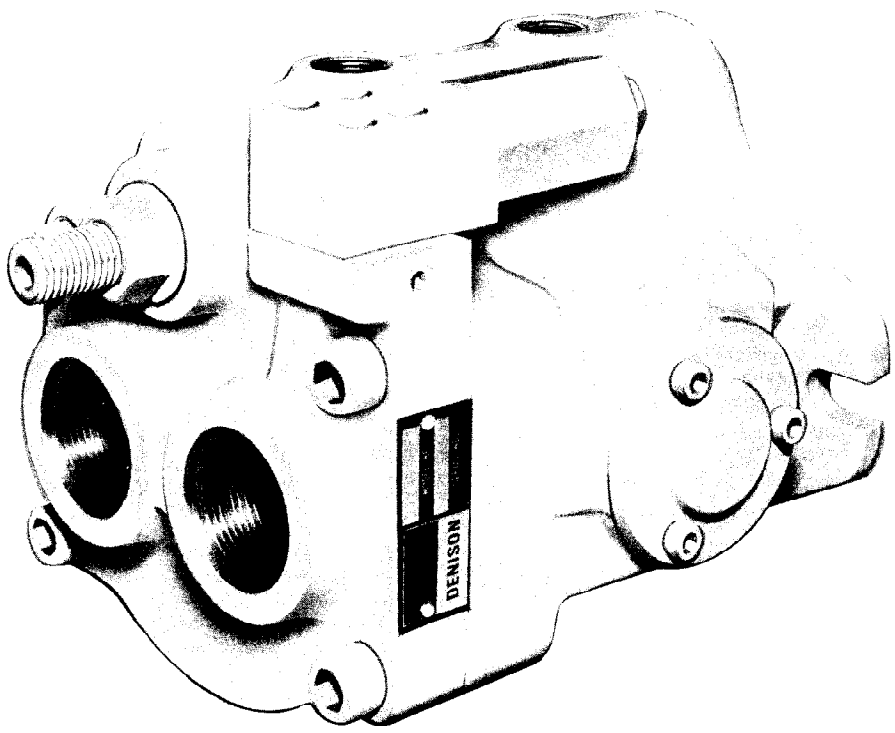
HÄGGLUNDS DENISON

Axial Piston Pumps

Variable Displacement
Open Loop

Series
PV Design B

Installation and Overhaul Instructions



CONTENTS

	PAGE
MODEL NUMBER KEY SHEET	2
TABLE I CHARACTERISTICS	2
INSTALLATION	
MOUNTING	3
PIPING	3
SERVICE INFORMATION	3
FLUIDS	3
MAINTENANCE	4
START UP PROCEDURE	4
TABLE II FLUID CONTAMINATION	4
TABLE III TROUBLESHOOTING	5
DISASSEMBLY	8
REWORK LIMITS	9
INSPECTION PROCEDURES	10
ASSEMBLY TOOL DRAWINGS	
FIGURE 1 SHAFT SEAL	15
FIGURE 2 BALL BEARING	15
FIGURE 3 PROTECTIVE CONE	15
ASSEMBLY PROCEDURES	
FIGURE 4 PORT PLATES	17
FIGURE 5 PUMP EXPLODED VIEW & "C" COMPENSATOR	18
FIGURE 6 "F&L" COMPENSATOR & "T" POWER LIMITER	19
TEST PROCEDURES	
PUMP TEST	24
"C" PRESSURE COMPENSATOR	24
"F" REMOTE PRESSURE COMPENSATOR	24
"L" LOAD SENSING	24
"T" POWER LIMITER	24
SEAL KIT (SEE PAGE 21)	

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MODEL NUMBER CODE

Use these codes to identify standard from their Model Numbers

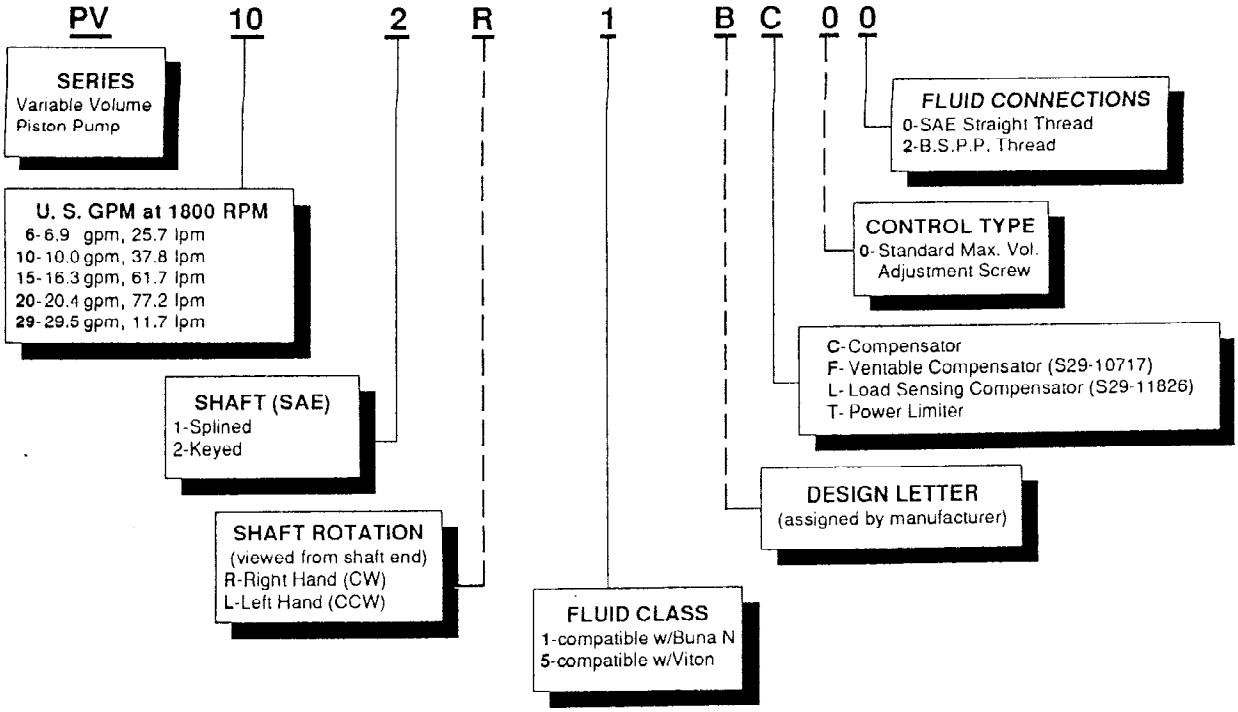


TABLE I GENERAL CHARACTERISTICS

Specification	Term	PV 6	PV 10	PV 15	PV 20	PV 29
Displacement	in^3/rev. cm^3/rev.	0.88 14.4	1.26 21.1	2.09 34.2	2.62 42.9	3.78 61.9
Flow @ 1800 RPM (theoretical)	u.s. gpm lpm	6.8 25.7	10.0 37.8	16.3 61.7	20.4 77.2	29.5 111.7
Max. Pressure—Continuous	psi bar	3500 241	3500 241	3500 241	3500 241	3000 207
—Intermittent*	psi bar	4000 276	4000 276	4000 276	4000 276	3500 241
Maximum Speed††	rpm	††For speeds over 1800 RPM, see page 27				
Compensator Range	psi bar	130-4000 9-275				130-3500 9-240
Mounting & Shaft, 2 Bolt	SAE	**A	B	B	C	C
Weight (approx.)	lb. Kg	24 11	36 16	43 20	57 26	73 33
Minimum Inlet Pressure @ 1800 RPM	in-Hg cm-Hg	-5 -12.7	-5 -12.7	-5 -12.7	-5 -12.7	-5 -12.7
Max. Case Pressure	psi bar	10 0.70	10 0.70	10 0.70	10 0.70	10 0.70
Peak Case Pressure Over Inlet Pressure	psi bar	15 1	15 1	15 1	15 1	15 1
Rotary Inertia	lb in^2 kg m^2	2.00 .0006	3.33 .00099	7.87 .00233	11.97 .00355	21.84 .00647

*10% of operation time, not exceeding 6 successive seconds.
**Splined shaft is SAE

Mounting

This pump is designed to operate in any position. The mounting hub and two bolt mounting flange conform with SAE standard as shown in Table 1. The pump shaft must be in alignment with the shaft of the Prime Mover and should be checked with a dial indicator. The mounting pad or adaptor into which the pump pilots must be concentric with the pump shaft to prevent bearing failure. This concentricity is particularly important if the shaft is rigidly connected to the Prime Mover without a flexible coupling or a coupling that allows only for minor misalignment. In that case the diametric concentricity and squareness of the mounting faces must be within 0.06 mm or .002 inch T.I.R. when the pump is foot mounted and 0.03 mm or .001 inch T.I.R. when flange mounted. The PV series is designed for "inline drive" and side load on the shaft is not recommended. If unavoidable consult your nearest Hägglunds Denison representative.

Shaft Information

Splined: The coupling interface must be lubricated. Hägglunds-Denison recommends lithium molydisulfate or similar grease. The female coupling should be hardened to 27-45 Rc and must conform to SAE-J498B (1971) Class 1 flat root side fit.

Keyed: High strength heat treated keys must be used. Replacement keys must be hardened to 27-34 Rc. The key corners must be chamfered .030"-.040" (.75-1 mm) at 45° to clear radii that exist in the keyway.

Piping

Connect inlet and outlet lines to the port block of the pump. The fluid connections are:

SAE straight thread, O-ring seal or B.S.P.P.
PV6: SAE-12 or 3/4" B.S.P.P.
PV10, 15, 20 & 29: SAE-20 or 1-1/4" B.S.P.P.

The maximum case pressure is 10 PSI (0.70 bar). Case pressures must never exceed inlet pressure by more than 15 PSI (1 bar). When connecting case drain line make certain that drain plumbing passes above highest point of the pump before passing to the reservoir. If not, install a 5 PSI (.3 bar) case pressure check valve to be certain the case is filled with oil at all times.

The case leakage line must be of sufficient size to prevent back pressure in excess of 10 PSI (0.70 bar) and returned to the reservoir below the surface of the oil as far from the supply suction as possible. All fluid lines, whether pipe, tubing, or hose must be adequate size and strength to assure free flow through the pump. An undersize inlet line will prevent the pump from reaching full speed and torque. An undersized outlet line will create back pressure and cause improper operation. Flexible hose lines are recommended. If rigid piping is used, the workmanship must be accurate to eliminate strain on the pump port block or to the fluid connections Sharp bends in the lines must be eliminated wherever possible. All system piping must be cleaned with solvent or equivalent before installing pump. Make sure the entire hydraulic system is free of dirt, lint, scale, or other foreign material.

Caution: Do not use glavanized pipe. Galvanized coating can flake off with continued use.

System Relief Valves

Although the PV series pumps have very fast off-stroke compensator response system relief valves are recommended in all cases for safety considerations.

Service Information

These hydraulic products are designed to give long dependable service when properly applied and their systems properly maintained. These general instructions apply to typical systems. Specific instructions for particular equipment can be developed from them.

Recommended Fluids

The fluid recommended for use in these pumps has a petroleum base and contains agents which provide oxidation inhibition and anti-rust, anti-foam and de-aerating properties as described in Hägglunds Denison standard HF-1. Where anti-wear additive fluids are specified, see Hägglunds Denison standard HF-O.

Viscosity:

Max. at cold start—7500 SUS (1600 Cst)
(at low pressure, low flow, and, if possible, low speed)
Max. at full power—750 SUS (160 Cst)
Optimum for max. life—140 SUS (30 Cst)
Minimum at full power—60 SUS (10 Cst)

Viscosity Index:

90 V.I. minimum. Higher valves extend the range of operating temperature but may reduce the service life of the fluid.

Temperature

Determined by the viscosity characteristics of the fluid used. Because high temperatures degrade seals, reduce the service life of the fluid and create hazards, fluid temperatures should not exceed 180°F (82°C) at the case drain.

Alternate Fluids

Some applications require fire-resistant fluids. They will give good service if the system is originally designed for their use. Permissible fire resistant fluids include:

Type	Hägglunds Denison Standard
Water-in-oil invert emulsions	HF-3
Water glycol solutions	HF-4
Phosphate esters	HF-5

Consult Hägglunds Denison for design requirements and warranty limitations for service with this class of fluids.

See Hägglunds Denison bulletin 2002 for more information.

Maintenance

This pump is self-lubricating and preventative maintenance is limited to keeping system fluid clean by changing filters frequently. Keep all fittings and screws tight. Do not operate at pressures and speeds in excess of the recommended limit. If the pump does not operate properly, check the Trouble Shooting Chart before attempting to overhaul the unit. Overhauling is relatively simple and may be accomplished by referring to the Disassembly, Rework Limits of Wear Parts and Assembly Procedures.

Note: It is especially important that the suction or inlet piping and fittings be tight and in good repair to prevent air from being drawn into the system.

Fluid Cleanliness

Fluid must be cleaned before and continuously during operation by filters that maintain a cleanliness level of NAS 1638 Class 8. This approximately corresponds to ISO 17/14. This fluid level cleanliness can usually be accomplished by the effective use of 10 micron filters. Better cleanliness levels will significantly extend the life of the components. As contaminant generation may vary with each application, each must be analyzed to determine proper filtration to maintain the required cleanliness level.

Start Up Procedure for New Installation

1. Read and understand the instruction manual. Identify components and their function.

2. Visually inspect components and lines for possible damage.

3. Check reservoir for cleanliness and drain and clean as required.

4. Check fluid level and fill as required with filtered fluid at least as clean as that recommended. Fill pump case with clean oil prior to starting.

5. Check alignment of drive.

6. Check oil cooler and activate it, if included in circuit. Check fluid temperature.

7. Reduce pressure settings of relief valve. Make sure accurate pressure readings can be made at appropriate places.

8. If solenoids in system, check for actuation.

9. Start pump drive. Make sure pump and motor fill properly.

10. Bleed system of air. Recheck fluid level.

11. Cycle unloaded machine at low pressure and observe actuation (at low speed, if possible).

12. Increase pressure settings gradually in steps. Check for leaks in all lines especially in pump and motor inlet lines.

13. Make correct pressure adjustments.

14. Gradually increase speed. Be alert for trouble as indicated by changes in sounds, system shocks and air in fluid.

15. Equipment is operational.

TABLE II

COMPARISON OF SOLID CONTAMINATION CLASSIFICATION SYSTEMS

NATIONAL AEROSPACE STANDARD (NAS) 1638

		CLASS													
		00	0	1	2	3	4	5	6	7	8	9	10	11	12
PARTICLE SIZE RANGE	5-15 µm	125	250	500	1,000	2,000	4,000	8,000	16,000	32,000	64,000	128,000	256,000	512,000	1,024,000
	15-25 µm	22	44	89	178	356	712	1,425	2,850	5,700	11,400	22,800	45,600	91,200	182,400
	25-50 µm	4	3	16	32	63	126	253	506	1,012	2,025	4,050	8,100	16,200	32,400
	50-100 µm	1	2	3	6	11	22	45	90	180	360	720	1,440	2,880	5,760
	>150µm	0	0	1	1	2	4	8	16	32	64	128	256	512	1,024
MAXIMUM PARTICLES	>5 µm	152	304	609	1,217	2,432	4,864	9,731	19,462	38,924	77,849	155,698	311,396	622,792	1,245,584
	>15 µm	27	54	109	217	432	864	1,731	3,462	6,924	13,849	27,698	55,396	110,792	221,584

ISO:DIS 4406; SAE J1165

		ISO SOLID CONTAMINANT CODE													
		8/5	9/6	10/7	11/8	12/9	13/10	14/11	15/12	16/13	17/14	18/15	19/16	20/17	21/18	22/19
MAXIMUM PARTICLES	>5 µm	250	500	1,000	2,000	4,000	8,000	16,000	32,000	64,000	130,000	250,000	500,000	1,000,000	2,000,000	4,000,000
	>15 µm	32	64	130	250	500	1,000	2,000	4,000	8,000	16,000	32,000	64,000	130,000	250,000	500,000

NOTES: ALL MEASUREMENTS ARE FOR A 100 ML SAMPLE SIZE.

Trouble Shooting

Component problems and circuit problems are often interrelated. An improper circuit may operate with apparent success but will cause failure of a particular component with it. The component failure is the effect, not the cause of the problem.
This general guide is offered to help in locating and eliminating the cause of problems by studying their effects.

Effect of Trouble	Possible Cause	Fault Which Needs Remedy
Noisy Pump	Air in Fluid	Leak in suction line Leak at shaft seal Low fluid level Turbulent fluid Return lines above fluid level Gas leak from accumulator Excessive pressure drop in the inlet line from a pressurized reservoir Suction line strainer acting as air trap
	Cavitation in pump or motor rotating group	Fluid too cold Fluid too viscous Fluid too heavy Shaft speed too high Suction line too small Suction line collapsed Suction strainer too small Suction strainer too dirty Operating altitude too high
	Misaligned shaft	Faulty installation Distortion in mounting Axial interference Faulty coupling Excessive overhung loads
	Mechanical fault in pump	Piston and shoe looseness or failure Bearing failure Incorrect port plate selection or index Eroded or worn parts in the displacement control
Erosion on barrel ports and port plate	Air in fluid	See above
	Cavitation	See above
High wear in pump	Excessive loads	Reduce pressure settings Reduce speeds
	Contaminant particles in fluid	Improper filter maintenance Filters too coarse Introduction of dirty fluid to system Reservoir openings Reservoir breather Improper line replacement
	Improper fluid	Fluid too thin or thick for operating temperature range Breakdown of fluid with time/temperature/shearing effects Incorrect additives in new fluid Destruction of additive effectiveness with chemical aging
	Improper repair	Incorrect parts Incorrect procedure, dimensions, finishes

(Continued)

Effect of Trouble	Possible Cause	Fault Which Needs Remedy
High Wear in pump and motor	Unwanted water in fluid	Condensation Faulty breather/strainer Heat exchanger leakage Faulty clean-up, practice Water in makeup fluid
Pressure shocks	Clogging load Worn relief valve	Mechanical considerations Needed repairs
	Worn compensator Slow response in check valves	Needed repairs Replace or relocate
	Small line capacitance (line volume, line stretch, accumulator effects)	Increase line size or lengths Bleed air
	Barrel blow-off	Recheck pump hold-down, rotating group, drain pressure
Heating of fluid	Excessive pump leakage	Recheck case drain flow and repair as required Fluid too thin Improper assembly, port timing
	Relief valve	Set too low (compared to load or to compensator) Instability caused by back pressure, worn parts
	Compensator	Set too high (compared to relief) Worn parts
	Pump too large for fluid needs	Select smaller pump displacement
	Heat exchanger	Water turned off or too little flow Water too hot Fan clogged or restricted Efficiency reduced by mud or scale deposits Intermittent hydraulic fluid flow
	Reservoir	Too little fluid Entrained air in fluid Improper baffles Insulating air blanket that prevents heat rejection Heat pickup from adjacent equipment

(Continued)

Effect of Trouble	Possible Cause	Fault Which Needs Remedy
Decrease in set pressure	Loose compensator adjusting screw Defective function or relief valves Lowering of tank oil level Deterioration in pump function	Tighten the adjusting screw (28-11) Overhaul or exchange Replenish fluid *Check drain (below 5% of discharge at rated pressure) Check internally and exchange defective or worn out parts
Pressure does not rise	Improper direction of rotation Lowering of tank oil level Wrong setting of relief valve or compensator Fault in relief valve or compensator Clogging of suction line Deterioration in pump function	Change the rotating direction Replenish fluid Readjust and lock Overhaul or exchange Check and clean suction strainers Open gate valve See*
Insufficient flow	Lowering of tank oil level Wrong sealing of suction line Improper adjustment of pump stroke control Deterioration in pump function Worn compensator valve	Replenish fluid Tighten fittings and exchange Release adjusting screw No. 22 and lock nut No. 45 See * Change compensator valve
Compensator hunting Type "C"	Check valve missing from pump discharge port	Install 30-50 PSI (2-3 bar) check valve within 12 inches (.3 meters) of pump discharge port

Disassembly Procedure

Disassemble the pump according to the instructions in this section. Please refer to the exploded view (Fig. 5).

Pump disassembly for inspection should be limited to the following cases:

a) Malfunction or oil leakage resulting from damage or wear and tear.
b) Trouble-shooting procedures described herein do not solve the problem.

Disassembly should be done only as far as necessary to replace or repair worn parts.

It should be noted that assembly and disassembly should be performed in a clean environment.

Caution: Springs assembled in the pump are normally set under high compression and are dangerous to any workman whenever disassembly is performed. Serious bodily injury may be inflicted during disassembly due to the springs' sudden release.

It is usually not necessary to replace a spring (18) fitted in cylinder barrel (3). Do not replace the spring unless absolutely necessary.

After disassembly, the internal parts should be coated with a film of clean oil and protected from dirt and moisture.

It is recommended that the length of the protruding part of the adjusting screws (22), (28, 64 or 68-11) and (64 or 68-18) be measured and noted as this information will prove useful during assembly.

Care must be taken to avoid dropping, damaging or contaminating the machined parts and the PC valve.

1. Drain housing (1) fluid.

2. Position the pump with the drain port up.

3. Loosen nut (45) and remove the adjusting screw (22) and thread seal (54).

4. Remove four screws (28, 64 or 68-13) and then remove valve assembly (28, 64 or 68) with O-ring (28, 64 or 68-10).

5. Remove four screws (46). First loosen two of the diagonally positioned screws. Then loosen the other two diagonally positioned screws. Remove the screws and carefully raise port block (2). If gasket (24) clings to block, tap the side of block opposite PC valve with a hammer.

Note: Port plate (4) may cling to the block (2) due to oil film. DO NOT ALLOW THE PLATE TO FALL AND BE DAMAGED.

6. Remove port plate (4) gently from barrel face.

7. Place pump onto work bench with the shaft in a horizontal position. Remove barrel (3) with piston assembly (5), guide ball (14), guide plate (15) and dowel (56) simultaneously.

8. Place barrel (3) on a clean cloth or plastic film. Before removing pistons, check for excess play. Then hold the side of guide plate (15) and gently remove the piston assembly (5).

9. It is recommended that the guide plate (15) be marked when removing the first piston and that the pistons be placed in order of removal due to the individual piston's fit between the rim of the shoe (7) and guide plate (15)

10. Remove guide ball (14) and dowel (56).

Note: With the given procedures (1) through (10), necessary inspection of the pump can be performed. Prior to inspection, the disassembled parts are to be handled as follows:

a) Place housing (1) on the fixture with the shaft downward. Cover the housing with a dust-proof plastic film.

b) Place port block (2) on the work bench with the assembled guide sleeve (23) and needle bearing (36). Guide sleeve must be placed upward. Cover the block with a dust-proof plastic film.

c) Place PC valve (28) with the machined face that attaches to port block (2) upward. Cover the PC valve with dust-proof plastic film.

Proceed to INSPECTION. Given on Page 10.

Note: Further disassembly may be required if any of the following is recognized.

a) When cylinder barrel (3) is placed flat, the dowels (56) must protrude slightly. If otherwise or if the dowel is easily pushed in, perform the following steps (11) through (13).

b) If the hanger (9) has little or no inclination against the shaft (8) or if it can easily be moved by hand, perform the following steps (14) through (16).

c) If oil seal leakage or excessive ball-bearing play is apparent, perform steps (17) through (21).

d) If PC valve functions irregularly, perform the following steps (22) through (26).

11. Place cylinder barrel (3) on the fixture with the face upward. Compress spring (18) with a simple hand press and remove retaining ring (40) with pliers.

Set load and spring back heights as follows.

Item	Model	PV-6	PV-10	PV-15	PV-20	PV-29
Spring Load	lbs.	55	68	99	111	133
	N	244	304	440	495	591
Spring Back Height	in	0.66	0.61	0.62	0.67	0.71
	mm	16.8	15.6	15.7	16.9	18.0

12. Remove washer (27) and spring (18).

13. Remove cylinder barrel from fixture.

Proceed to INSPECTION.

14. Place housing (1) on the fixture and remove screws (49) which secure the trunnion shaft (10).

15. Attach push rod to hand press and push down tongue-shaped part of hanger (9). Remove trunnion shaft (10).

16. With the hand press, remove the hanger (9), spring seat (20) and spring (19) in this order.

Proceed to INSPECTION.

17. Remove key (12). Tap gently at the end of the key with a hammer or chisel if it is difficult to remove.

18. Remove retaining ring (41).

19. Remove shaft (8) (Pull shaft toward port block (2). Light hammering may be applied if removal is difficult.

20. If ball-bearing play is excessive or abnormal noise is heard when the outer ring is rotated by hand, replacement with new parts is necessary. Remove retaining ring (42) and remove the ball bearing (35) with a hand press or by light hammering toward the spline.

21. If oil leaks are observed, the oil seal must be replaced. Remove oil seal (38) from the housing (1). Use a push rod which is of a smaller diameter than the outside diameter of the oil seal.

Caution: Removed seals should not be re-used.

Item	Model	PV-6	PV-10	PV-15	PV-20	PV-29
Outside Diameter of oil seal	in	1.77	1.77	1.97	2.16	2.16
	mm	45	45	50	55	55

Proceed to INSPECTION.

22. Loosen hex. nut (28-12) and remove adjusting screw (28-11) from cap (28-3).

23. Remove cap (28-3).

24. Remove spring (28-6) and spring seat (28-5).

25. Remove spool (28-2).

26. Repeat steps 22, 23, 24 and (25) for 'F, L and T' valves using item (64-*) or (68-*).

27. Loosen hex. nut (64-22 or 68-12) and remove adjusting screw (64 or 68-18) from body (64 or 68-1).

28. Remove spring (64 or 68-7) and cone (64 or 68-16).

Proceed to INSPECTION.

Note: If cone is badly worn or damaged, perform the following steps.

29. Remove plug (64-20). Using a rod, tap seat out from the opposite end ('F & L' Compensator).

30. Fitting (68-27) along with the adjusting screw (68-18) can be removed from body as an assembly.

31. Remove pin (68-24) and ball (68-17).

32. Remove fitting (68-29). Using a rod, tap seat out from the opposite end.

Rework Limits of Wear Parts

1. Barrel bores—measure each bore at 4 places, including one deep within the bore where the piston normally doesn't run. If the difference in measurements exceeds .0004" or .010 mm the barrel should be replaced.

2. Barrel face—may be lapped slightly, not more than .0002" or .005mm.

3. Pistons—measure each piston at 4 places, including one at the shoe end where the piston doesn't enter the barrel. If the difference in measurements exceeds .0004" or .010mm the piston is worn out.

4. Shoes—end play on piston balls not to exceed .003" or .080 mm.

5. Shoe face—may be lapped .004" or .102 mm. They must be lapped as a set of nine with the guide plate (15) in place.

6. Port plate—may be lapped .006" or .153 mm, maintain flatness to 5 microns.

7. Wear plate (16)—may be lapped .004" or .102 mm max.

8. Guide plate (15)—do not lap. If thickness measured at several points varied more than .004" or .102 mm, replace the plate.

No.	Part	Inspection Procedure	Corrective Action
1	Housing	Check for cracks around tapped holes. Check for cracks around retainer ring groove. Perform dye color check over entire housing when oil leakage is observed.	Replace if cracked. Replace if cracked. Replace if cracked.
2	Port Block	Defect can be observed. Excessive wear of guide sleeve (23), (when axial scratch can be detected by fingernail or diameter difference is over 0.025 mm or 0.001 in. on several random points. When there is excessive play with the drive shaft (8) inserted into the needle bearing (36). (Maximum radial play is 0.076 mm or 0.003 in.)	Replace. Replace
3	Cylinder Barrel	Visual inspection of face, Uniform, minute concentric nicks. Deep, localized nicks. Seizure, scoring or discoloring. Visual inspection of bore's inner condition, Localized polish at edge. Minute, longtitudinal nicks. Localized longtitudinal nicks. Localized seizure, scoring or discoloring. Bore Wear Wash inside of bore and piston surface with solvent. Insert piston completely in bore, cover the sausage shaped hole in the barrel and the center hole of shoe and withdraw the piston Insert piston halfway into bore and check for excessive play in the radial direction.	Can be lap-repaired up to 5 µm or .005 mm. Replace part (flush reservoir and circuit). Replace part (check hydraulic fluid type, oil temperature rise, excessive pressure and correct as required). Can be re-used as is. Can be re-used as is. Replace part (flush reservoir and circuit). Replace part (check hydraulic fluid type, oil temperature rise, excessive pressure and correct as required. Also replace mating piston assy). If there is resistance when withdrawing, the bore is alright. Measure piston diameter at several random points, if the difference is over .015 mm (.0006 in.) replace both piston assembly (5) and barrel (3). When piston is within above dimension, replace the barrel only.
4	Port Plate	Visual check of surface Uniform minute concentric pattern. Deep indention on plate. Heat colored at places other than surfaces next to port. Cavitation erosion between ports.	Repair by lapping. Grind until indention is removed and lap. Use as is. Lap if excessively discolored. Grind and lap until erosion is removed. Can be used until fine groove links up between port edge and small hole.

No.	Part	Inspection Procedure	Corrective Action
5	Piston Assembly	Shoe play, Excessive play apparent when pressed down with the fingers and drawn out if clatter of movement can be heard; also if movement can be visibly detected.	Replace part. Check suction pressure (when below -5in. Hg, improve suction pressure), clean strainer.
		Visual check of shoe face. Minute, slight trace or localized polished portion.	Repair by lapping (difference in flange thickness between the 9 shoes should not be more than .03 mm or 0.0012 in.). This also applies to the following repairs.
		Random radial marks are clearly visible.	Repair by lapping. (Flush reservoir and circuit.) Check suction pressure and if less than -5 in. Hg, improve suction pressure.
		Burrs on shoe flange.	If slight, repair by lapping. If severe, replace part.
		Visual check of piston outer diameter, Measure several points with a micrometer.	Replace if dimensional difference is more than .015 mm or 0.0006 in.
		Visual check of piston's outer surface, Slight discoloration or cross hatch trace.	Can be used as is. (Recommend polishing with emery paper).
		Localized scratch marks apparent in longtitudinal direction.	Can be used as is if removed with emery paper. If the marks cannot be removed, replace. (Flush reservoir and circuit).
		Seizure, scoring or discoloring.	Replace both piston assy. (5) and cylinder barrel (3). Check hydraulic fluid type, temperature rise, excessive pressure and correct as required.
8	Drive Shaft	Visual check of shaft end's outer surface, Burnt brown spots over entire surface. Uneven wear on key side surface.	Remove with emery paper. Check fitting to coupling hub. If loose, remake to force fit.
		Pitting or corrosion over entire surface or partial surface.	Replace part. Check fitting to coupling hub. If loose, remake to force fit. Check alignment between prime mover and pump and correct as required.
		Visual check of oil seal surface, Lip contact marks, Bright polish.	Can be used as is.
		Contact marks width over 1mm or 0.04 in. and can be detected with fingernail.	Replace part. (Check oil seal lip for wear and hardening and replace oil seal if worn or hard).

No.	Part	Inspection Procedure	Corrective Action
8	Drive Shaft (con't.)	Visual check of key groove bottom end, (if in doubt, check for cracks with dye-color).	If cracked, replace drive shaft (8). Check alignment with prime mover and correct as required.
		Needle bearing (36) rolling contact surface, Apparent wear on contact surface.	If dimensional difference with non-contact surface is more than .020 mm or 0.0008 in., replace part.
9	Hanger	Visual check of trunnion bearing (10), When contact surface is not excessively worn.	Can be used as is.
		When contact surface shows apparent wear, uneven contact and localized nicks.	When inside diameter difference is directionally more than .020 mm or 0.0008 in., replace part.
		Visual check of contact surface with plunger (21), Wear Marks: Up to width 5 mm or 0.2 in.	Can be used as is.
		Over width 5 mm or 0.2 in.	Replace part. (When used without replacement, adjust such that maximum volume is below catalog value using adjustment screw (22).
10	Trunnion Shaft	Visual check of contact surface to hanger (9), very slight wear.	Re-use after polishing with emery cloth.
		Localized seizure, scoring or discoloring.	Replace part. Also replace hanger (9). Check hydraulic fluid type, temperature rise, excessive pressure and correct as required.
12	Key	Wear on side surface, Discoloration.	Re-use after removing discoloration with emery paper.
		Stepped wear.	Measure and if worn over .051 mm or 0.002 in., replace part. When coupling hub and shaft fit is loose, remake to force fit. Re-check alignment with prime mover and check for excessive pressure and side load and correct as necessary.
15	Guide Plate	Contact condition with flange surface of shoe (7), Contact surface is brightly polished.	Re-use as is.

No.	Part	Inspection Procedure	Corrective Action
15	Guide Plate (con't)	Contact surface is apparently indented and shoe flange is brightly polished or slightly deformed.	Replace part. Piston assy. (5) can be used unless excessively defective and if shoe outer flange edge is not burred. Check hydraulic fluid type, temperature rise, suction pressure and correct as required.
16	Wear Plate	Check face condition, Polish over entire surface or partial bright polish. Scratches or wear over entire surface or over partial surface. Copper alloy adhesion over entire surface or on high pressure side only.	 Re-use as is. Repair by lapping and re-use. Flush reservoir and circuit. Repair by lapping and re-use. Check hydraulic fluid type, temperature rise, excessive pressure and correct as required.
18	Spring	Measure free heights, PV-6 35 mm or 1.38 in. PV-10 40 mm or 1.57 in. PV-15 45.5 mm or 1.79 in. PV-20 50 mm or 1.97 in. PV-29 52 mm or 2.05 in.	 Replace when height is decreased more than 5% from the given heights.
19	Spring	Measure free heights, PV-6 62 mm or 2.44 in. PV-10 66 mm or 2.60 in. PV-15 76 mm or 2.99 in. PV-20 76 mm or 2.99 in. PV-29 81 mm or 3.19 in.	 Replace when height is decreased more than 3% from the given heights.
21	Plunger	Check contact condition of spherical surface, Wear up to width 5 mm or 0.2 in. Wear over width 5 mm or 0.2 in.	 Re-use as is. Replace. If re-use is necessary, rotate contacting surface location 180 degrees. When wear occurs over a short period of time, check temperature rise, excessive pressure and correct as required.
23	Guide Sleeve	Check contact condition of outer surface, Slight and uneven contact on one side and partially polished. Clear localized contact with strong, bright polish.	 Re-use as is. Take micrometer reading at several points and if difference more than .020 mm or 0.0008 in., replace with block (2). Check hydraulic fluid type, temperature rise, excessive pressure and correct as required.

No.	Part	Inspection Procedure	Corrective Action
23	Guide Sleeve (con't)	Seizure, scoring or discoloring.	Replace with port block (2). Check hydraulic fluid type, oil temperature, excessive pressure and correct as required.
28 64 68	'C' Compensator 'F,L' Compensator 'T' Power Limiter	O-Ring (*-8, *-9, *-10) Cross sectional condition. Surface condition. Spring (*-6), Measure free height. Visual check of spool (68-2), Localized contact or discoloration. Wear condition of control edge of land.	Replace if diameter difference is over 15%. Replace when cracked, torn or hardened. Replace when less than 45.7 mm or 1.8 in. Replace when dimensional difference is more than .010 mm or .0004 in. Replace PC valve if rounded off either in localized areas or over the entire circumference. Spool (*-2) is not interchangeable with valve body (*-1).
64 68	'F,L' Compensator 'T' Power Limiter	Visual check of cone (*-16). Wear condition of cone and seat contact area. Visual check of spring (*-7).	Replace if worn or pitted in this area. Replace if distorted.
35	Ball Bearing	Check wear condition, Radial play of outer race. Rotation noise, Wash with cleaning fluid and dry with air Rotate outer ring manually. Visual check of rolling surface. Discoloration or pitting signs on ball surface or race track.	Replace if excessive play is detected. Replace if irregular noise audible. Replace when clear discoloration or pittings can be detected visually.
36	Needle Bearing	Check wear condition.	Refer to Par. 2
24	Gasket	Check wear condtion.	Replace
25	Gasket	Check wear condition.	Replace
38	Oil Seal	Check wear condition.	Replace
54	Thread Seal	Check wear condition.	Replace as a rule.†
56	O-Ring	Check wear condition.	Replace as a rule.† †Thread seal (54) and O-Ring (55) can be used unless oil leak, deformation, hardening or hair cracks are apparent.

Figure 1. Shaft Seal Installation Tool

Series	A*	B	C†	D&E	F
PV-6 (in)	1.75	2.17	.185	As Needed	.79
(mm)	(44.5)	(55.1)	(4.7)		(20.06)
PV-10 (in)	1.75	2.17	.197		.79
(mm)	(44.5)	(55.1)	(5.0)		(20.06)
PV-15 (in)	1.95	2.36	.197		.79
(mm)	(49.5)	(59.9)	(5.0)		(20.06)
PV-20 (in)	2.15	2.56	.204		.79
PV-29 (mm)	(54.6)	(65.0)	(5.2)		(20.06)

Material — Steel

*±.008"(±.204 mm) †$\frac{+.0"}{-.008"}$ $\left(\frac{+.0\ mm}{-.204\ mm}\right)$

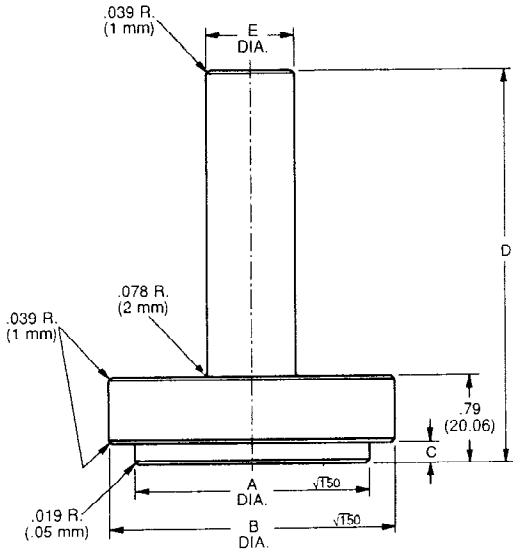


Figure 2. Ball Bearing Installation Tool

Series	A	B*	C	D
PV- (in)	2.36	2.08	1.02	4.33
(mm)	(59.9)	(52.8)	(25.9)	(110)
PV-10 (in)	2.76	2.44	1.02	4.52
(mm)	(70.1)	(62)	(25.9)	(114.8)
PV-15 (in)	3.15	2.83	1.22	5.19
(mm)	(80.0)	(71.9)	(31)	(131.8)
PV-20 (in)	3.54	3.15	1.42	6.30
PV-29 (mm)	(89.9)	(80.0)	(36)	(160)

Material — Steel

*$\frac{+.012"}{-.004"}$ $\left(\frac{+.306\ mm}{-.102\ mm}\right)$

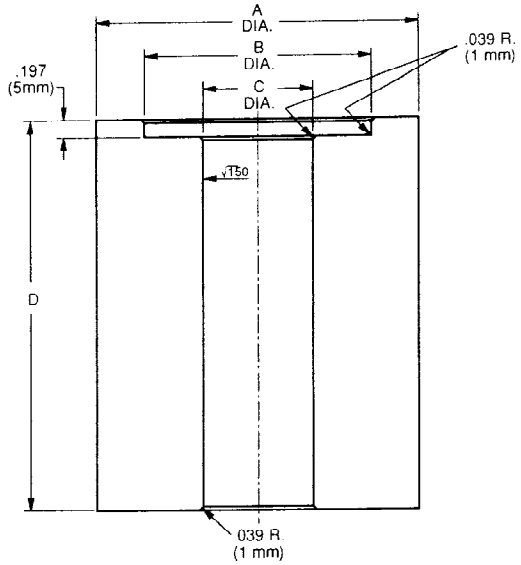
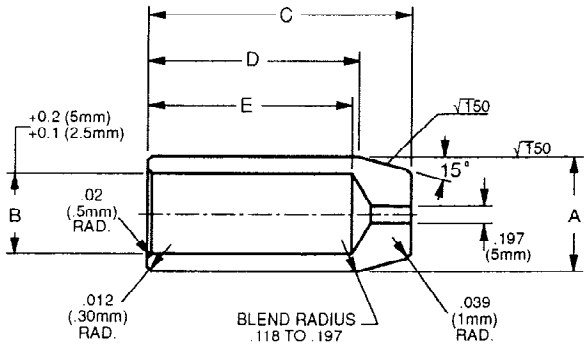


Figure 3. Protective Cone

Series	A*	B†	C	D	E
PV-6 (in)	1.00	0.750	2.24	1.65	1.57
(mm)	(25.4)	(19.1)	(56.9)	(41.9)	(39.9)
PV-10 (in)	1.00	0.875	2.68	2.08	2.00
(mm)	(25.4)	(22.2)	(68)	(52.8)	(50.8)
PV-15 (in)	1.20	0.875	2.68	2.08	2.00
(mm)	(30.5)	(22.2)	(68)	(52.8)	(50.8)
PV-20 (in)	1.40	1.250	2.68	2.08	2.00
PV-29 (mm)	(35.6)	(31.8)	(68)	(52.8)	(50.8)

Material — Teflon (preferred) or steel heat treated to Rc 40 to 45. Chromium plated.

*±.004"(± .102 mm) † $\frac{+.008"}{-.004"}$ $\left(\frac{+.204\ mm}{-.102\ mm}\right)$



The assembly operation must be performed more carefully than the disassembly operation and should be performed in a clean environment using parts that have been adequately cleaned.

1. Check the disassembled parts with the exploded view given in Fig. 5 for any missing parts or irregularities. Use emery paper #600 to #800 to remove any slight corrosion.

2. Check deformation of retaining ring. If deformed, replace.

3. Place the housing in the press with the mounting flange facing upwards.

4. Apply grease between the lips of the oil seal. Grease should not protrude above the tip of the lip and should fill approximately 80% of the space.

5. Use push rod and slowly press the oil seal into the housing (1) until seated. Use tool (Fig. 1).

6. Inspect drive shaft (8) oil seal surface for nicks or scratches Use emery paper to remove minor nicks and scratches. When the nicks or scratches are deep, finish by grinding and polish with emery paper.

In all cases, use caution with plunge cuts such that the finished surface will not feed in the axial direction.

7. Assemble the retaining ring (42) only on the drive shaft end side. The side opposite the part to be held by the retaining ring must always be on the sharp edged side of the retaining ring.

8. Then press ball bearing onto the drive shaft (8).

The following is maximum pressing force guidelines. Use tool (Fig. 2).

Series	Bearing P/N	Pressing Force	
		LBS	N
PV6	230-03205	1330	5900
PV10	230-82054	1500	6700
PV15	230-03206	1690	7500
PV20	230-82193	2200	9800
PV29	230-82193	2200	9800

9. Rotate the outer ring manually to check for any irregular noise.

10. Fit a protective cone for oil seal on the shaft end and apply a light coat of lithium grease on the outer surface. Then carefully assembly the drive shaft (8) into the housing (1). Use tool (Fig. 3).

11. Assemble retaining ring (41) into the housing.

12. Place the housing on a fixture with the shaft end facing downwards and insert spring (19), spring seat (20) into the housing.

13. Lightly coat the wear plate (16) with grease and mate to hanger (9). Then fit into the housing.

14. Using a mechanical press, press the hanger (9) until approximately horizontal. Then install the trunnion shaft (10) with gasket (25).

15. With the three socket head screws (49), secure the trunnion shaft (10) tightly. Tightening torque should be as follows:

Series	N-m		Lbs.-Ft.	
	Min.	Max.	Min.	Max.
PV-6	5.4	6.9	4.0	5.1
PV-10	7.8	9.8	5.8	7.3
PV-15	21.6	25.5	16.0	18.9
PV-20	39.2	43.1	29.0	31.9
PV-29	39.2	43.1	29.0	31.9

16. Place the cylinder barrel (3) on a fixture and insert washer (27) and spring (18) in the center hole. Washers (27) should be located on both ends of the spring.

Confirm that the face and the bore surface of the cylinder barrel (3) are free of scratches and foreign substances.

17. Compress spring (18) using a mechanical press and secure with retaining ring (40.)

Make sure the retaining ring has been correctly fitted into the groove.

18. Place cylinder barrel (3) on a clean sheet of paper or cloth and insert the three dowels (56) into the holes located outside of the spline hole. Place the guide ball (14) on top.

Compress manually and ascertain spring (18) force.

19. Hold the guide plate (15) horizontally with one hand, insert the 9 piston assemblies (5) into the bores of the guide plate, in order of disassembly. The shoes (7) should freely move on the piston (6).

20. Support the guide plate horizontally and insert the piston assembly (5) carefully into the cylinder barrel bores (3).

21. Place the housing (1) so that the drive shaft (8) is horizontal, assemble the cylinder barrel (3), piston assembly (5), guide ball (14) and guide plate (15) together onto the drive shaft.

Do not force the drive shaft spline into the cylinder barrel groove to mate but carefully rotate while applying slight thrust. The assembly is correct when the edge of the cylinder barrel is inserted approximately 1/3 inches below the edge of the housing.

22. Place the housing with the shaft end pointing downwards on a fixture and coat the face of the cylinder barrel with clean hydraulic fluid. Place gasket (24) on the housing.

23. Assemble the plunger (21) and port plate (4) onto the port block (2).

Lightly coat surface of plate with grease and place the port plate on the port block (2) locating the "U" shaped slot marked R or L over the pin (57, figure 5) as shown in Figure 4.

24. Hold the port block so the plunger (21) does not fall off and carefully place the block on the housing.

With the pin (63) inserted in the housing and into the mating hole of the port block, the clearance between the housing and port block on the contact surface should be approximately 0.04 to 0.1 in.(1 to 2.5 mm).

25. Secure the port block (2) with socket head screws (46), tightened diagonally.

The final tightening torque should be as follows:

Series	N-m		Lbs.-ft.	
	Min.	Max.	Min.	Max.
PV-6	27.5	32.4	20.3	23.9
PV-10	48.5	64.7	35.8	47.8
PV-15	95.0	112.0	70.1	82.7
PV-20	95.0	112.0	70.1	82.7
PV-29	152.9	178.4	113.2	132.1

26. 'C' Compensator valve (28) is assembled as follows:

26-1 Carefully clean the valve body (28-1) and spool (28-2) and soak in clean hydraulic fluid.

26-2 Check O-Rings (28-8 and 28-9) for deformation and wear (as given in Par. 28 of "INSPECTION", Article 4) and when determined to be in good condition, assemble (28-8) to cap, (28-3), (28-9) to spring seat (28-4).

26-3 Insert clean wire in the hole (diameter 1.2 mm or 0.047 in.) at the front end of spool (28-2) and carefully insert into the bore in the valve body (28-1). Remove wire after insertion. (Spool and body are matched set.)

26-4 Fit spring seats (28-4) and spring seat (28-5) on both ends of the spring (28-6) and assemble into the valve body.

26-5 With adjusting screw (28-11) and nut (28-12) set on the cap, place the cap on the spring seat (28-4) and screw into the threaded hole on the valve body. Tighten until the edge surface is flush.

Screw (28-11) adjustment rate approx. 650 psi (45 bar) per turn.

26-6 After checking the O-ring (28-10) for deformation and wear, coat the lithium grease on the mounting surface facing the valve body and install the O-ring.

27. Repeat step 26 for 'F', L valves using items (64-*).

28. To install seat (64-15), insert open end into bore and press in place. Install plug (64-20) and tighten.

29. Fit washer (64-24) and spring (64-7) on adjusting screw (64-18), fit cone (64-16) in spring and assemble into the valve body.

30. Set adjusting screw to measurement taken at disassembly and lock in place with nut (64-22) Cover with acorn nut (64-12).

31. Repeat steps 28, 29 and 30 using items (68-*).

32. Place ball (68-17) in body atop orifice (68-2).

33. Insert pin (68-24) into fitting assembly (68-27, see disassembly) and tighten in valve body.

34. Screw fitting (68-29) into valve body. This part is off center and must be positioned when tight so that the high side is toward top of valve body. This is necessary to allow installing the cap (68-3).

35. Repeat step 26 using items (68-*).

36. Assemble valve (28), (64) or (68) on the shoulder of port block.

The tightening torque is as follows:
8.3 to 9.7 lbs.-ft.(11.3 to 13.2 N-m)

37. Install thread seal (54) and hex nut (45) to adjusting screw (22) and then screw into the hole on port block. Return to the protrusion dimensions given below and lock up with hex nut.

Max. Volume Adjustment Screw (22)			
Series	No. Turns Full to Zero	Max. Torque (in-lbs.)	(N-m)
6	8.5	28	(3.2)
10	8.5	25	(2.8)
15	8.5	41	(4.6)
20	9.7	49	(5.5)
29	10.5	45	(5.1)

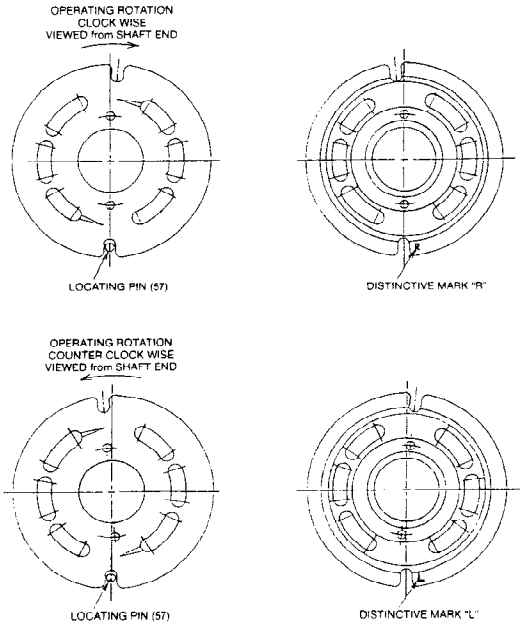
38. Rotate the drive shaft (8) with a lever or hub attached to the drive shaft end in the direction of the arrow plate several times and confirm that the rotation is smooth.

Cover the piping port on the side where the PC valve is mounted with the palm of the hand. Rotate the drive shaft and if air is forced out of the piping port, the pump is properly functioning.

39. Screw plug (58) with O-ring (55) to the housing and seal other openings with plastic cap seals.

40. Clean the outside of the pump and install onto the original equipment or return to storage room.

Figure 4. Port Plate Installation



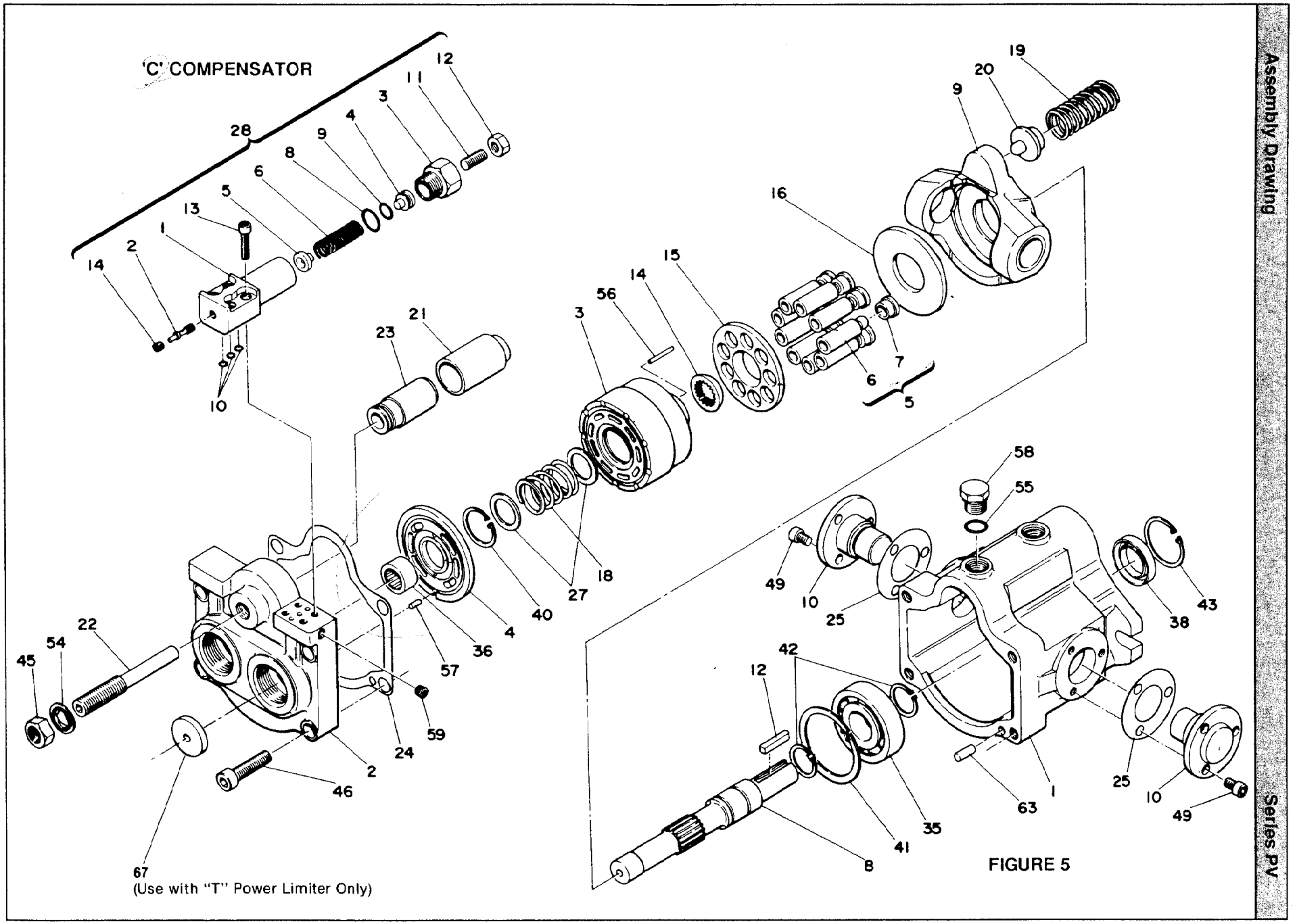


FIGURE 5

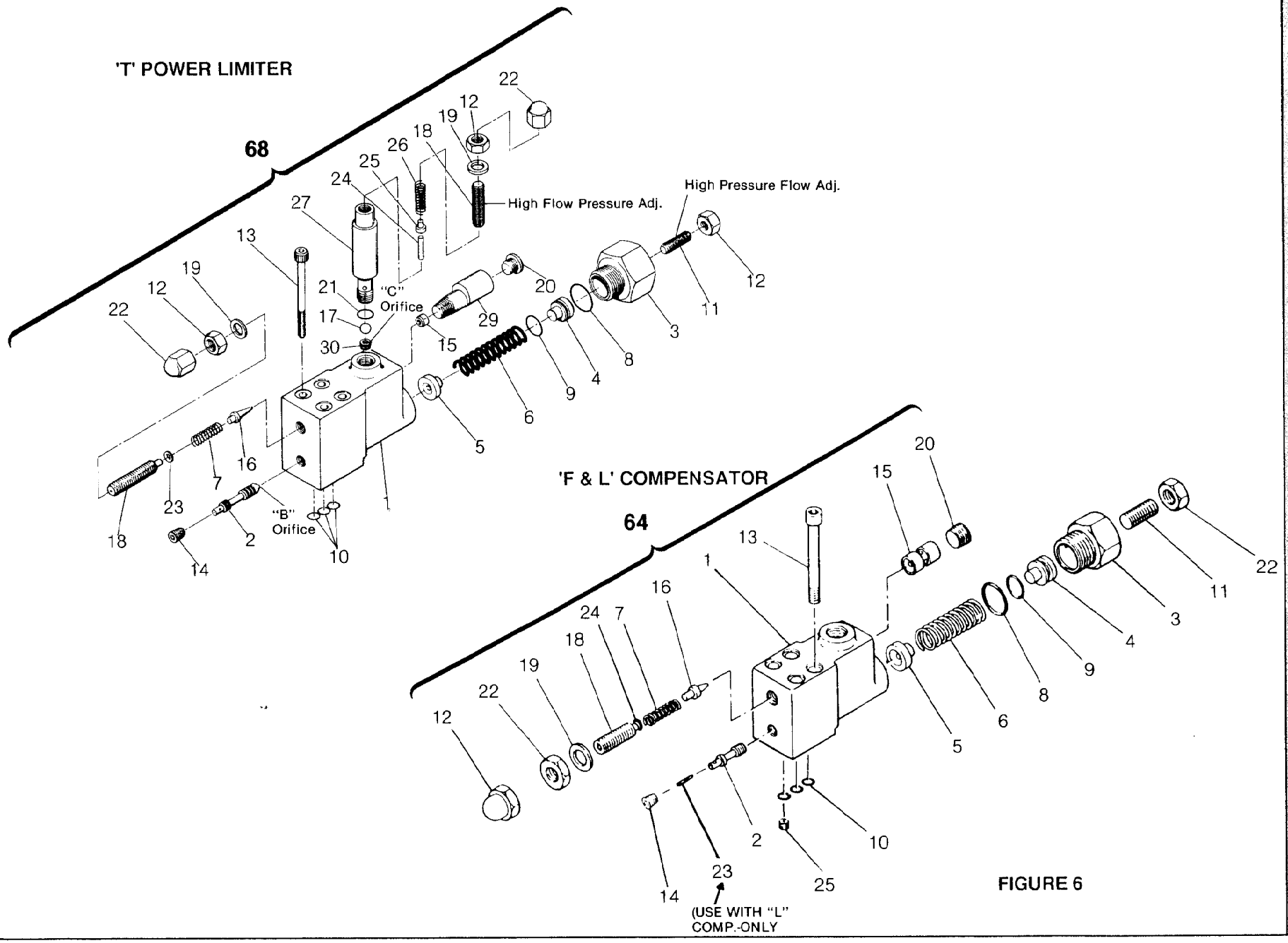

'T' POWER LIMITER
68
High Flow Pressure Adj.
High Pressure Flow Adj.
"C" Orifice
"B" Orifice
'F & L' COMPENSATOR
64
(USE WITH "L" COMP.-ONLY

FIGURE 6

Item	Description	PV6 Part No.	PV10 Part No.	PV15 Part No.	PV20 Part No.	PV29 Part No.	Qty
1	Housing-UNF	039-54005	039-59782	039-59788	039-59794	039-59800	1
	-BSPP	039-59836	039-59783	039-59789	039-59795	039-59801	1
2	Port Block-(UNF-CW)	S29-01330	S29-10811	S29-10815	S29-10819	S29-10823	1
	Port Block-(UNF-CCW)	S29-01335	S29-10812	S29-10816	S29-10820	S29-10824	1
	Port Block-(BSPP-CW)	S29-10891	S29-10813	S29-10817	S29-10821	S29-10825	1
	Port Block-(BSPP-CCW)	S29-10892	S29-10814	S29-10818	S29-10822	S29-10826	1
3	Barrel*	039-54035	039-54036	039-54037	039-54038	039-54039	1
4	Port Plate (CW)*	039-54040	039-54041	039-54042	039-54043	039-54044	1
	(CCW)*	039-54045	039-54046	039-54047	039-54048	039-54049	1
5	Piston & Shoe Assy.*	S29-01166	S29-01167	S29-01168	S29-01169	S29-01170	1
6	Piston*	Part of item 5					9
7	Shoe*	Part of item 5					9
8	Shaft (Key)	039-54050	039-54051	039-54052	039-54053	039-54054	1
	Shaft (Spline)	039-54055	039-54056	039-54057	039-54058	039-54059	1
9	Hanger	039-91000	039-91001	039-91002	039-91003	039-91004	1
10	Trunnion	039-54065	039-54066	039-54067	039-54068	039-54069	2
12	Key	039-54075	039-54076	039-54076	039-54078	039-54078	1
14	Guide Ball*	039-54254	039-54255	039-54256	039-54257	039-54258	1
15	Guide Plate*	039-54080	039-54081	039-54082	039-54083	039-54084	1
16	Wear Plate*	039-54085	039-54086	039-54087	039-54088	039-54089	1
18	Spring*	039-54090	039-54091	039-54092	039-54093	039-54094	1
19	Spring	039-54095	039-54096	039-54097	039-54098	039-54099	1
20	Spring Seat	039-54100	039-54101	039-54102	039-54103	039-54104	1
21	Plunger	039-54105	039-54106	039-54107	039-54108	039-54109	1
22	Adjust. Screw	039-54110	039-54111	039-54112	039-54113	039-54114	1
23	Guide Sleeve	039-54120	039-54121	039-54122	039-54123	039-54124	1
24	Gasket	Part of Seal Kit					1
25	Gasket	Part of Seal Kit					2
27	Washer*	039-54135	039-54136	039-54137	039-54138	039-54139	2
28	**"C" Press. Comp. Valve**	**(See Chart Below)**					**1**
35	Bearing, Ball	230-03205	230-82054	230-00306	230-82193	230-82193	1
36	Bearing, Needle	230-82199	230-82200	230-82201	230-82202	230-82203	1
38	Shaft Seal	620-82091	620-82091	620-82092	620-82093	620-82093	1
	(Part of Seal Kit)						
40	Retaining Ring*	356-65104	356-65108	356-65110	356-65114	356-65118	1
41	Retaining Ring	356-65105	356-65109	356-65111	356-65115	356-65115	1
42	Retaining Ring	356-65106	356-65106	356-65112	356-65116	356-65116	2
43	Retaining Ring	356-65107	356-65107	356-65113	356-65117	356-65117	1
45	Hex. Nut	333-00004	333-00004	333-00005	333-00005	333-00005	1
46	Screw, S.H.C.	361-10234-8	361-11234-8	361-12254-8	361-12254-8	361-13264-8	4
49	Screw, S.H.C.	361-07104-8	361-08104-8	361-10124-8	361-11154-8	361-11154-8	6
54	Thread Seal	Part of Seal Kit					1
55	O-Ring*	Part of Seal Kit					1

* Part of Rotating Group Parts Kit

Item	Description	PV6 Part No.	PV10 Part No.	PV15 Part No.	PV20 Part No.	PV29 Part No.	Qty
56	Dowel	324-30016	324-30017	324-30018	324-30019	324-30020	3
57	Pin	324-30015	324-30021	324-30022	324-30022	324-30023	1
58	Plug (UNF)	039-54232	039-54233	039-54233	039-54233	039-54233	1
	Plug (BSPP)-(Part of Seal Kit)	447-00032	447-01008-2	447-01008-2	447-01008-2	447-01008-2	1
59	Plug	447-00029	447-00029	447-00029	447-00029	447-00026	1
60	Not Shown- (UNF)	449-00588	449-00574	449-00574	449-00574	449-00574	1
	Drain-Cap Seal (BSPP)	449-00599	449-00601	449-00601	449-00601	449-00601	1
61	Not Shown-Nameplate	039-54241	039-54241	039-54241	039-54241	039-54241	1
62	Not Shown-Drive Screws	320-65018	320-65018	320-65018	320-65018	320-65018	4
63	Pin	324-30014	324-30024	324-30025	320-30025	324-30025	1
64	**"F & L" Press. Comp.**	**(See Chart Below)**					
65	Not Shown-Arrow Plate	039-54250	039-54250	039-54250	039-54250	039-54250	1
66	Not Shown-Main (UNF)	449-00525	449-00584	449-00584	449-00584	449-00584	2
	Port-Cap Seal (BSPP)	449-00600	449-00602	449-00602	449-00602	449-00602	2
67	Orifice ("T" Power Limiter)	039-57983	039-57984	039-57985	039-57986	039-57987	1
68	**"T" Power Limiter**	**(See Chart Below)**					
	****S-1 Seal Kit (SAE)**	S29-02080	S29-02081	S29-02082	S29-02083	S29-02084	
	****S-1 (BSPP)**	S29-02147	S29-02148	S29-02149	S29-02150	S29-02151	
	****S-5 Seal Kit (SAE)**	S29-02080-5	S29-02081-5	S29-02082-5	S29-02083-5	S29-02084-5	
	****S-5 (BSPP)**	S29-02147-5	S29-02148-5	S29-02149-5	S29-02150-5	S29-02151-5	
	****S-4 Seal Kit (available for customer conversion only)**						
	****S-4 (SAE)**	S29-02080-4	S29-02081-4	S29-02082-4	S29-02083-4	S29-02084-4	
	****S-4 (BSPP)**	S29-02147-4	S29-02148-4	S29-02149-4	S29-02150-4	S29-02151-4	
	Rotating Group Parts Kit						
	CW Rotation*	S29-10706	S29-10707	S29-10708	S29-10709	S29-10710	
	CCW Rotation*	S29-10711	S29-10712	S29-10713	S29-10714	S29-10715	
	ITEM 28 "C" PRESSURE COMPENSATOR VALVE						
28	Pressure Compensator	S29-12119	S29-12119	S29-12119	S29-12119	S29-12119	1
28-1	Body & Spool	S29-11834	S29-11834	S29-11834	S29-11834	S29-11834	1
28-2	Spool	(Matched to Item 28-1)					1
28-3	Cap	Part of Item 28					1
28-4	Spring Seat	Part of Item 28					1
28-5	Spring Seat	Part of Item 28					1
28-6	Spring	Part of Item 28					1
28-8	O-Ring	Part of Seal Kit					1
28-9	O-Ring	Part of Seal Kit					1
28-10	O-Ring	Part of Seal Kit					3
28-11	Adj. Screw 3/8-16 UNC	Part of Item 28					1
28-12	Nut, Hex. 3/8-16 UNC	Part of Item 28					1
28-13	Screw	361-08704-8	361-08704-8	361-08704-8	361-08704-8	361-08704-8	4
28-14	Plug	Part of Item 28					1

* Part of Rotating Group Part Kit

** SEALS MUST BE ORDERED AS A COMPLETE KIT

Item	Description	PV6 Part No.	PV10 Part No.	PV15 Part No.	PV20 Part No.	PV29 Part No.	Qty
ITEM 64 "F & L" PRESSURE COMPENSATOR VALVE							
64	"F" Press. Comp. (UNF)	S29-12120	S29-12120	S29-12120	S29-12120	S29-12120	1
	"L" Press. Comp. (UNF)	S29-12122	S29-12122	S29-12122	S29-12122	S29-12122	1
	"F" Press. Comp. (BSPP)	S29-12121	S29-12121	S29-12121	S29-12121	S29-12121	1
	"L" Press. Comp. (BSPP)	S29-12123	S29-12123	S29-12123	S29-12123	S29-12123	1
64-1	Body & Spool (UNF)	S29-11823	S29-11823	S20-11823	S29-11823	S29-11823	1
	Body & Spool (BSPP)	Part of Item 64					1
64-2	Spool	(Matched to Item 64-1)					1
64-3	Cap	Part of Item 64					1
64-4	Spring Seat	Part of Item 64					1
64-5	Spring Seat	Part of Item 64					1
64-6	Spring	Part of Item 64					1
64-7	Spring	Part of Item 64					1
64-8	O-Ring	Part of Seal Kit					1
64-9	O-Ring	Part of Seal Kit					1
64-10	O-Ring	Part of Seal Kit					3
64-11	Adj. Screw 3/8-16 UNC	Part of Item 64					1
64-12	Nut, Hex.	Part of Item 64					1
64-13	Screw	361-08284-8	361-08284-8	361-08284-8	361-08284-8	361-08284-8	4
64-14	Plug	Part of Item 64					1
64-15	Seat	039-59947	039-59947	039-59947	039-59947	039-59947	1
64-16	Cone	039-59948	039-59948	039-59948	039-59948	039-59948	1
64-18	Adj. Screw 3/8-16 UNC	Part of Item 64					1
64-19	Seal	Part of Item 64					2
64-20	Plug	Part of Item 64					1
64-22	Nut. Hex. 3/8-16	Part of Item 64					1
64-23	**Needle**	Part of Item 64 (Use with "L" Press. Comp.-ONLY-) (324-30016)					1
64-24	Washer	Part of Item 64					1

Item	Description	PV6 Part No.	PV10 Part No.	PV15 Part No.	PV20 Part No.	PV29 Part No.	Qty
ITEM 68 "T" POWER LIMITER VALVE							
68	"T" Power Limiter (UNF)	S29-12364	S29-12365	S29-12366	S29-12367	S29-12368	1
	(BSP)	S29-12369	S29-12370	S29-12371	S29-12372	S29-12373	1
68-1	Body & Spool (UNF)	S29-12226-0	S29-12226-0	S29-12226-0	S29-12226-0	S29-12226-0	1
	Body & Spool (BSP)	Part of item 68					1
68-2	Spool	(Matched to Item 68-1)					1
68-3	Cap	Part of Item 68					1
68-4	Spring Seat	Part of Item 68					1
68-5	Seat-Spring	Part of Item 68					1
68-6	Spring	Part of Item 68					1
68-7	Spring	Part of Item 68					1
68-8	O-Ring	Part of Seal Kit					1
68-9	O-Ring	Part of Seal Kit					1
68-10	O-Ring	Part of Seal Kit					3
68-11	Screw, Soc hd 3/8-16 UNC	Part of Item 68					1
68-12	Locknut Hex	Part of Item 68					3
68-13	SHCS M6 x 60mm	361-08284-8	361-08284-8	361-08284-8	361-08284-8	361-08284-8	4
68-14	Plug	Part of Item 68					1
68-15	Seat	039-57952-0	039-57952-0	039-57952-0	039-57952-0	039-57952-0	1
68-16	Cone	039-59948-0	039-59948-0	039-59948-0	039-59948-0	039-59948-0	1
68-17	Ball	201-10001-0	201-10001-0	201-10001-0	201-10001-0	201-10001-0	1
68-18	Set Screw 3/8-16	Part of Item 68					2
68-19	Threadseal	Part of Item 68					2
68-20	Plug	Part of Item 68					1
68-21	O-Ring	Part of Seal Kit					1
68-22	Nut, Acorn	Part of Item 68					2
68-23	Washer	Part of Item 68					1
68-24	Pin	Part of Item 68					1
68-25	Seat	Part of Item 68					1
68-26	Spring	Part of Item 68					1
68-27	Fitting	Part of Item 68					1
68-28	Fitting	Part of Item 68					1
68-29	Fitting	Part of Item 68					1
68-30	Orifice .0625 (1.59 mm)	036-20641-0	036-20641-0	036-20641-0	036-20641-0	036-20641-0	1

NOTE: 1. Items that have part numbers may be purchased separately. Others available only as part of a kit.
2. For rotation change, both port block (2) and port plate (4) must be changed.
3. Spool and Body are a matched set. Do not attempt to change spool or body. Entire compensator or limiter must be replaced.

Pump Test:

1. With the operating speed at 1770 ±30 RPM, record delivery flow rate, drain flow rate and fluid temperature at minimum outlet pressure and maximum rated continuous pressure.

Unit	Max. Rated Continuous Pressure
PV6	3,500 PSI (241 bar)
PV10	3,500 PSI (241 bar)
PV15	3,500 PSI (241 bar)
PV20	3,500 PSI (241 bar)
PV29	3,000 PSI (207 bar)

A. Rate of flow at minimum outlet pressure:
B. Rate of flow at max. rated continuous pressure:
C. Case drain leakage at max. rated continuous pressure and full flow:
D. Compensator leakage—the additional case drain leakage incurred at the max. rated continuous pressure when the pump is compensated (The actual increase in case leakage above the actual case leakage in "C".)

Unit	Rate of Flow at: GPM (LPM)	
	Minimum Outlet Pressure	Rated Continuous Pressure
PV6	6.5- 7.1 (24.6-26.9)	5.9 min. (22.3)
PV10	9.5-10.3 (36-39)	8.7 min. (32.9)
PV15	15.8-16.6 (59.8-62.8)	14.4 min. (54.5)
PV20	20.3-21.4 (76.8-81)	18.6 min. (70.4)
PV29	28.5-30.4 (107.9-115.06)	26.6 min. (100.7)

Case Drain Leakage: GPM (LPM)		
Pump Leakage	Compensator Leakage	
	"C"	"F or L"
0.53 max. 2.0)	.4 max. (1.5)	.9 max. (3.4)
0.53 max. (2.0)	.4 max. (1.5)	.9 max. (3.4)
0.66 max. (2.5)	.4 max. (1.5)	.9 max. (3.4)
1.20 max. (4.5)	.4 max. (1.5)	.9 max. (3.4)
1.50 max. (5.7)	.4 max. (1.5)	.9 max. (3.4)

Compensator Test:

"C"Compensator(Pressure)

1. Increase the system pressure above the compensator setting. Observe system pressure when the pump starts to destroke. Continue increasing system pressure until pump fully destrokes. At no time should the system pressure vary ±150 PSI (10.3 bar) from the compensator setting. The control should be steady and stable during all stages of destroking.

2. Adjust system pressure to a maximum of 150 PSI (10.3 bar) below compensator setting while running at "test conditions".

Compensator Test: (continued)

Unit	Flow/Leakage: GPM (LPM)	
	System Output Flow Should Return To:	Case Leakage Should Be:
PV6	5.9 min. (22.3)	.53 max. (2.0)
PV10	8.7 min. (32.9)	.53 max. (2.0)
PV15	14.4 min. (54.5)	.66 max. (2.5)
PV20	18.6 min. (70.4)	1.2 max. (4.5)
PV29	26.6 min. (100.7)	1.5 max. (5.7)

3. Repeat two more times. Compensator settings should be repeatable.

"F Compensator(Remote Pressure)

1. Insert a needle valve in the vent port of "F" compensator. Back main pressure adjustment screw (64-18) out. Set differential adjustment screw (64-11) at 250 PSI (17.2 bar) system pressure. Reset main pressure adjustment to 500 PSI (34.5 bar) above the maximum rated continuous pressure for the pump. Check to see that the pump will compensate at 500 PSI (34.5 bar) above the maximum rated continuous pressure.

2. Test according to the test procedure for the "C" compensator. Open and close valve in vent port several times. (When valve is open, pressure should go to differential pressure setting, 250 PSI (17.2 bar). If all flows and leakages are acceptable, remove the valve from the vent port.

"L" Compensator(load Sensing)

1. Insert a needle valve in the vent port of "L" compensator. Remove the pin from inside the spool of "L" compensator. Back main adjustment screw (64-18) out. Set differential adjustment screw (64-11) at 250 PSI (17.2 bar) system pressure. Reset main pressure adjustment to 500 PSI (34.5 bar) above the maximum rated continuous pressure for the pump. Check to see that the pump will compensate at 500 PSI (34.5 bar) above the maximum rated continuous pressure.
2. Test according to test procedure for the "C" compensator. Open and close valve in vent port several times. (When valve is open, pressure should go to differential pressure setting, 250 PSI (17.2 bar). If all flows and leakages are acceptable, remove the valve from the vent port, reinsert pin into spool.

"T" Power Limiter

1. Unthread the "High Flow Pressure Adjustment" to release the spring tension.

2. Test the pump per "F" Compensator & set compensator at operations pressure.

3. Connect the line between the Discharge Port & the T-Power Limiter

4. Use the following horsepower and compensator settings when adjusting the "T" Power Limiter.

Series	HP (kW)	Comp Setting	High Flow Pressure Setting	High Pressure Flow Setting
PV6	8 (6)	3500 PSI (241 bar)	1750 PSI (121 bar)	2.4 GPM (9 LPM)
PV10	12 (9)	3500 PSI (241 bar)	1750 PSI (121 bar)	3.5 GPM (12.2 LPM)
PV15	19 (14)	3500 PSI (241 bar)	1750 PSI (121 bar)	5.8 GPM (22 LPM)
PV20	24 (18)	3500 PSI (241 bar)	1750 PSI (121 bar)	7.5 GPM (28.4 LPM)
PV29	29 (22)	3000 PSI (241 bar)	1750 PSI (121 bar)	10.8 GPM (40.9 LPM)

5. Place a flow meter & needle valve (shut off) in the pump discharge line.

6. Start the pump and slowly close the needle valve until pressure reaches the high flow pressure setting. At that time thread the "High Flow Pressure Adjustment" into the body clockwise or counter clockwise until the maximum flow is achieved. Note: The flow and pressure may change a small amount during this adjustment, which will require readjusting the needle valve and the "High Flow Pressure Adjustment."

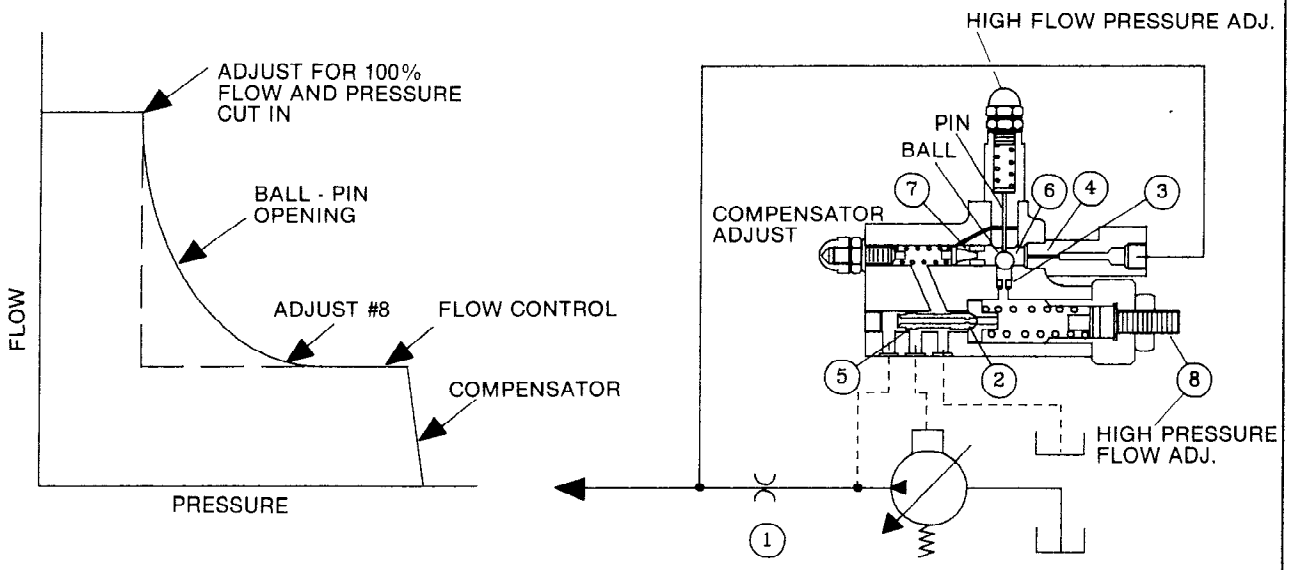
7. Continue closing the needle valve. The pump should begin destroking as the pressure increases. Adjust the "High Pressure Flow Adjustment" until the flow decreases to the high pressure flow setting as shown in the above chart.

8. The flow should remain at this decreased volume until the pump reaches the compenstor setting. See chart above.

9. Slowly operate the needle valve and observe the flow meter and the discharge pressure as the needle valve is opened and closed. The pressure and flow should follow the below curve.

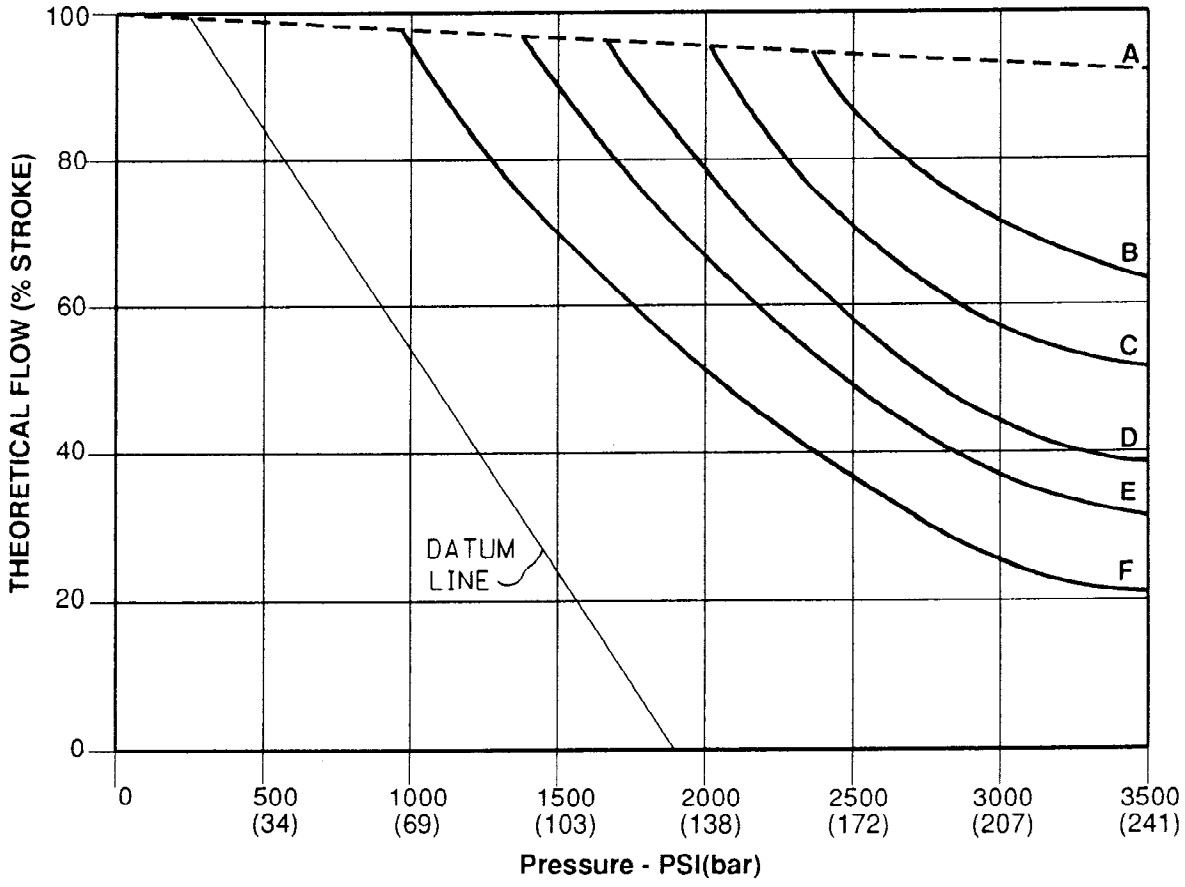
10. If the flow does not follow the below curve, repeat steps 6 thru 9.

Note: Check ball & seat if difficulty is experienced with the above adjustment. Orifice for ball must be fully seated so ball sets evenly on the seat.



PV6-29 HORSEPOWER LIMITER - 1800 RPM

Series		A	B	C	D	E	F
PV6	HP (kW)	14 (10.4)	11 (8.2)	9.2 (6.9)	8 (6)	7.4 (5.5)	5.6 (4.2)
PV10	HP (kW)	20 (14.9)	15.7 (11.7)	13.1 (9.8)	12 (9)	10.5 (7.8)	8 (6)
PV15	HP (kW)	33.2 (24.8)	26.1 (19.5)	21.8 (16.3)	19 (14.2)	17.5 (13.1)	13.3 (9.9)
PV20	HP (kW)	41.7 (31.1)	32.8 (24.5)	27.4 (20.4)	24 (17.9)	22 (16.4)	16.7 (12.5)
PV29	HP (kW)	60 (44.8)	47.1 (35.1)	39.4 (29.4)	29 (21.6)	31.7 (23.6)	24 (17.9)



HIGHER SPEED GUIDELINES

UNIT	SPEED – rpm	MINIMUM INLET PRESSURE		MAXIMUM CASE PRESSURE	
PV6	1800	-5 in-Hg	-12.7 cm-Hg	10 psi	.69 bar
	2150	-5 in-Hg	-12.7 cm-Hg	7 psi	.48 bar
	2300	-3 in-Hg	-7.6 cm-Hg	5 psi	.34 bar
	2450	-1 in-Hg	-2.5 cm-Hg	5 psi	.34 bar
	2550	0	0	5 psi	.34 bar
	2750	3 psi	.21 bar	5 psi	.34 bar
	3000	6 psi	.41 bar	5 psi	.34 bar
PV10	1800	-5 in-Hg	-12.7 cm-Hg	10 psi	.69 bar
	2250	-5 in-Hg	-12.7 cm-Hg	7 psi	.48 bar
	2450	-3 in-Hg	-7.6 cm-Hg	5 psi	.34 bar
	2600	-1 in-Hg	-2.5 cm-Hg	5 psi	.34 bar
	2700	0	0	5 psi	.34 bar
	2800	3 psi	.21 bar	5 psi	.34 bar
	3000	6 psi	.41 bar	5 psi	.34 bar
PV15	1800	-5 in-Hg	-12.7 cm-Hg	10 psi	.69 bar
	2000	-5 in-Hg	12.7 cm-Hg	7 psi	.48 bar
	2200	-3 in-Hg	-7.6 cm-Hg	5 psi	.34 bar
	2300	-1 in-Hg	-2.5 cm-Hg	5 psi	.34 bar
	2350	0	0	5 psi	.34 bar
	2500	3 psi	.21 bar	5 psi	.34 bar
PV20	1800	-5 in-Hg	-12.7 cm-Hg	10 psi	.69 bar
	1850	-5 in-Hg	-12.7 cm-Hg	7 psi	.48 bar
	1950	-3 in-Hg	-7.6 cm-Hg	5 psi	.34 bar
	2050	0	0	5 psi	.34 bar
	2250	3 psi	.21 bar	5 psi	.34 bar
	2400	6 psi	.41 bar	5 psi	.34 bar
PV29	1800	-5 in-Hg	-12.7 cm-Hg	10 psi	.69 bar
	1870	-3 in-Hg	-7.6 cm-Hg	7 psi	.48 bar
	1920	-1 in-Hg	-2.5 cm-Hg	5 psi	.34 bar
	1950	0	0	5 psi	.34 bar
	2150	3 psi	.21 bar	5 psi	.34 bar
	2300	6 psi	.41 bar	5 psi	.34 bar
	2400	7.5 psi	.52 bar	5 psi	.34 bar

NOTE: WATCH THE CASE PRESSURES CAREFULLY. Rapid compensation at high speeds can cause severe case spikes. If the pump feeds into a blocked center valve that closes quickly, use both case drain ports and direct short case drain lines and a relief valve.

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