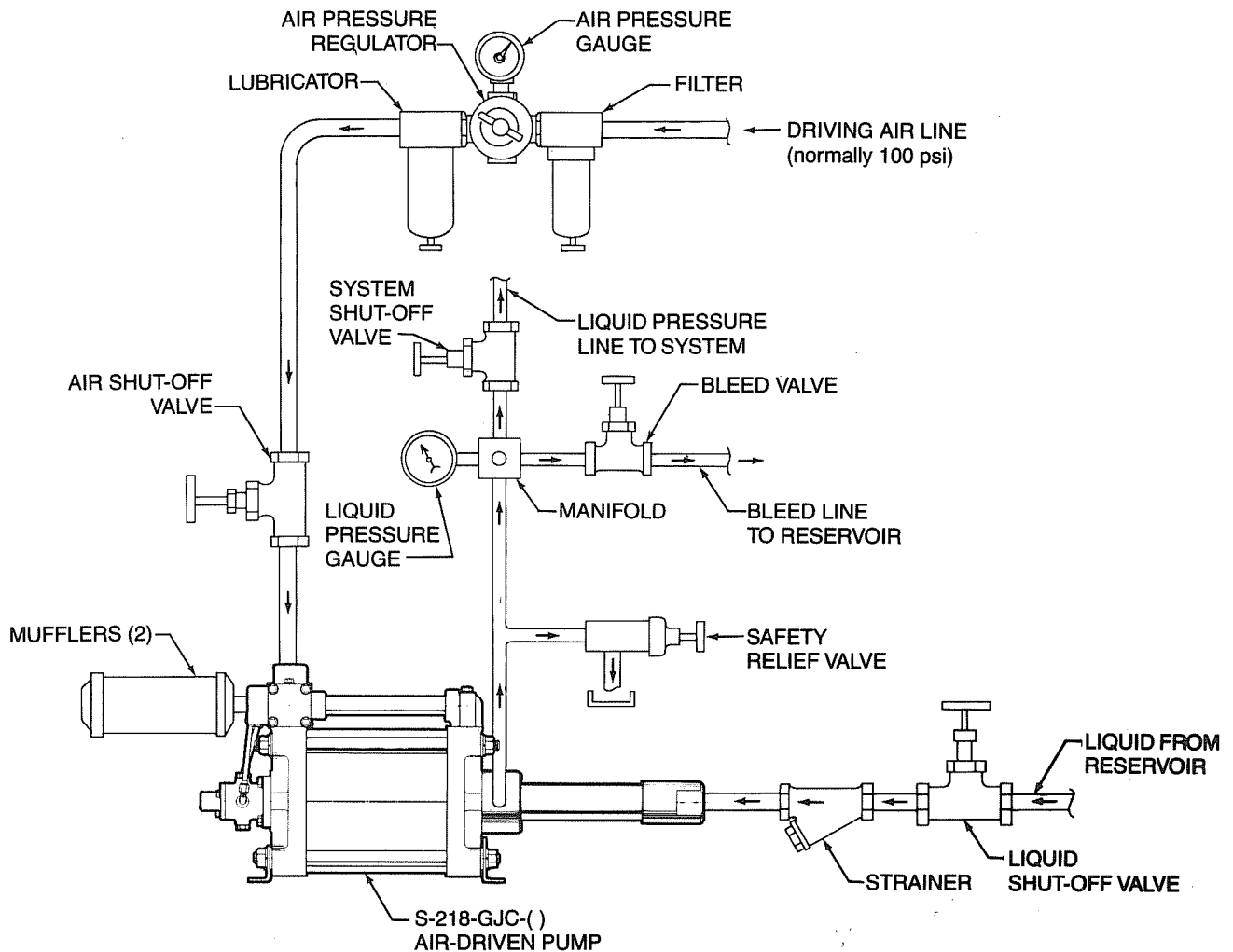


Figure 1-2, Pump installed in typical hydraulic system with recommended accessories.

- d. Mufflers (2) may be attached to the pump's air exhaust ports.

For line hook-up to pump, pump installation within hydraulic circuit and recommended accessories, see Figure 1-2.

2.0 OPERATION

2.1 The pump requires lubricated driving air. Normal driving air pressure should be 100 ± 10 psi (6.8 ± 0.068 bars) to obtain maximum performance. The pump will operate with less air pressure, refer to Section 8.0, Tables 8-2 and 8-3, Performance Charts.

2.2 START PUMP

- Close air shut-off valve between pump and pressure regulator.
- Turn on driving air supply.
- Adjust air pressure regulator at air control unit (FRL). Minimum operating pressure for a new pump is 30 psi (2.07 bars).
- Open valve in hydraulic circuit to allow free liquid flow.
- Slowly open the air shut-off valve to start the pump operating.
- After pump has been primed, close valve in hydraulic circuit.
- Check pump and air circuit for leaks in lines, fittings, etc.
- With pump and circuit operating properly, readjust

air pressure regulator until desired pump discharge pressure is reached. The hydraulic circuit is ready to operate.

2.3 STOP PUMP

- Close air shut-off valve. Normally after driving air supply has been adjusted, the pump can be on-off controlled or reduced in discharge rate at the air shut-off valve.
- After stopping pump, bleed off hydraulic pressure before disconnecting the hydraulic circuit.

3.0 MAINTENANCE

3.1 SPECIAL TOOLS—None are required to service pump. Use standard tools.

3.2 INSPECTION and MAINTENANCE—Refer to Chart 3-1 as a guide to general maintenance. Recommended inspection periods may require adjustment to comply with local conditions or as determined by experience.

3.3 TROUBLE-SHOOTING—Chart 3-2 aids in checking the pump and outlines corrective action.

To eliminate the unnecessary disassembly of the pump, probable causes of malfunction are listed in the following order:

- a. Causes that can be corrected without disassembly of pump.
- b. Causes that can be corrected with partial disassembly of pump.
- c. Causes that require complete disassembly of pump. In the disassembly and assembly instructions that follow the number in parenthesis following the part name corresponds to the item number on the S-218-GJC-45 and S-218-GJC-65 Illustrated Parts Breakdown (IPB) publications, TSE 8138 and TSE 8136 respectively.

3.4 For disassembly, inspection, repair and reassembly of the pump, refer to Sections 4.0, 5.0, 6.0 and 7.0 following.

ITEM	INSPECTION PERIOD	REQUIRED MAINTENANCE
(1) Driving Air Filter	(a) 10 hours.	Check for and drain liquid accumulated in filter.
	(b) 50 hours.	Check filter element and other components for clogging. Clean as required.
(2) Driving Air Lubricator	(a) 10 hours.	Check oil supply to fill line. Use SAE #10 or equivalent good quality oil. Check oil drip rate (2 drops per minute normal) at adjustment knob.
(3) Driving Air Pressure Regulator	(a) Periodic.	Check for air leaks. Repair as required.
(4) Driving Air Pressure Gauge	(a) 10 Hours.	Shut-off inlet air pressure and check for zero reading.
	(b) 50 hours.	Calibrate against master gauge.
(5) Pump	(a) 10 hours.	Check pump and fittings for air or liquid leakage. Repair as required.

Chart 3-1, Schedule of inspection and maintenance.

TROUBLE	PROBABLE CAUSE	CORRECTION
(1) PUMP IS NOT DELIVERING LIQUID (pump running)	(a) Reservoir liquid supply is low.	Add liquid as required
	(b) Liquid supply line to pump inlet check valve is clogged.	Remove and clean line. Check reservoir, its inlet filter and outlet, for accumulation of foreign matter. Clean as required.
	(c) Foreign matter is lodged in pump inlet check valve.	Remove and clean check valve. Replace o-ring (76) on poppet (74).
(2) PUMP IS NOT DELIVERING LIQUID (pump not running)	(d) Driving air supply is disconnected, air shut-off valve closed or air filter clogged.	Reconnect line. Open valve. Clean air filter.
	(e) Air pressure regulator not adjusted.	Adjust regulator.
	(f) Air shuttle assembly is sticking or damaged.	Remove and clean air shuttle assy or replace.
	(g) Piston o-rings (3 or 7) damaged.	Replace o-rings.
	(h) Connecting rod (8) broken or out of adjustment.	Replace or readjust.
	(i) Fitting on tubes (28 or 36) are loose, leaking air.	Tighten fittings.
	(j) Compression springs (38), valve spring (77) or spring (68) are broken	Replace springs.
	(k) Shifting rod (53) is improperly adjusted or broken.	Readjust or replace.
(3) PRESSURE DROP OR PUMP FAILS TO BUILD-UP DISCHARGE FLOW (PRESSURE).	(a) Leakage or blockage at inlet check valve poppet (74) or at ball (70) seat. Damaged or worn o-ring.	Remove and clean check valve. Look for foreign matter lodged in seating areas or at ball seat. Replace damaged or worn o-ring.
	(b) Damaged o-ring (51), in outer groove of air piston (57), or scratched or scored cylinder (52). Either or both allow air pressure to escape to exhaust port.	Replace o-ring. Inspect cylinder for scores or scratches. If so marred, replace cylinder
	(c) Damaged piston seal (83).	Replace.
(4) HYDRAULIC LIQUID IN EXHAUST AIR	(a) Damaged seals in liquid body (61) or piston rod (64) may be scored.	Replace o-ring (88), piston rod seal (87) and spacers (85 or 86). Inspect piston rod (64) for score marks; polish as required. If rod is heavily scored or damaged, replace.
(5) AIR IN SYSTEM	(a) Air leak in suction line from reservoir to pump or at pump inlet check valve.	Tighten line fittings; use teflon tape to seal fittings.
	(b) Reservoir liquid level below reservoir suction outlet.	Check reservoir liquid level. Replenish liquid as required.

Chart 3-2, Trouble-shooting pump operation.

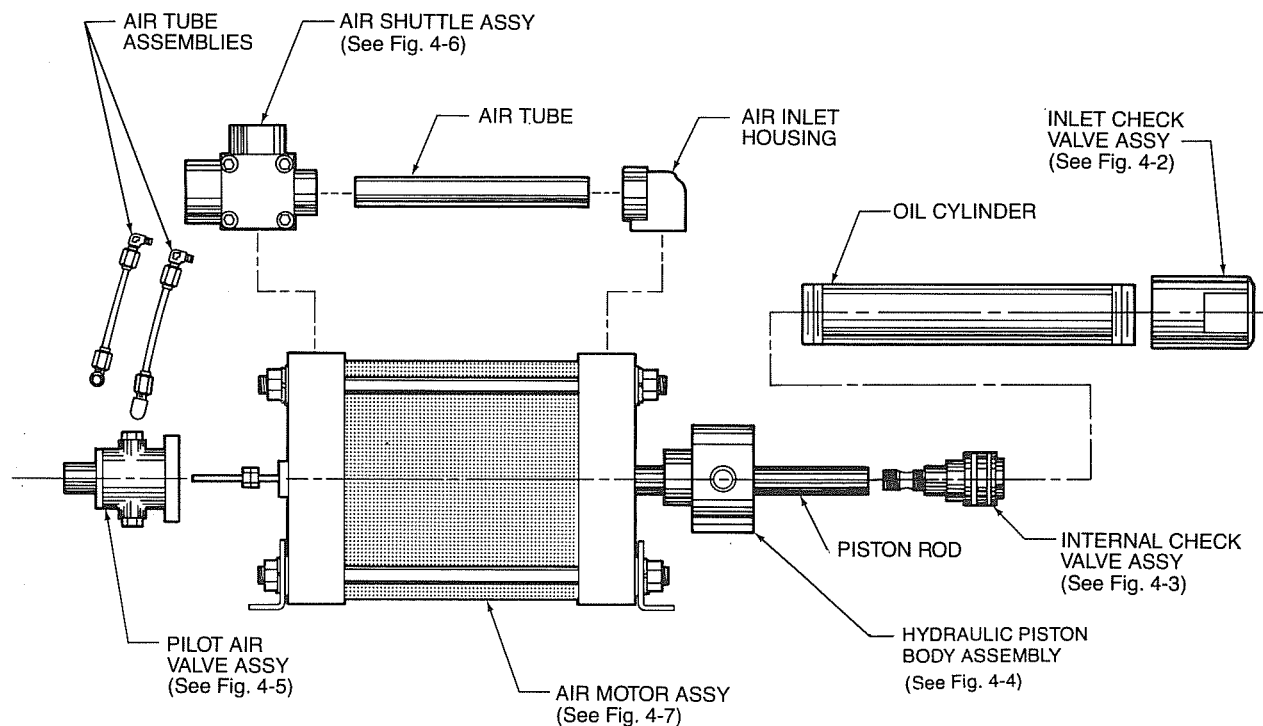


Figure 4-1, Pump disassembly groups.

4.0 DISASSEMBLY.

See Figure 4-1.

This section is divided into disassembly groups depending on the need to service or overhaul certain functional areas of the pump. Disassembly groups are in sequence of probable service need:

- 4.1 Hydraulic Piston Body and Check Valve Assemblies,
- 4.2 Pilot Air Valve Assembly,
- 4.3 Air Shuttle Assembly and
- 4.4 Air Motor Assembly.

For referenced item numbers in text and illustrations of pump components, refer to item numbers on Illustrated Parts Breakdown drawings TSE 8136 and TSE 8138.

4.1 HYDRAULIC PISTON BODY AND CHECK VALVE ASSEMBLIES.

This portion of the pump is divided into three functional groups:
The inlet check valve assembly, the internal check valve assembly, the oil cylinder and the hydraulic piston body assembly and piston rod.

4.1.2 INLET CHECK VALVE ASSEMBLY. — See Figure 4-2.

Using strap wrench on oil cylinder (65) and wrench on check valve body (75), unscrew check valve body (75) from oil cylinder (65). On work bench disassemble valve assembly in following order: back-up ring (78), o-ring (79), retaining ring (72), spacer (73), compression spring (77), poppet (74) and o-ring (76). This completes the removal and disassembly of the inlet check valve.

4.1.3 INTERNAL CHECK VALVE

See Figure 4-3. Using strap wrench, unscrew and remove oil cylinder (65) from hydraulic piston body (61). Remove set screw (27) from retaining nut (71). Unscrew retaining nut (71) and remove its back-up ring (80) and o-ring (81). Also remove from inside of liquid piston (67), ball (70), compression spring (69) and spacer (68). Remove set screw (27) from piston rod (64) and unscrew cap screw (66) and liquid piston assembly. From liquid piston

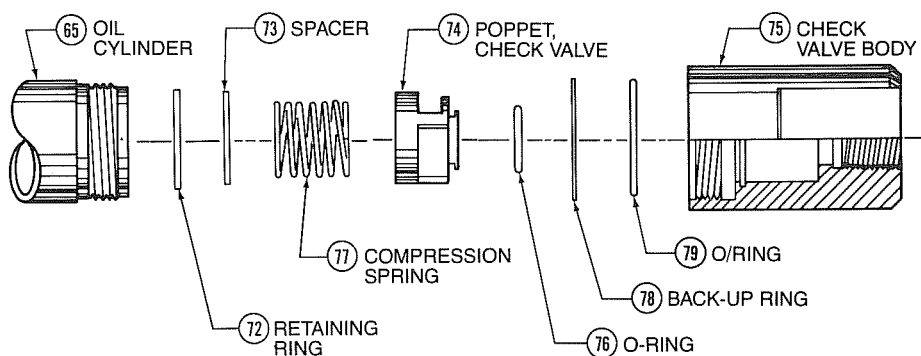


Figure 4-2, Inlet check valve components.

This completes removal of the internal check valve assembly.

This completes removal of the hydraulic piston body assembly.

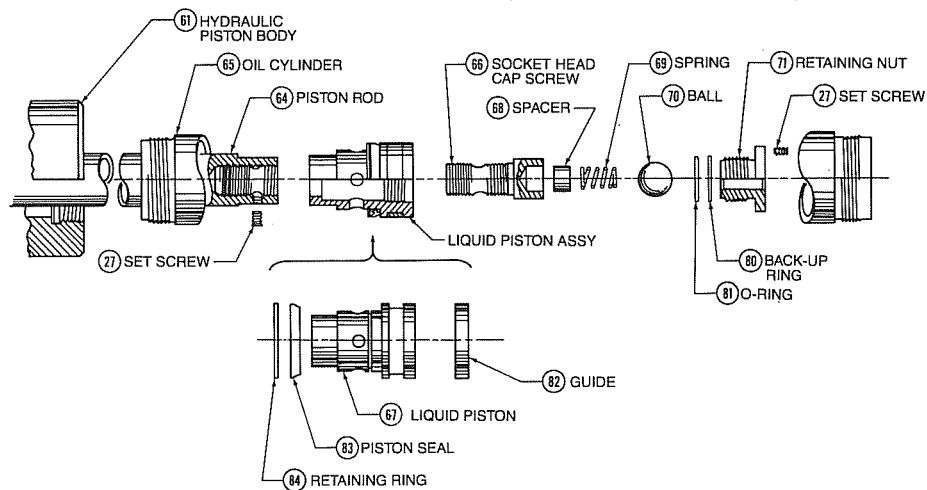


Diagram illustrating the assembly components for the hydraulic piston, numbered 56 through 80:

- 56 OIL END PLATE
- 57 AIR PISTON
- 58 SCRAPER RING
- 59 FRONT ROD SEAL SPACER
- 60 PISTON ROD SEAL
- 61 PISTON ROD
- 62 REAR ROD SEAL SPACER
- 63 CHAMBER
- 64 VENT HOLES
- 65 O-RING
- 66 HYDRAULIC PISTON BODY
- 67 BACK-UP RING
- 68 O-RING
- 69 LOCK WASHER (4)
- 70 SOCKET HEAD SCREW (4)

4.2 PILOT AIR VALVE ASSEMBLY.

See Figure 4-5. Remove the end cap (37) by removing three screws (35) and lock washers (18). Disconnect the two air tube elbows (29). From the end of the shifting rod (53), remove the first pair of nuts (5), washer (23) and spring (38). Remove the housing (45) by unscrewing four screws (22), lock washers (4) and flat washers (23). Remove two bolts (42). From within the housing, remove the shuttle (44). Remove spring (38) and flat washer (23). Remove the two sets of bolts (42), o-rings (43), springs (41) and detent pins (2).

This completes the disassembly of the pilot air valve assembly.

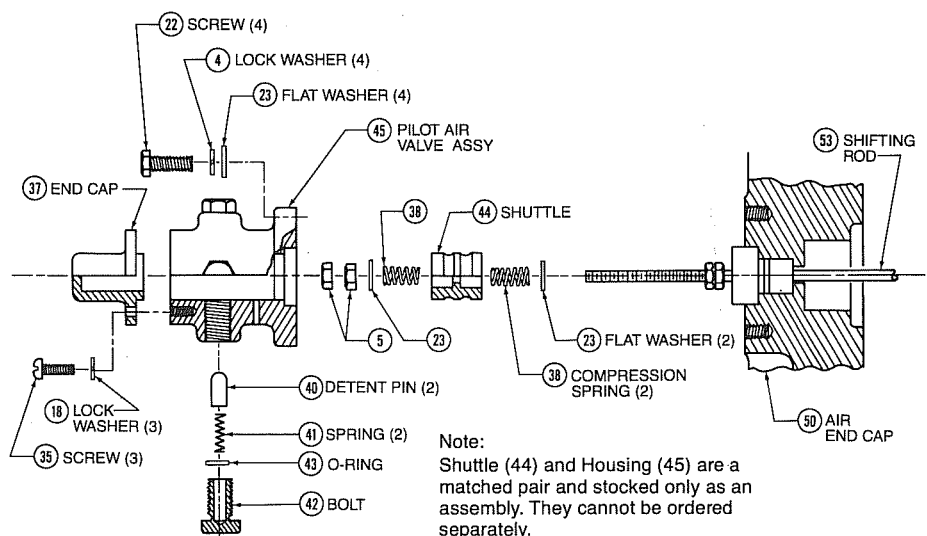


Figure 4-5. Pilot Air Valve assembly and other components.

(17), lock washer (18) and flat washer (19).

4.3.3 See Figure 4-6 center.

Using pliers through the other exhaust port, grip connecting rod (8) to revert rotation. Use an extension socket to remove locknut (10) and flat washer (11) from piston end of connecting rod. Using a teflon rod, push against opposite end of connecting rod to press air shuttle piston (6) out of air shuttle body (16). Unscrew and remove air shuttle piston (6) from connecting rod (8). From piston (6) remove o-rings (3 and 7).

4.3.4 See Figure 4-6 lower.

Push connecting rod (8) in opposite direction to remove connecting rod and shuttle assembly. Disassemble the latter on work bench. Do NOT remove sleeve (13) unless damaged. Using Phillips type screw driver through exhaust port, pry sleeve (13) and o-ring assembly out of valve body (16). Use Phillips screw driver with care so as not to damage the porting holes in the sleeve. Disassemble the latter on work bench.

This completes the disassembly of the air shuttle assembly.

4.4 AIR MOTOR ASSEMBLY

Depending on the need for trouble-shooting or general overhaul, the air motor assembly can be disassembled completely or just in a particular area. Refer to Figure 4-7 for sequence of disassembly.

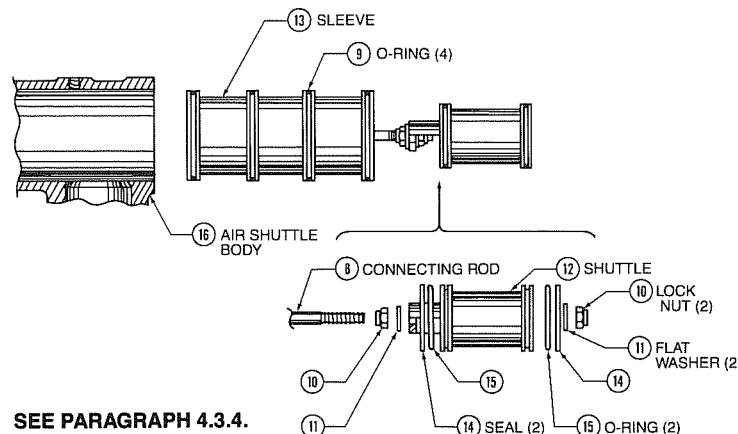
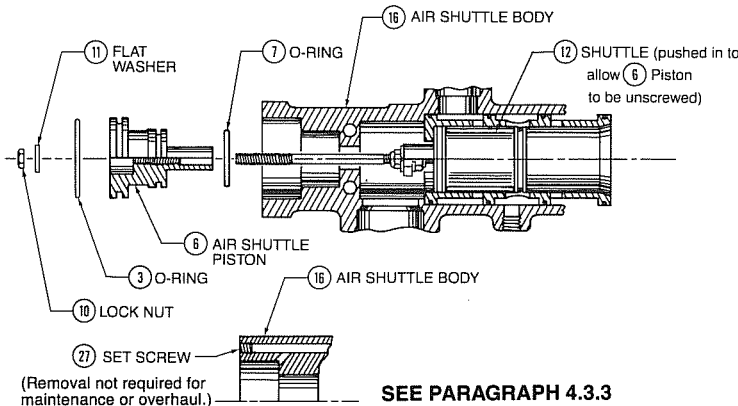
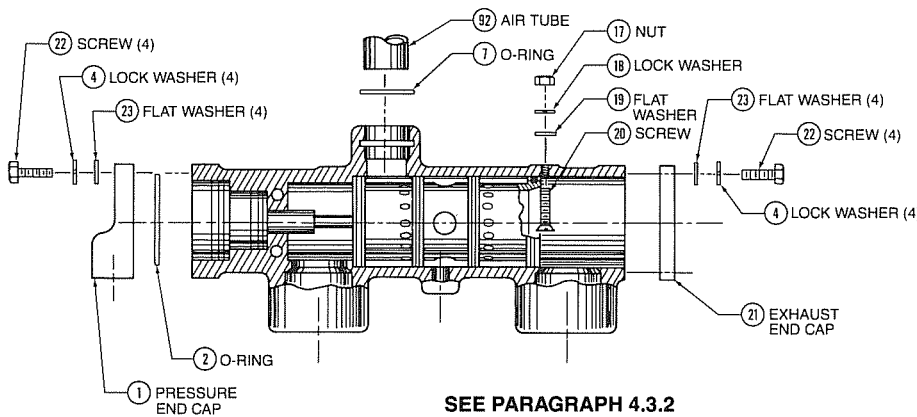


Figure 4-6, Air shuttle assembly components—and disassembly steps.

4.3 AIR SHUTTLE ASSEMBLY.

4.3.1 Disconnect the two air tube assemblies (28 and 36). Remove three each $\frac{5}{16}$ screws (24), lockwashers (25) and flat washers (26) to disconnect air shuttle assembly from the top of the pump. Separate air shuttle assembly from air tube (92) and remove o-ring (7) from air port.

4.3.2 See Figure 4-6 upper.

Using vise to hold air shuttle assembly, remove the pressure end cap (1) and the exhaust end cap (21) by removing from each four screws (22) lock washer (4) and flat washers (23). Remove o-ring (2) from the pressure end cap (1). Using a screw driver to reach through the exhaust port, remove the screw (20), nut

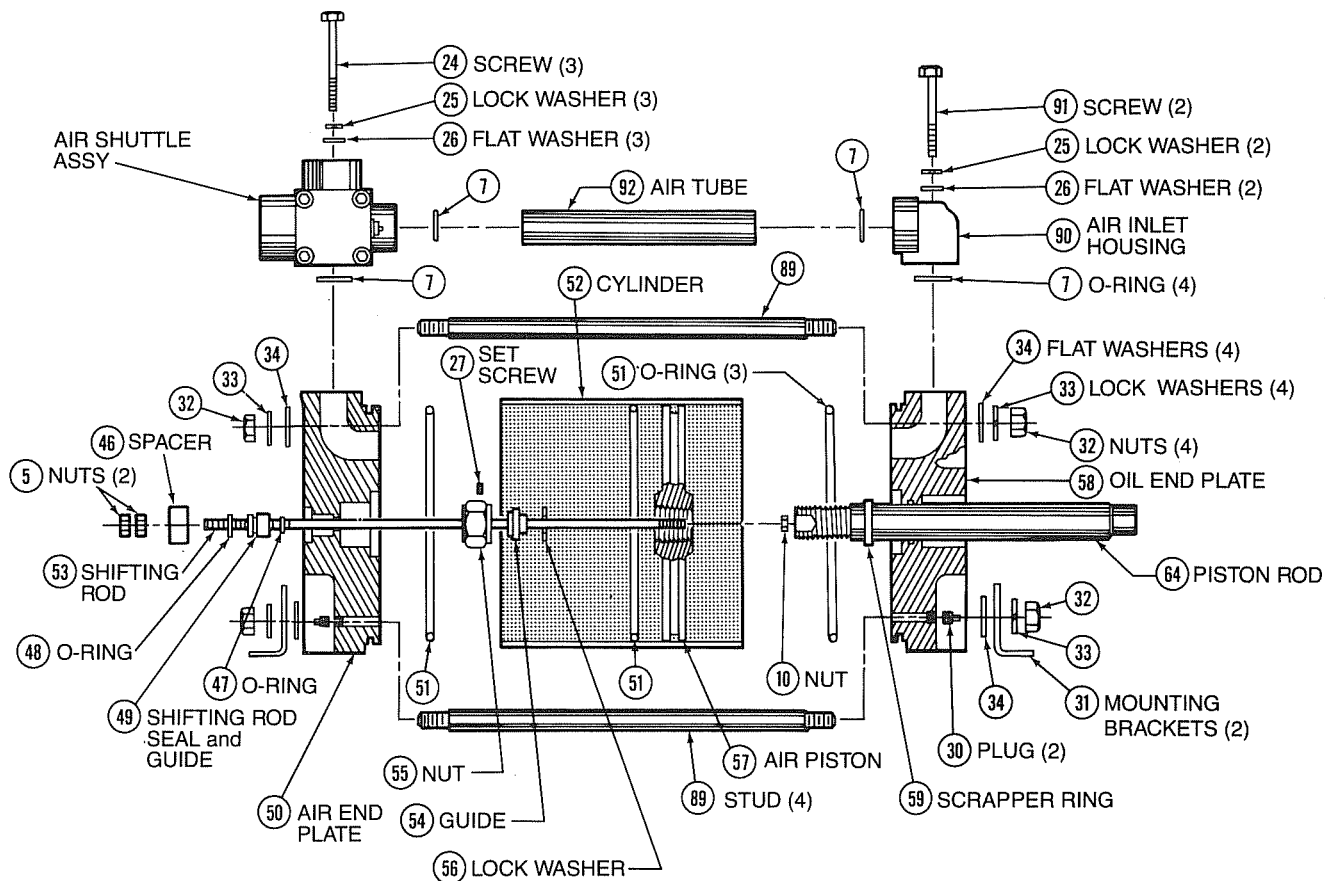


Figure 4-7, Air motor components.

5.0 INSPECTION

5.1 Wash all metal parts in solvent. Dry parts thoroughly with air or lint-free cloth. Remove hardened sediment with soft bristle brush. Do not scrape parts with a metal tool.

5.2 Under a light, and preferably under magnification, visually inspect parts for cracks, pitting, scoring, corrosion or galling.

5.3 Inspect all threaded parts for chipped, crossed or stripped threads.

5.4 Inspect and measure the free length of springs:

- Detent springs (41), $\frac{3}{16}$ O.D. x $\frac{7}{8}$ (0.48 x 2.18 cms).
- Shifting rod springs (38), $\frac{3}{8}$ O.D. x $\frac{13}{16}$ (0.91 x 2.08 cms).
- Internal check valve spring (69): -65 pump, $\frac{31}{64}$ O.D. x $\frac{23}{32}$ (1.23 x 1.83 cms).

d. Inlet check valve spring (77), $1\frac{9}{32}$ O.D. x $1\frac{1}{8}$ (3.25 x 2.86 cms).

5.5 Roll springs over a flat surface to check for wobble.

5.6 Check tube assemblies (28 & 36) for kinks, breaks or defective flares.

5.7 In the inlet check valve portion of the pump, check the valve body (75), poppet (74) spring (77) and o-ring (76) for nicks, excessive wear or rust. See Fig. 4-2.

5.8 In the internal check valve portion of the pump, check the piston seal (83) and Teflon® piston guide (82) for excessive wear. Check the inside surface of the oil cylinder (65) for scoring or scratches. See Fig. 4-3.

5.9 In the liquid body assembly, replace the piston rod seal (87) and o-ring (88) whenever disassembled. Check the piston

rod (64) for scoring or scratches.

5.10 In the pilot air valve assembly, check for free movement between the shuttle (44) and the bore of the housing (45). Check contacting surfaces for dirt, scratches or galling. If surfaces are badly scratched or galled, replace the shuttle and housing. If worn, replace both detent pins (40) and springs (41) at the same time. See Fig. 4-5.

5.11 In the air motor assembly, check cylinder (52) inside surface for scratches or galling. Check air piston's dynamic o-ring (51) and other o-rings for nicks or excessive wear. See Figure 4-7.

5.12 In the air shuttle assembly, inspect o-rings and seals for nicks or excessive wear. Check interior surfaces of sleeve (13) for scoring or scratches. See Fig. 4-6.

6.0 REPAIR AND REPLACEMENT

6.1 Polish metal parts to remove minute imperfections, minor scratches or scoring. Use wet-or-dry paper grit #600.

6.2 Liquid piston (67), piston rod (64), rear rod seal spacer (86) and front rod seal spacer (85) should be removed from the hydraulic piston body (61) and checked for galling, minor scratches or nicks. Carefully polish to remove these flaws. Replace piston rod seal (87).

6.3 Pilot air valve assembly (39) should be opened to inspect for minor imperfections on the mating surfaces of shuttle (44) and housing (45). Polish out imperfections. Too much polishing will cause excessive air leakage between these matched parts.

6.4 Clean all repaired parts in solvent as described in paragraph 5.1 preceding.

6.5 Replace all metal parts that fail to pass inspection or are damaged or worn beyond simple repair.

6.6 At each pump overhaul, replace all o-rings, seals, springs and detent pins. Refer to figures 6-1 and 6-2 for available seal and overhaul kits that conveniently contain these replacement parts.

SEAL KIT, Part No. 90447				OVERHAUL KIT, Part No. 90448			
ITEM			QTY.	ITEM			QTY.
NO.	PART NUMBER	PART NAME	REQ'D	NO.	PART NUMBER	PART NAME	REQ'D
2	91417-032	O-ring, Nitrile	1	2	91417-032	O-ring, Nitrile	1
3	79550-27	O-ring, Nitrile	1	3	79550-27	O-ring, Nitrile	1
5	MS51968-2	Nut, 1/4-28	4	5	MS51968-2	Nut, 1/4-28	4
7	79550-19	O-ring, Nitrile	5	7	79550-19	O-ring, Nitrile	5
14	90230	Seal, Air Shuttle	2	14	90230	Seal, Air Shuttle	2
15	79550-21	O-ring, Nitrile	2	15	79550-21	O-ring, Nitrile	2
33	MS35338-50	Washer, Lock Spring	4	27	MS51023-48	Set Screw, Socket, 10-32 x 3/16 long	2
34	MS27183-21	Washer, Flat	4	33	MS35338-50	Washer, Lock Spring	4
38	88116	Spring, Compression	2	34	MS27183-21	Washer, Flat -b	4
40	82871	Pin, Detent	2	38	88116	Spring, Compression	2
41	88543	Spring	2	40	82871	Pin, Detent	1
43	79552-5	O-ring, Nitrile	2	41	88543	Spring	2
47	79550-5	O-ring, Nitrile	1	43	79552-5	O-ring, Nitrile	2
51	79550-70	O-ring, Nitrile	3	47	79550-5	O-ring, Nitrile	1
60	91417-031	O-ring, Nitrile	1	48	91417-016	O-ring, Nitrile	1
76	79550-17-1	O-ring, Nitrile 90 Shore	1	49	90248	Shifting Rod Seal & Guide	1
78	90262-1	Back-up Ring	2	51	79550-70	O-ring, Nitrile	3
79	91417-135	O-ring, Nitrile	2	52	001-103-2	Cylinder	1
82	90259-1	Guide	1	60	91417-031	O-ring, Nitrile	1
83	88525-221-33	Seal, Piston	1	68	90256-1	Cap Screw, Hex Socket Head	1
85	90273	Rod Seal Spacer, Front	1	69	S-99	Spring	1
87	90275	Seal, Piston Rod	1	70	89864C-.750	Ball	1
88	91417-024	O-ring, Nitrile	1	71	90278	Retaining Nut	1
				78	79550-17-1	O-ring, Nitrile, 90 Shore	1
				78	90262-1	Back-up Ring	2
				79	91417-135	O-ring, Nitrile	2
				80	MS35803-212	Back-up Ring	1
				81	79550-17-1	O-ring, Nitrile	1
				82	90259-1	Guide	1
				83	88525-221-33	Seal, Piston	1
				85	90273	Rod Seal Spacer, Front	1
				87	90275	Seal, Piston Rod	1
				88	91417-024	O-ring, Nitrile	1

OVERHAUL and SEAL KITS

These kits permit the pump user to perform routine servicing of the pump. Or, if the user prefers, the pump can be returned to the factory for service.

Figure 6-1, Seal and Overhaul Kits, S-218-GJC-45 pump.

SEAL KIT, Part No. 90429				OVERHAUL KIT, Part No. 90430			
ITEM			QTY.	ITEM			QTY.
NO.	PART NUMBER	PART NAME	REQ'D	NO.	PART NUMBER	PART NAME	REQ'D
2	91417-032	O-ring, Nitrile	1	2	91417-032	O-ring, Nitrile	1
3	79550-27	O-ring, Nitrile	1	3	79550-27	O-ring, Nitrile	1
5	MS51968-2	Nut, 1/4-28	4	5	MS51968-2	Nut, 1/4-28	4
7	79550-19	O-ring, Nitrile	5	7	79550-19	O-ring, Nitrile	5
14	90230	Seal, Air Shuttle	2	14	90230	Seal, Air Shuttle	2
15	79550-21	O-ring, Nitrile	2	15	79550-21	O-ring, Nitrile	2
33	MS35338-50	Washer, Lock Spring	4	37	MS51023-48	Set Screw, Socket, 10-32 x 31.6 long	2
34	MS27183-21	Washer, Flat	4	33	MS35338-50	Washer, Lock Spring	4
38	88116	Spring, Compression	2	34	MS27183-21	Washer, Flat	4
40	82871	Pin, Detent	2	38	88116	Spring, Compression	2
41	88543	Spring	2	40	82871	Pin, Detent	2
43	79552-5	O-ring, Nitrile	2	41	88543	Spring	2
47	79550-5	O-ring, Nitrile	1	43	79552-5	O-ring, Nitrile	2
51	79550-70	O-ring, Nitrile	3	47	79550-5	O-ring, Nitrile	1
60	91417-031	O-ring, Nitrile	1	48	91417-016	O-ring, Nitrile	1
76	79550-17-1	O-ring, Nitrile 90 Shore	1	49	90248	Shifting Rod Seal & Guide	1
78	90262	Back-up ring	2	51	79550-70	O-ring, Nitrile	3
79	91417-131	O-ring, Nitrile	2	52	001-103-2	Cylinder	1
82	90259	Guide	1	60	91417-031	O-ring, Nitrile	1
83	92867-1	Seal, Piston	1	68	90256	Cap Screw, Hex Socket Head	1
85	90250	Rod Seal Spacer, Front	1	69	S-866	Spring	1
87	90253	Seal, Piston Rod	1	70	89864C-.562	Ball	1
88	91417-024	O-ring, Nitrile	1	71	90252	Retaining Nut	1
				78	79550-17-1	O-ring, Nitrile, 90 Shore	1
				78	90262	Back-up Ring	2
				79	91417-131	O-ring, Nitrile	2
				80	90098-60	Back-up Ring	1
				81	79550-14	O-ring, Nitrile	1
				82	90259	Guide	1
				83	92867-1	Seal, Piston	1
				85	90250	Rod Seal Spacer, Front	1
				87	90253	Seal, Piston Rod	1
				88	91417-024	O-ring, Nitrile	1

OVERHAUL and SEAL KITS

These kits permit the pump user to perform routine servicing of the pump. Or, if the user prefers, the pump can be returned to the factory for service.

Figure 6-2, Seal and Overhaul Kits, S-218-GJC-65 pump.

7.0 ASSEMBLY

This section is divided into assembly groups depending on the need to service or overhaul certain functional areas of the pump. Complete assembly requires about 1-1/2 manhours. Assembly groups in sequence of normal overhaul need are:

7.1 Air Shuttle Assembly,
7.2 Air Motor Assembly,
7.3 Pilot Air Valve Assembly,
7.4 Hydraulic Piston Body,
7.5 Air Shuttle Installation and
7.6 Oil Cylinder and Check
Valve assemblies.

Referenced item numbers in text and illustrations of pump parts refer to parts list item numbers on Illustrated Parts Breakdown, TSE 8136, for S-218-GJC-65 pump and TSE 8138 for S-218-GJC pump.

ASSEMBLY MATERIALS

Vaseline® petroleum jelly, hydraulic oil or petrolatum per Fed. Spec VV-P-36.

Loctite® 200 Adhesive/Sealer (Loctite Corp.).

Molykote® 55M grease (Dow Corning Co.).

Stoddard dry-cleaning solvent per Federal Spec. P-D-680.

1/2" NPT nipple 6-10" long.

"D" Drill.

Rawhide or rubber mallet.

Before reassembling pump, wash metallic parts thoroughly in solvent and dry.

Lubricate dynamic seals with Molykote® 55M. Lubricate static seals, components and threads with Vaseline® petroleum jelly, hydraulic oil or petrolatum.

Use Loctite® 200 adhesive/sealer on set screws.

7.1 AIR SHUTTLE ASSEMBLY

7.1.1 Hold connecting rod (8) in vise. Install lock nut (10), top first, onto shorter length of threads of rod. Screw nut to leave only two threads exposed at shank end of threads. In sequence, install: flat washer (11), shuttle (12), flat washer (11) and lock nut (10). See Figure 7-1.

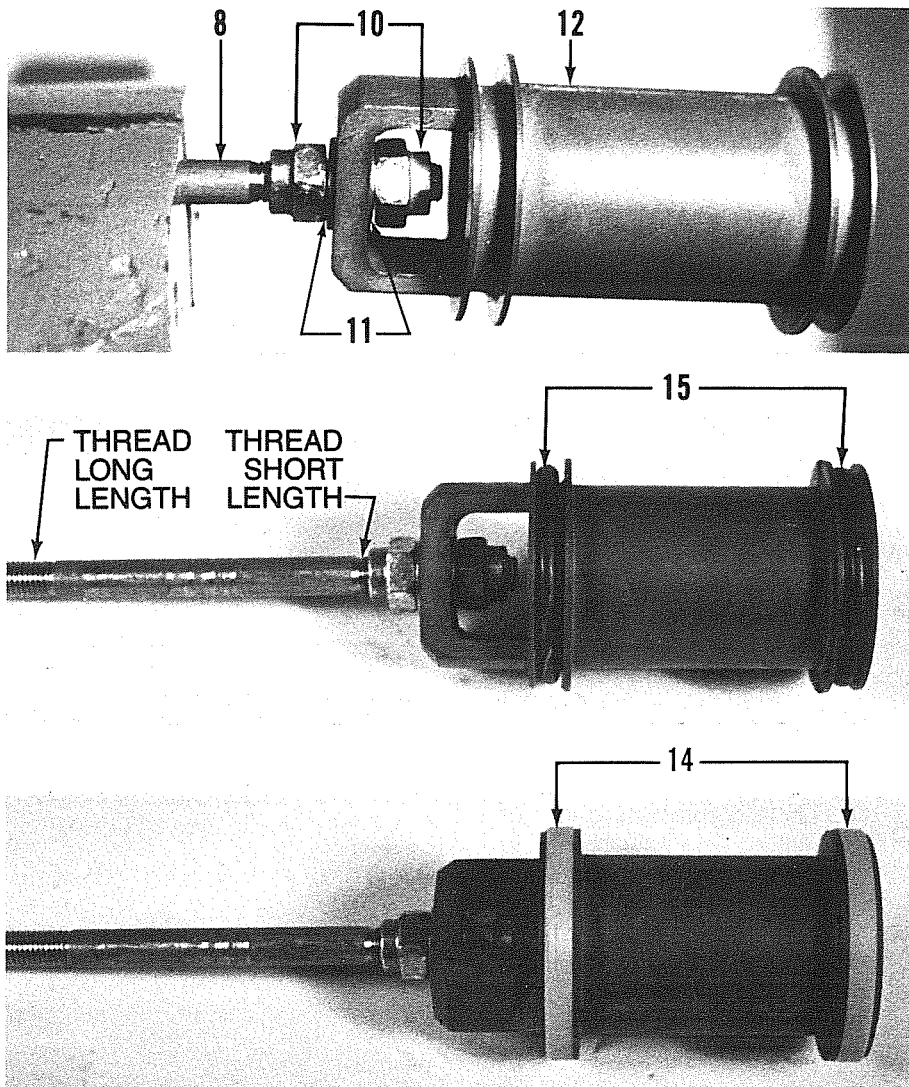


Figure 7-1, Shuttle and connecting rod components.

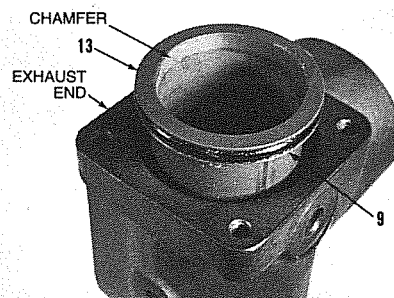


Figure 7-2, Inserting sleeve into air body.

Tighten lock nut, but leave loose enough to allow shuttle to rotate fully. In grooves of shuttle (12), install in each an o-ring (15) and, over o-ring, seal (14).

7.1.2 Lubricate four o-rings (9) with petrolatum and install in grooves of sleeve (13). Position air shuttle body (16) in vise, exhaust end up. Apply petrolatum to inner wall of body. Insert sleeve (13) fully into body, chamfered end up. See Figure 7-2. Lubricate inside of sleeve and outside seals of assembled shuttle with Molykote®. Insert shuttle assembly, rod end down, through sleeve.

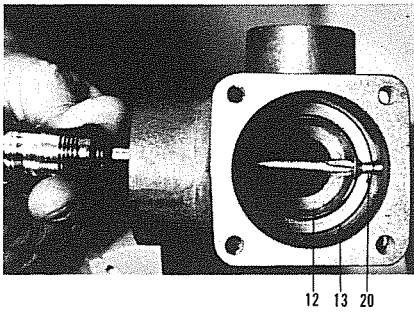


Figure 7-3, Locking sleeve into valve body with screw.

7.1.3 Install countersunk head screw (20), from inside body to lock sleeve in place. Attach on outside of body with flat washer (19), lock washer (18) and nut (17). Tighten screw so that its underside of head seats on chamber on end of installed sleeve. See Figure 7-3.

7.1.4 Follow procedure below to obtain the proper adjustment between the piston (6) and the shuttle (12) relative to the porting in the sleeve. With the shuttle (12) and connecting rod (8) assembled and fully seated in body (16), insert the shank end of a "D" drill (.2460) into the body port (to air motor) and in through the drilled holes in the sleeve (13). See Figure 7-4. The drill now acts as a temporary stop for the shuttle. Place

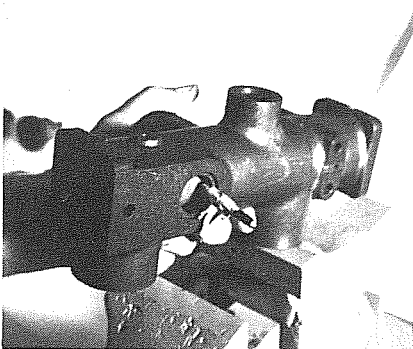


Figure 7-4, "D" drill serves as temporary stop for shuttle.

the body (16) in vise, pressure end up. Coat o-rings (3 & 7) with Molykote® and assemble on piston (6). Insert pliers through body port to hold connecting rod to prevent rotation. See Figure 7-5. Insert piston (6) into the body and screw onto end of connecting rod (8). With shuttle end pressed against the drill shank, screw the piston on rod until the piston end is flush with the pres-

sure end of the body. Install lock washer (4) and nut (5) onto connecting rod (8). See Figure 7-6. Remove drill from assembled body. Before closing the two ends of the body (16) with end caps (1 & 21), check movement of shuttle (12) by pushing piston (6) from flush position to full down into the body (16). With shuttle shifted to one position, the drilled holes in the sleeve should not be blocked by the seals in the shuttle nor when the shuttle is shifted to the opposite position. If holes are misaligned, recheck thread adjustment procedure above.

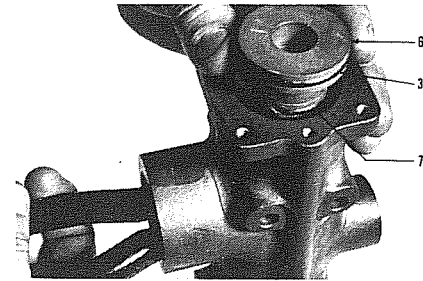


Figure 7-5, Installing air shuttle piston. Note piston being screwed into connecting rod while latter is gripped with pliers to prevent rotation.

7.1.5 Before closing this end of body, check to be sure set screw (27) which plugs air passageway is installed. Lubricate o-ring (2) with petroleum and insert into groove in pressure end cap (1). Bolt pressure end cap to body (16) with four each flat washers (23), lock washers (4) and screws (22). See Figure 7-7.

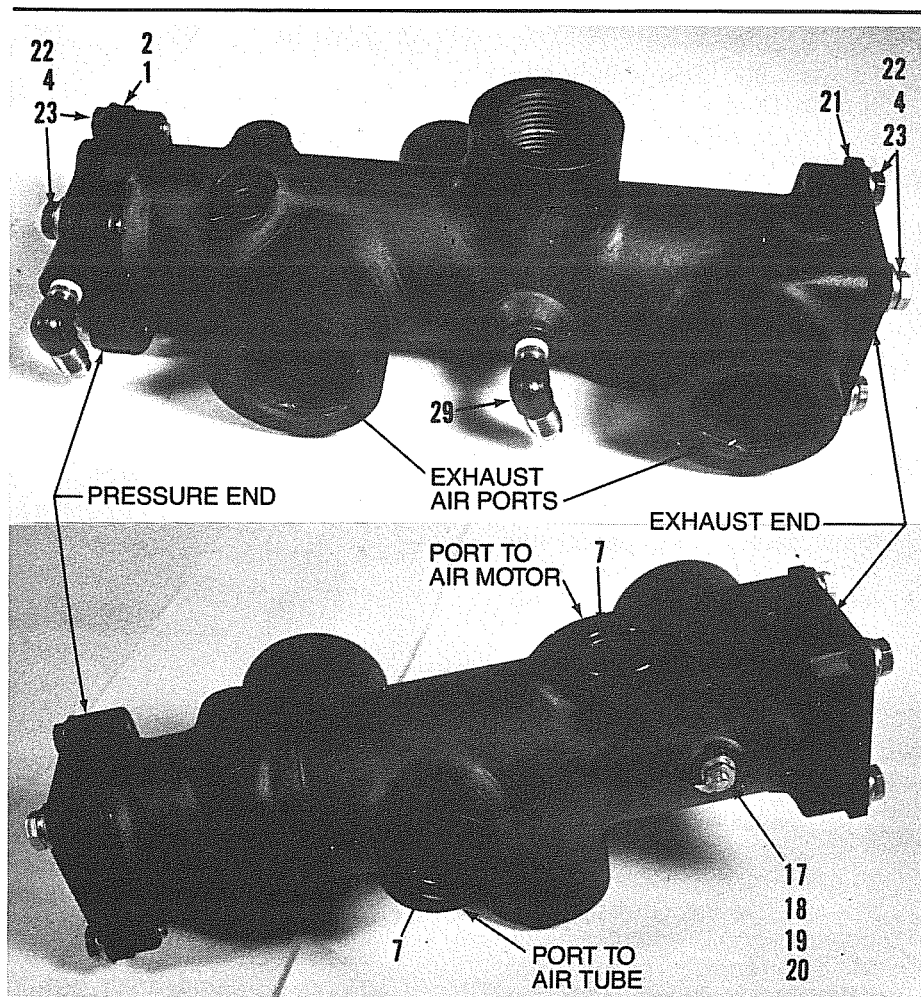


Figure 7-7, Assembled air shuttle assembly.

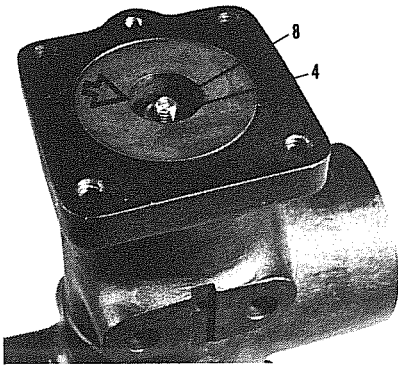


Figure 7-6, Installing lock washer and nut connecting rod. Note piston end is pushed flush to end of body.

7.1.6 Reverse position of body (16) in vise. Bolt exhaust end cap (21) to body with four each flat washers (23), lock washers (4) and screws (22). See Figure 7-7.

7.1.7 Coat two o-rings (7) with petrolatum and insert into air-shuttle body (16) ports, one to top of air end plate (50) and the other to air tube (92). See Figure 7-7.

This completes the assembly of the air shuttle assembly.

7.2 AIR MOTOR ASSEMBLY

7.2.1 Install lock nut (10) fully on short threaded end of shifting rod (53) Check to be sure rod is straight, without any bend.

7.2.2 With air piston (57) gripped in rise, torque rod (64) securely into piston. Check for aluminum chips (from air piston) on exposed end of rod; clean rod end. See Figure 7-8.

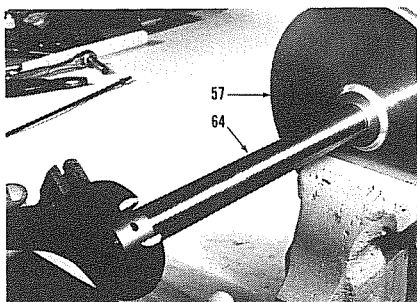


Figure 7-8, Assembling air piston on piston rod.

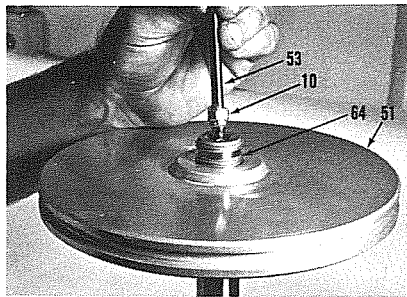


Figure 7-9, Inserting shifting rod into piston rod.

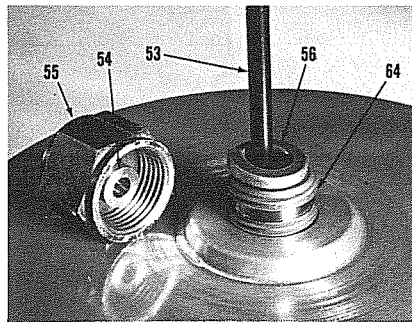


Figure 7-10, Tubing nut ready for assembly.

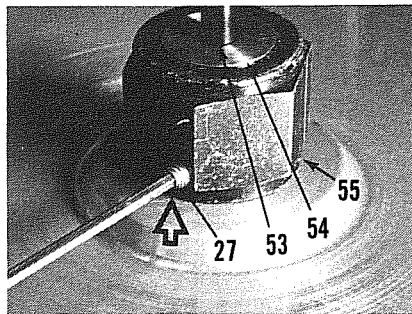


Figure 7-11, Screwing set screw into tubing nut.

7.2.3 Lubricate nut end of shifting rod (53) with petrolatum. Insert shifting rod end with lock nut into the deep hole end of piston rod (64). See Figure 7-9. Apply Loctite® to threads of tubing nut (55). Assemble lock washer (56), shifting rod guide (54) and tubing nut (55) on shifting rod (53). See Figure 7-10. Tighten tubing nut securely on piston rod (64). Coat set screw (27) with Loctite® and screw into tubing nut (55). See Figure 7-11.

7.2.4 Place oil end plate (58) flat on bench, outside up. Wrap threads of square head plug (30) with Teflon® tape and install in end plate drain hole. See Figure 7-12.

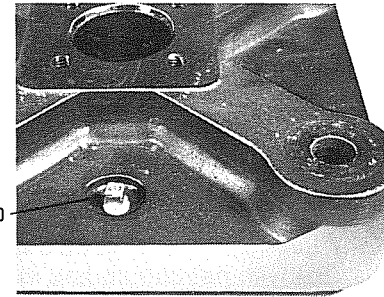


Figure 7-12, Installing drain plug in oil end plate.

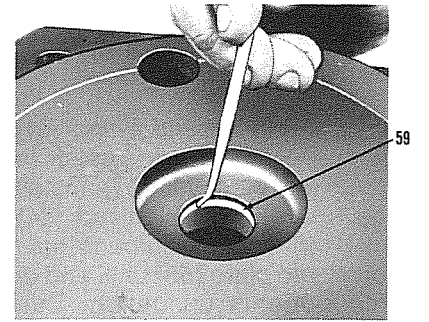


Figure 7-13, Installing scraper ring into oil end plate.

7.2.5 Lubricate scraper ring (59) with Molykote®. Using installation pry tool, install ring in oil end plate (58). See Figure 7-13.

7.2.6 Position oil end plate (58) on its side and insert the threaded ends of the four threaded studs (89) through the four corner holes from the outside of the end plate. Assemble two of the studs in top holes with two sets of flat washers (34), lock washers (33) and nuts (32). Assemble the other two sets of flat washers, lock washers and nuts with mounting bracket (31) onto the studs in the bottom holes. See Figure 7-14.

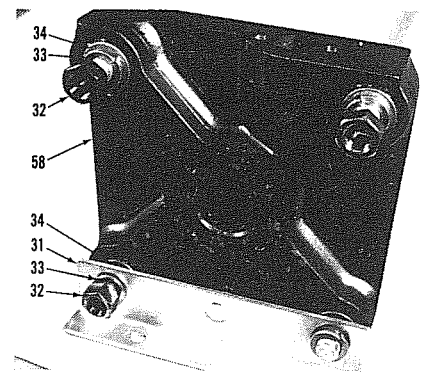


Figure 7-14, Installing nuts and washers on studs.

Note bottom holes assembly order: flat washer, mounting bracket, lock washer and the nut.

Position oil end plate outside face flat on bench with studs pointed up.

7.2.7 Lubricate first of three o-rings (51) with petrolatum and install into oil end plate (58).

7.2.8 Lubricate interior wall of cylinder (52) with Molykote® and install in circular groove in oil end plate. Press cylinder end to fully seat in groove.

7.2.9 Lubricate second o-ring (51) with Molykote® and install in groove of air piston (57). Install air piston and piston rod (64) into cylinder and through hole of oil end plate (58) until end of rod bottoms on bench. See Figure 7-15.

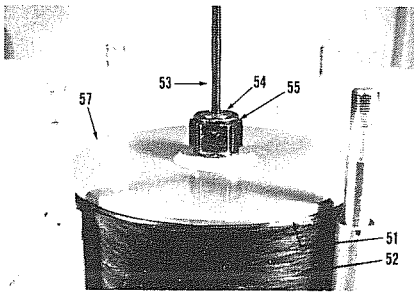


Figure 7-15, Air piston installed in cylinder.

7.2.10 Lubricate third o-ring (51) with petrolatum and install in groove of air end plate (50). Turn air end plate over. Wrap threads of square head plug (30) with Teflon® tape and install in drain hole of air end plate.

7.2.11 Install air end plate (50) on top of cylinder (52). Tap end plate with mallet to fully seat end plate groove on cylinder end. Install flat washers (34), lock washers (33), nuts (32) and mounting bracket on threaded studs, in same manner as paragraph 7.2.6 above. Place pump on a level surface, push piston rod (64) inward until it bottoms, then tighten nuts (32).

NOTE: Tighten nuts on studs evenly and securely. Torque in sequence of opposite corners, i.e. 1 and 3, 2 and 4, to attain even tightness.

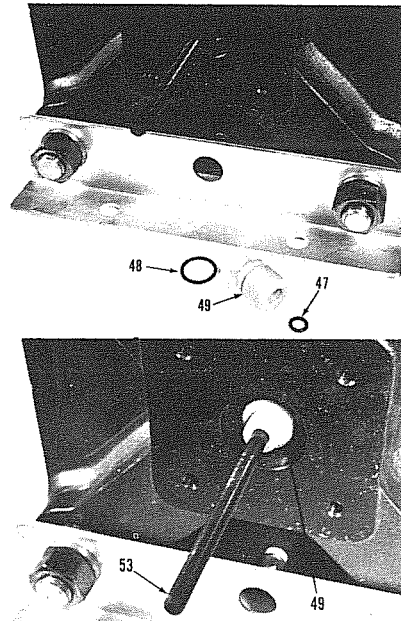


Figure 7-16, Assemble (upper) and install (lower) shifting rod seal and guide; replacement guide does not have smaller diameter neck.

7.2.12 Lubricate o-rings (47 and 48) with Molykote® and install in groove and recess of shifting rod seal and guide (49). Install guide (49) into air end plate (50). See Figure 7-16. Use Teflon® tube and mallet to seat guide fully in hole.

This completes the assembly of the air motor assembly.

7.3 PILOT AIR VALVE ASSEMBLY

7.3.1 Prior to assembly and adjustments of pilot air valve, the air piston (57) must be bottomed at air end plate (50). The bottoming can be accomplished

by pushing strongly against the rod end (64) or by tapping against rod with a mallet (rawhide or rubber). This bottoming action moves the shifting rod (53) to a maximum outward protrusion from the air end plate.

7.3.2 Lubricate spacer (46) with Molykote® and install. Tap spacer to fully seat it in recess of air end plate. See Figure 7-17.

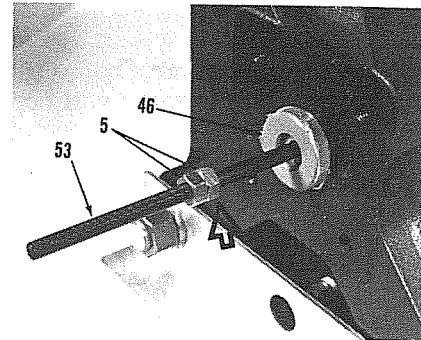


Figure 7-17, Nuts screwed on shifting rod to thread run-out.

7.3.3 Thread two nuts (5) on shifting rod (53) until 1/2" distance separates first nut from spacer (46). See Figures 7-19. Install flat washer (23) against nuts.

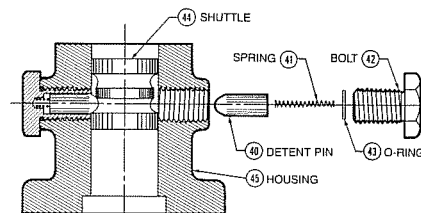


Figure 7-18, Partial assembly of pilot air valve.

7.3.4 On flat surface, insert shuttle (44) into air valve housing (45) so that shuttle groove nearest air end plate aligns with detent holes in housing. Lubricate detent pins (40) with Molykote® and install along with springs (41), o-rings (43) and bolts (42) in pilot air valve housing (45). See Figure 7-18. Do not over-tighten bolts (42).

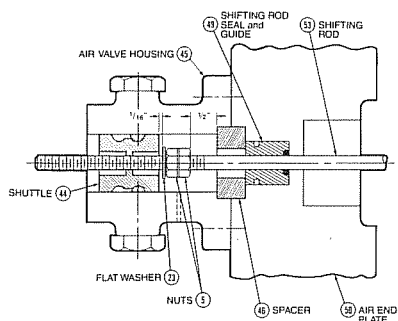


Figure 7-19, Adjustment dimensions for pilot air valve.

7.3.5 A $\frac{1}{16}$ " clearance is required between the end of the shuttle (44) and the washer (23). See Figure 7-19. Take partially assembled pilot air valve (paragraph 7.3.4 preceding) and hold in position against air end plate (50). Grasp shifting rod (53) and determine if rod moves in and out $\frac{1}{16}$ " approximately. If rod movement is $\frac{1}{16}$ ", tighten nuts securely. If not, readjust and tighten nuts securely. Remove housing (45). See Figure 7-20. Lubricate first spring (38)

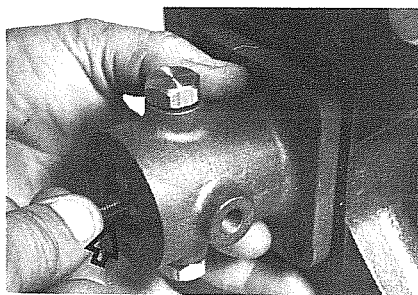


Figure 7-20, Checking for $\frac{1}{16}$ movement of shifting rod.

with Molykote® and assemble on shifting rod. Permanently install partially assembled pilot air valve assembly with four each screws (22), lock washers (4) and flat washers (23). Tighten screws evenly.

Note: Be sure housing is positioned on air end plate so its air bleed hole points downward toward air end plate's mounting bracket (32). See Figure 7-21.

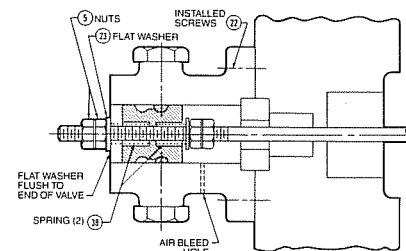


Figure 7-21, Pilot air valve components installed.

7.3.6 Lubricate second spring (38) with Molykote® and assemble on shifting rod. Install flat washer (23) and second pair of nuts (5) on shifting rod to retain spring in shuttle. With shifting rod pulled outward to maximum protrusion, adjust nuts so that face of washer is flush with end of valve housing. Torque nuts tightly together. See Figure 7-21.

7.3.7 The operation of the pilot air valve will be checked after the installing of the hydraulic piston body (61) and the air shuttle assembly with its interconnecting tube assemblies (28 & 36).

This completes the assembly of the pilot air valve assembly. Do not install pilot air valve end cap (37) until after fully assembled pump has been tested.

7.4 HYDRAULIC PISTON BODY ASSEMBLY

7.4.1 Check to see if the hydraulic piston (61) (new replacement body) slides freely with the mating hole in the oil end plate (58). If not, the body may require the polishing of its smaller O.D. to achieve a proper fit. Wash in clean solvent. Check rod seal spacers (86 & 85 new replacement spacers) to see if they slide freely onto piston rod (64). If fit is too tight, polish I.D. of spacers and wash in solvent. See Figure 7-22.

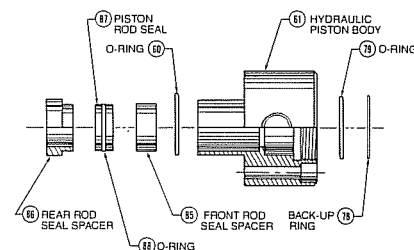


Figure 7-22, Hydraulic piston body components.

7.4.2 Use Molykote® to lubricate the front rod seal spacer (85), rear rod seal spacer (86) and piston rod seal (87) with o-ring (88). When installing these parts into the hydraulic piston body (61), be sure the front rod seal spacer (85) is inserted with chamfered edge into the piston body and the piston rod seal (87) is inserted with its two vent holes pointed into the piston body (61).

7.4.3 Lubricate o-ring (79) with petrolatum and install with back-up ring (78) inside piston body.

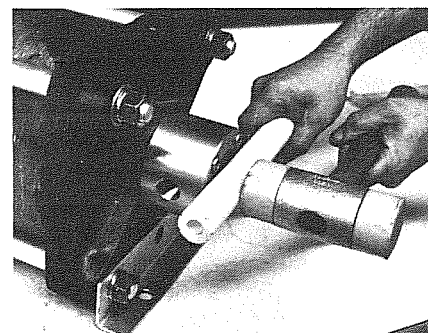


Figure 7-23, Tapping hydraulic piston body into oil end plate.

7.4.4 Lubricate smaller O.D. of piston body (61) with petrolatum and insert assembled piston body into mating hole in oil end plate. Use of mallet may be necessary to seat piston body fully into oil end plate because of the compression created by the piston rod seal (87). See Figure 7-23.

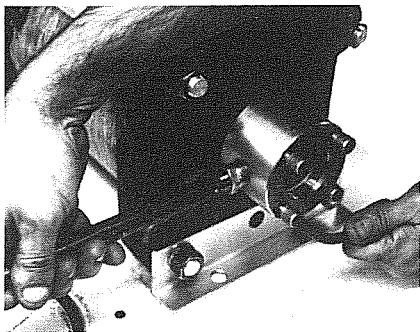


Figure 7-24, Installing bolts in hydraulic piston body. Note use of nipple in liquid outlet port to assist in aligning bolt holes.

7.4.5 Temporarily install a 1/2 NPT threaded pipe or nipple into liquid outlet port of piston body. Holding pipe, rotate piston body 360 degrees (freely without binding) with piston rod (64) extended or retracted. If binding occurs, studs (89) may be improperly torqued. Retorque evenly as required. Rotate the piston body (grasping threaded pipe) to align bolt holes to those in the oil end plate as described in next paragraph.

7.4.6 Before bolting piston body to oil end plate, be sure to check position of liquid outlet port to pump assembly. Normal position of outlet port is to the side (9 o'clock) but, if pump installation requires, the port can be positioned to 12, 3 or 6 o'clock without interfering with the pump performance. Install with socket head screws (62) and lock washers (63). Coat bolt threads with petrolatum before installing. Torque tighten evenly four bolts in sequence of opposing positions (1, 3, 2 and 4). Remove the pipe or nipple from liquid outlet port. See Figure 7-24.

This completes the installation of the hydraulic piston body assembly.

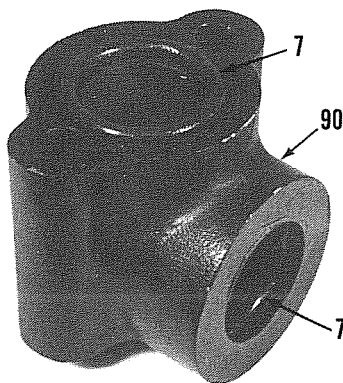
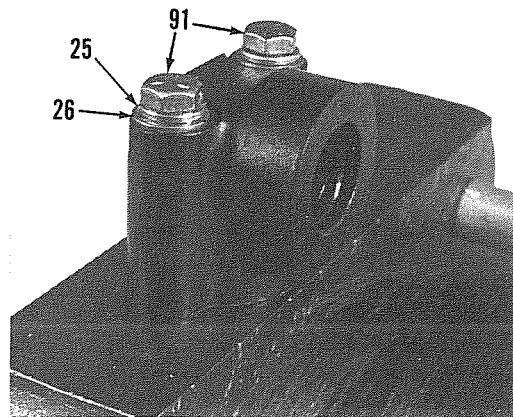


Figure 7-25, Assemblies and installing air inlet housing.



7.5 AIR SHUTTLE INSTALLATION

7.5.1 Install two petrolatum coated o-rings (7) in housing (90). Apply petrolatum to threads of two screws (91) and with two each flat washers (26) and lock washers (25), bolt housing to oil end plate (58). See Figure 7-25. Coat outside ends of air tube (92) with petrolatum and insert one end in port in housing (90). See Figure 7-26.

7.5.2 Install air shuttle assembly to air end plate and to air tube (92). Bolt with three each flat washers (26), lock washers (25), and screws (24). Before installing air shuttle assembly, be sure o-rings are installed in ports (reference paragraph 7.1.7). See Figure 7-26.

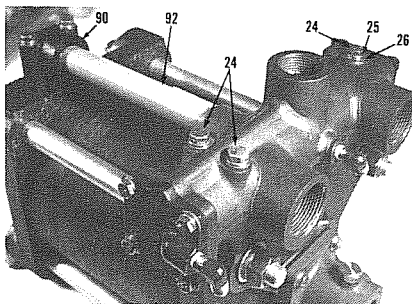


Figure 7-26, Installing air tube and air shuttle assembly.

7.5.3 Using Teflon® tape, wrap two layers on threads of four elbows (29). Install two elbows finger tight in port in air shuttle valve assembly and the remaining two elbows finger tight in the housing (45) of the pilot

air valve assembly. Install the tube assemblies (28 and 36) into the elbows. Tighten tube fittings at elbows. See Figure 7-27.

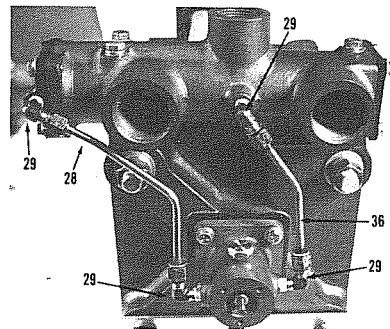


Figure 7-27, Installing elbows and tube assemblies.

7.5.4 Before installing air valve end cap (37), make a preliminary test of assembled pump for proper cycling action and adjustment. Apply air pressure to the driving air inlet port on the top of the air shuttle body. The use of a bushing reducer on this 1" NPT port may be needed to adapt the shop air supply line to the port. Apply air supply at reduced pressures and do not cycle the pump faster than 5-15 cycles/minute for one to three minutes. On initial cycling, check for any binding between the piston rod (64) and hydraulic piston body (61). Observe action of the shifting rod (53) and the movement of the air shuttle (44). If the air shuttle (44) moves only in one direction and not in the other direction,

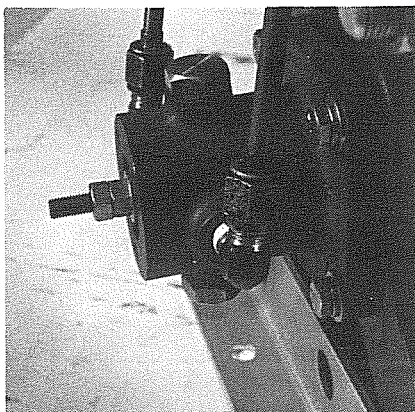


Figure 7-28, Shifting rod and adjustment nut movements.

recheck adjustments noted in paragraphs 7.3.3 through 7.3.6. See Figure 7-28.

On completion of this preliminary test, leave piston rod (64) in the outward extended position for further assembly of related components.

7.5.5 With above testing completed and adjustments verified, install end cap (37) with three each lock nuts (18) and screws (35) on air valve housing (45). See Figure 7-29.

This completes the installation of the air shuttle assembly and the preliminary testing.

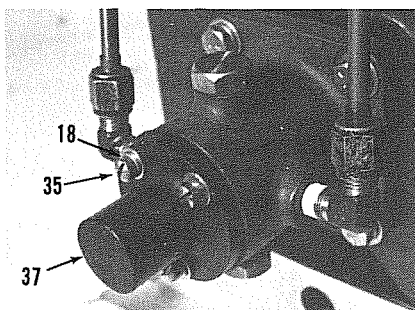


Figure 7-29, End cap installed.

7.6 OIL CYLINDER AND CHECK VALVE ASSEMBLIES

7.6.1 Assemble onto liquid piston (67), the piston seal (83), retainer ring (84) and guide (82). Lubricate contacting surfaces of assembled liquid piston with Molykote.[®] Insert liquid piston (in reverse position) in and out of oil cylinder (65) several times to lubricate cylinder's inner wall and to check for excessive binding. See Figure 7-30.

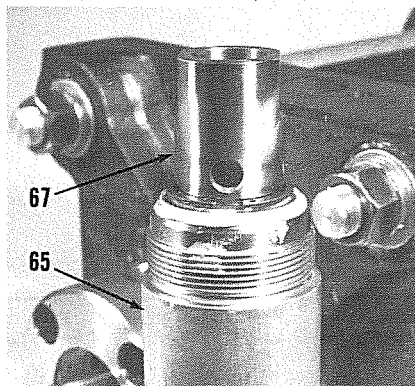
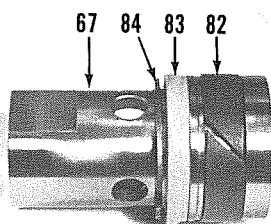


Figure 7-30, Liquid piston components (upper). Lubricating oil cylinder (lower).

7.6.2 Insert cap screw (66) into assembled liquid piston (67). Insert both into piston rod (64) and tighten with Allen wrench. After tightening, liquid piston (67) should still be able to be rotated easily with fingers. Daub Locktite[®] on threads of set screw (27) and install in piston rod (64) to lock cap screw (66). See Figures 7-31 and 7-32.

7.6.3 If original factory assembled retaining nut (71) is being replaced with a new retaining nut, insert retaining nut (71) and seated ball (70) in bench vise. Tighten vise. Apply sharp rap on vise with hammer to create an even seat between ball and end of retainer nut.

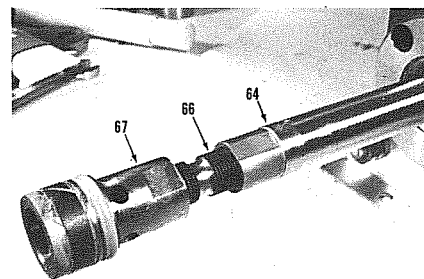


Figure 7-31, Assembling liquid piston and cap screw into oil cylinder.

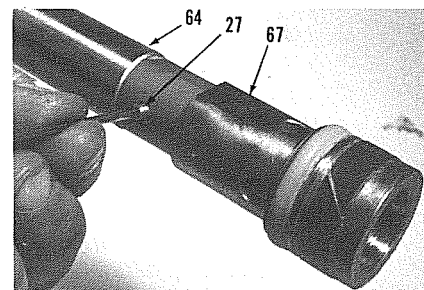


Figure 7-32, Locking liquid piston to oil cylinder with set screw.

7.6.4 Cut back-up ring (80) in one place and insert under head of retaining nut (71) and insert o-ring (81) next to back-up ring (80). Insert spacer (68) and spring (69) into internal recess of cap screw (66). Install ball (70) and torque retaining nut (71) securely into liquid piston (67). Daub set screw (27) with Locktite[®] and screw into retaining nut (71) to lock the latter to the piston rod. See Figure 7-33.

7.6.5 Apply Molykote[®] to piston seal (83), guide (82) installed on liquid piston (67). Insert oil cylinder (65) over liquid piston (67) and rod (64). Apply petrolatum to threaded end of oil cylinder then tightly screw oil cylinder into hydraulic piston body (61). See Figure 7-34.

7.6.6 Lubricate o-ring (76) with petrolatum and install on poppet (74). In the following order, install into the check valve body: poppet (o-ring end first), compression spring (77), spacer (73), retaining ring (72), o-ring (79) and back-up ring (78). See Figure 7-35.

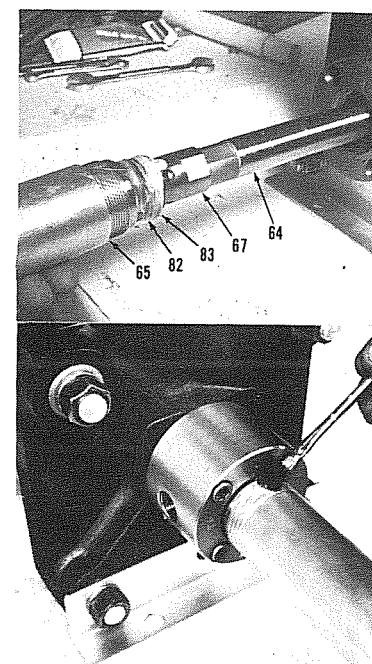
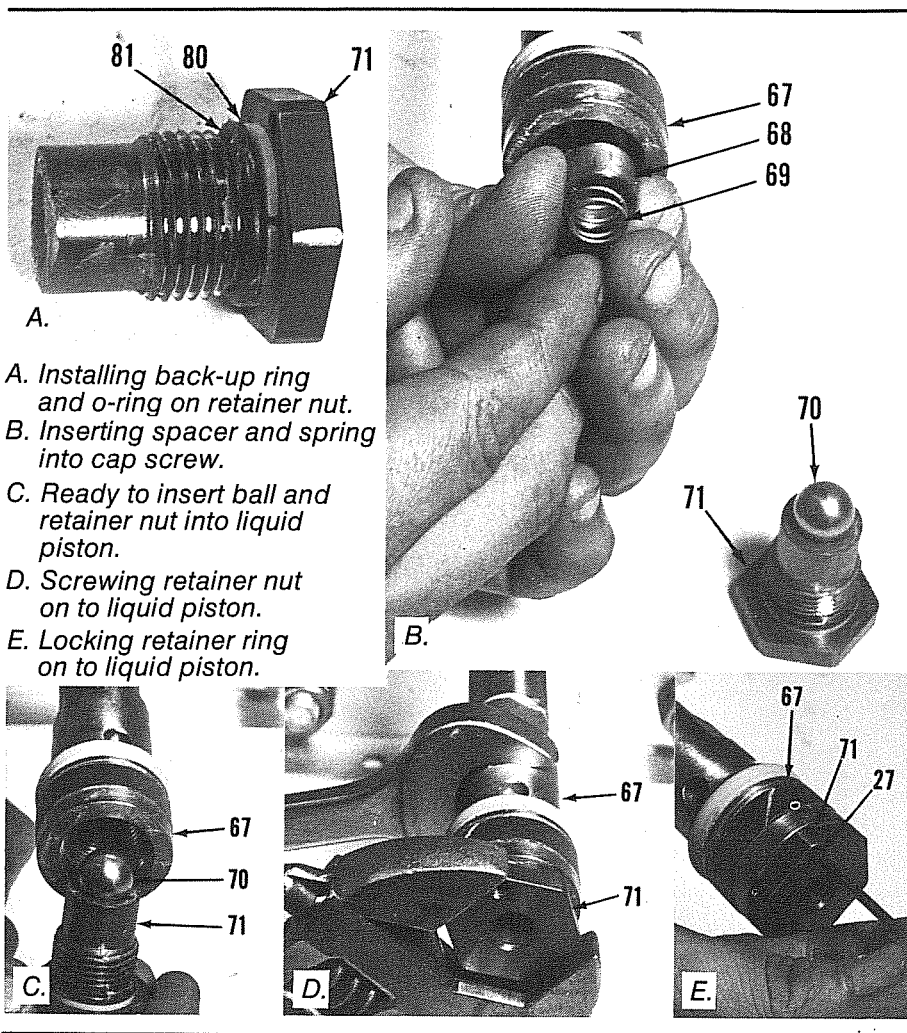


Figure 7-34, Installing oil cylinder over piston rod and into hydraulic piston body.

Figure 7-33, Installing retainer nut into liquid piston.

7.6.7 Apply petrolatum to inside threads of assembled check valve body and with wrench screw tightly onto threaded end of cylinder (65).

This completes the assembly of the air-driven hydraulic pump.

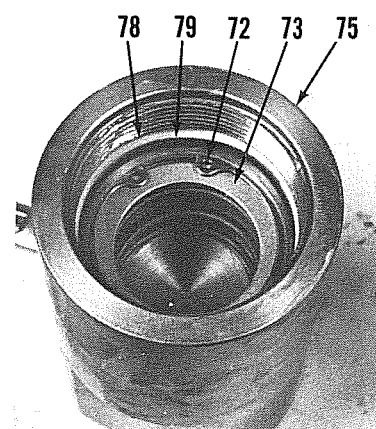
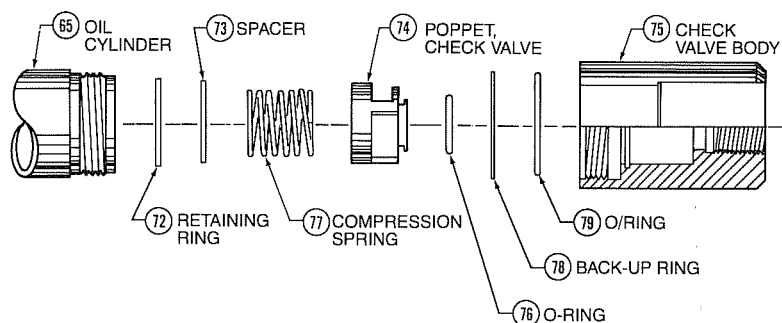


Figure 7-35, Check valve components.

8.0 TEST

1 Install pump into a typical circuit, see Figure 1-2. Operate pump in accordance with Section 2.0, Operation.

8.2 Conduct tests operating pump at different driving air pressures. Close liquid shut-off valve in pump discharge line to permit pump to build up its maximum pressure output. At

this point the pump will slow to a stop, indicating a pressure balance has been reached between liquid pressure and driving air pressure. The pump will automatically restart when pressure imbalance occurs.

8.3 Compute ratio of liquid maximum output pressure to driving air input pressure. Compare pump dash no. to pump's rated liquid output pressure, referring to Table 8-1.

Pump Model Dash Number	Driving Air Input Operating Pressure-		Liquid Output Max. Pressure-	
	PSI	BARS	PSI	BARS
—45	40	2.76	1800	124.2
(45:1 ratio)	60	4.14	2650	182.85
	80	5.52	3550	244.95
	100	6.90	4500	310.5
—65				
(65:1 Ratio)	40	2.76	2650	182.85
	60	4.14	3850	265.65
	80	5.52	5650	389.85
	100	6.90	6500	448.50

Table 8-1, Rated air input pressures to liquid output pressures.

9.0 IPB AND SUPPLEMENTAL DATA

TSE 8136 (-65) Illustrated Parts Breakdowns, (I.P.B.) provides additional data on the S-216-GJC-65 basic pump.

TSE 8138 (-45) Illustrated Parts Breakdown (IPB) provides additional data on the S-218-GJC-45 basic pump.

