DENISON HYDRAULICS
axial piston, variable displacement
open loop pump series PV/PVT D-mod

service information

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DENISON Hydraulics

ISO 9001
DNV
DNV Certification, Inc.
REGISTERED FIRM

CONTENTS

TYPICAL CHARACTERISTICS

Specification	Term	Series PV6 PVT6	Series PV10 PVT10	Series PV15 PVT15	Series PV20 PVT20	Series PV29 PVT29
•displacement	in^3/rev.	0.88	1.26	2.09	2.62	3.78
at max angle	cm^3/rev.	14.4	21.1	34.2	42.9	61.9
•pressure, continuous	psi	3500	3500	3500	3500	3000
	bar	241	241	241	241	207
intermittent [1]	psi	4500	4500	4500	4500	4000
	bar	310	310	310	310	276
•speed, max. [2]	rpm	1800	1800	1800	1800	1800
•rotating inertia	lb in^2	2.00	3.3	7.87	11.97	21.84
	kg m^2	.0006	.00099	.00233	.00355	.00647
•compensator response						
off-stroke	ms	50	50	50	50	50
on-stroke	ms	120	120	120	120	120
•maximum compensator	psi	4000	4000	4000	4000	3500
setting	bar	276	276	276	276	241
•compensator-	psi/turn	650	650	650	650	650
adjustment	bar/turn	44.8	44.8	44.8	44.8	44.8
•max. vol. adjustment						
full to zero- stroke	turns	8.5	8.5	8.5	9.7	10.5
maximum torque [3]	lb-in	28	25	41	49	45
	Nm	3.2	2.8	4.6	5.5	5.1
•minimum inlet-	in-Hg	-6.12	-6.12	-6.12	-6.12	-6.12
at 1800 rpm	mm-Hg	-155	-155	-155	-155	-155
•maximum inlet-	psi	50	50	50	50	50
pressure all series	bar	3.4	3.4	3.4	3.4	3.4
•max. case pressure	psi	10	10	10	10	10
	bar	0.70	0.70	0.70	0.70	0.70
•peak case pressure-	psi	15	15	15	15	15
over inlet pressure	bar	1	1	1	1	1
•input mounting	SAE	82-2 (A)	101-2 (B)	101-2 (B)	127-2 (C)	127-2 (C)
•input shaft, keyed	SAE	19-1	22-1	22,25-1[4]	32-1	32-1
splined		22-4	22-4	22,25-4[4]	32-4	32-4
		(A,B)	(B)	(B,B-B)	(C)	(C)
•shaft bearing life at-						
1800 rpm, 2500 psi						
ball bearing	hrs	3100	4800	3500	4400	2100
roller bearing	hrs	9600	9400	3100	5100	2600
1500 rpm, 172 bar						
ball bearing	hrs	3720	5760	4200	5280	2520
roller bearing	hrs	11520	11280	3720	6120	3120
•weight-approx. -PV	lb	24	36	43	57	73
	Kg	11	16	20	26	33
•weight-approx. -PVT	lb	30	45	55	71	93
	Kg	14	20	25	32	42

[1] 10% of operation time, not exceeding 6 successive seconds.
[2] for speeds over 1800 rpm see higher speeds guideline chart pg. 4.
[3] this is a maximum torque-actual torque reduces by about 25% at full stroke.
[4] PV15 uses 22-1,22-4 (SAE-B) only.

FLUID CONNECTIONS

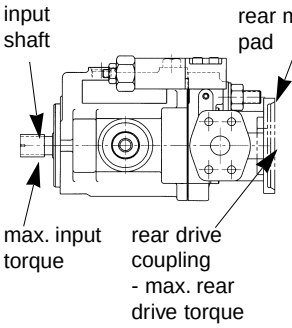
	Term	Series PV6 PVT6	Series PV10 PVT10	Series PV15 PVT15	Series PV20 PVT20	Series PV29 PVT29
•port A&B, PV	SAE St. Thd.	-12	-20	-20	-20	-20
(inlet, outlet)	BSPP	3/4	1-1/4	1-1/4	1-1/4	1-1/4
•port A (inlet),PVT	in.	1”	1-1/4”	1-1/2”	1-1/2”	2”
SAE code 61split flg.	mm	25.4	31.75	38.1	38.1	50.8
•port B (outlet),PVT	in.	3/4”	1”	1”	1”	1”
SAE code 61split flg.	mm	19.1	25.4	25.4	25.4	25.4
•port D	SAE St. Thd.	-8	-10	-10	-12	-12
	BSPP	1/2	3/4	3/4	1	1
•port V	SAE St. Thd.	-4	-4	-4	-4	-4
	BSPP	1/4	1/4	1/4	1/4	1/4

HIGHER SPEED GUIDES

	speed	Minimum inlet pressure						maximum	
		pressure gage				absolute pressure		case pressure	
	rpm	psi	bar	in-Hg	mm-Hg	psi	bar	psi	bar
PV6	1800	-3.00	-0.21	-6.12	-155	11.70	0.80	10	0.69
PVT6	2050	-3.00	-0.21	-6.12	-155	11.70	0.80	7	0.48
	2100	-3.00	-0.21	-6.12	-155	11.70	0.80	5	0.34
	2750	-2.35	-0.16	-4.79	-122	12.35	0.85	5	0.34
	2900	-0.96	-0.07	-1.97	-50	13.74	0.95	5	0.34
	3000	0.00	0.00	0.00	0	14.70	1.00	5	0.34
PV10	1800	-3.00	-0.21	-6.12	-155	11.70	0.80	10	0.69
PVT10	2100	-3.00	-0.21	-6.12	-155	11.70	0.80	7	0.48
	2500	-3.00	-0.21	-6.12	-155	11.70	0.80	5	0.34
	2550	-2.51	-0.17	-5.12	-130	12.19	0.84	5	0.34
	2700	-1.03	-0.07	-2.10	-53	13.67	0.94	5	0.34
	2800	0.00	0.00	0.00	0	14.70	1.00	5	0.34
	3000	2.18	0.15	4.44	114	16.88	1.16	5	0.34
PV15	1800	-3.00	-0.21	-6.12	-155	11.70	0.80	10	0.69
PVT15	2100	-3.00	-0.21	-6.12	-155	11.70	0.80	7	0.48
	2230	-3.00	-0.21	-6.12	-155	11.70	0.80	5	0.34
	2275	-2.53	-0.17	-5.16	-130	12.17	0.84	5	0.34
	2350	-1.71	-0.12	-3.49	-89	12.99	0.90	5	0.34
	2500	0.00	0.00	0.00	0	14.70	1.00	5	0.34
PV20	1800	-3.00	-0.21	-6.12	-155	11.70	0.80	10	0.69
PVT20	2050	-3.00	-0.21	-6.12	-155	11.70	0.80	7	0.48
	2100	-2.45	-0.17	-6.12	-127	12.25	0.85	5	0.34
	2200	-1.25	-0.09	-5.16	-65	13.45	0.93	5	0.34
	2300	0.00	0.00	0.00	0	14.70	1.00	5	0.34
	2400	1.31	0.09	2.66	68	16.01	1.10	5	0.34
PV29	1800	-3.00	-0.21	-6.12	-155	11.70	0.80	10	0.69
PVT29	2050	-3.00	-0.21	-6.12	-155	11.70	0.80	7	0.48
	2100	-2.45	-0.17	-4.99	-127	12.25	0.85	5	0.34
	2200	-1.25	-0.09	-2.55	-65	13.45	0.93	5	0.34
	2300	0.00	0.00	0.00	0	14.70	1.00	5	0.34
	2400	1.31	0.09	2.66	68	16.01	1.10	5	0.34

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.

MAXIMUM ALLOWABLE THROUGH DRIVE TORQUE



Max. input torque: max. torque allowed on input shaft from the combined torques of front and rear pumps.
Max. rear drive torque: max. torque allowed from rear pump.

	input shaft	max. input torque lbs-in.(Nm)	rear mounting pad	rear drive coupling (spline)	max. rear drive torque lbs-in.(Nm)
PVT6	SAE-19-1 (A) key	1125 (127,1)	SAE-82-2 (A)	SAE-16-4 (A)	1125 (127,1)
	SAE-22-4 (B) spline	2025 (228,8)		SAE-22-4 (B)	1125 (127,1)
PVT10	SAE-22-1 (B) key	1680 (189,8)	SAE-82-2,101-2 (A, B)	SAE-16-4 (A)	1680 (189,8)
	SAE-22-4 (B) spline	2550 (288,1)		SAE-22-4 (B)	1925 (217,5)
PVT15	SAE-22-1(B) key	1680 (189,8)	SAE-82-2,101-2 (A, B)	SAE-16-4 (A)	1680 (189,8)
	SAE-22-4 (B) spline	2185 (246,9)		SAE-22-4 (B)	2000 (226)
	SAE-25-1 (B-B) key	2850 (332)		SAE-25-4 (B-B)	2000 (226)
	SAE-25-4 (B-B) spline	3825 (432,2)			2000 (226)
PVT20	SAE-32-1 (C) key	4675 (528,3)	SAE-82-2,101-2,127-2	SAE-16-4 (A)	3850 (435)
	SAE-32-4 (C) spline	4675 (528,3)	(A,B,C)	SAE-22-4 (B)	3850 (435)
				SAE-25-4 (B-B)	3850 (435)
				SAE-32-4 (C)	3850 (435)
PVT29	SAE-32-1 (C) key	4880 (551,4)	SAE-82-2,101-2,127-2	SAE-16-4(A)	3850 (435)
	SAE-32-4 (C) spline	6300 (711,9)	(A,B,C)	SAE-22-4 (B)	3850 (435)
				SAE-25-4 (B-B)	3850 (435)
				SAE-32-4 (C)	3850 (435)

GENERAL INFORMATION

The PV pumps have a displacement of 0.88 to 3.78 cu. in/rev,. 14.4 to 61.9 cc/rev. with a continuous working pressure of 3500 psi, 241 bar except the PV29 which is rated at 3000 psi, 207 bar, intermittent operation at 4500 psi, 310 bar except the PV29 which is rated at 4000 psi, 276 bar. These pumps can be equipped with a pressure compensator, ventable compensator, load sensing or power limit control.

The PV pumps have been designed to operate in a wide range of applications in industries where high pressure and variable flow are required at competitive cost.

OPERATION OF PUMP

These pumps have the familiar principles originated for **DENISON HYDRAULICS** axial piston units.

The shaft is splined to the barrel which carries the nine axial pistons. Each piston terminates in a ball on which is swaged a shoe that is free to pivot and rotate. It bears against the cam surface which is angled to the shaft axis. The opposite end of the barrel lightly bears against the port plate with its arcuate openings. These communicate to the ports A & B of the piston unit. The barrel and piston shoes are free to move axially to compensate for wear, for thickness variations of the fluid film and for dimensional changes caused by temperature and pressure.

The piston shoes are held against the cam surface by the hold-down plate. It rotates at shaft speed and is permitted to adjust to the cam angle by the hold-down ball which loads it.

The hanger cam axis, the shaft, and the plane of the piston ball centers all coincide with the center of moments of the unit to give a fully balanced design. This reduces control forces and wear to a mimimum.

The angle of the cam surface determines the displacement as well as the direction of fluid flow for a given rotation. The cam surface is supported on a movable hanger. Various controls adjust and limit the hanger angle.

MOUNTING

These pumps are designed to operate in any position. The mounting hub and two bolt mounting flange are in full conformance with SAE standards, except as noted on installation drawings. The pump shaft must be in alignment with the shaft of the source driver and should be checked with a dial indicator. The mating pilot bore and coupling must be concentric. This concentricity is particularly important if the shaft is rigidly connected to the driven load without a flexible coupling.

See installation drawings pgs. 31 through 42, for mounting and pg. 4 **maximum allowable torque** in the data section for torque limits.

series	**6**	**10**	**15**	**20**	**29**
PV (rear ported)	23-9862	23-9863	23-9864	23-9865	23-9866
PVT (side ported)	23-9982	23-9983	23-9980	23-9984	23-9985
PV/PVT torque limiter	23-9996	23-9996	23-9996	23-9996	23-9996

SHAFT OPTIONS:

SAE splined and keyed, see installation drawings for details.

SHAFT INFORMATION:

Splined: The shafts will accept a maximum misalignment of 0.002”, 0,06mm total indicator reading when the pump is foot mounted and 0.001”, 0,03 mm when flange mounted. Angular misalignment at the male and female spline axis must be less than ± 0.002” per inch radius, ± 0,002 mm/mm per mm radius. The coupling interface must be lubricated.
DENISON recommends lithium molydisulfide or similar grease. The female coupling should be hardened to 27-34 Rc and must conform to SAE-J498c, class 5 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 0.030”-0.040”, 0.075-1.0 mm at 45° to clear radii that exist in the keyway.

SIDE LOAD CAPABILITY:

The PV series is designed for inline-drive and side loading on the shaft is not recommended. If this is unavoidable consult your nearest **DENISON HYDRAULICS** representative.

PIPING

Connect inlet and outlet lines to the port block of the pump.

See installation drawings in the back of this bulletin for port connections.

The maximum case pressure is 10 psi, 0.7 bar continuous, 15 psi, 1 bar intermittent. Case pressure 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, 0.3 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 15 psi, 1 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 operating at full rated speed. An undersize outlet line will create back pressure and cause heat generation. 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 galvanized 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 **DENISON HYDRAULICS** standard HF-1. Where anti-wear additive fluids are specified, see **DENISON HYDRAULICS** standard HF-0.

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 values 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 temperature should not exceed 180^{0}F,. 82^{0}C. at the case drain.

MAINTENANCE

The 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 troubleshooting chart before attempting to overhaul the unit. Overhauling may be accomplished by referring to the disassembly, rework limits of wear parts, and assembly procedures. Refer to the service manual for troubleshooting and overhaul information.

FLUID CLEANLINESS

Fluid must be cleaned before and continuously during operation, by filters that maintain a cleanliness level of ISO 17/14. This approximately corresponds to NAS 1638 class 8 (class 9 for 15 micron and smaller). 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.

COMPARISON OF SOLID CONTAMINATION CLASSIFICATION SYSTEM

NATIONAL AERONAUTICS STANDARD (NAS) 1638

		class													
		00	0	1	2	3	4	5	6	7	8	9	10	11	12
particle size range	5-15µm	125	250	500	1000	2000	4000	8000	16000	32000	64000	128000	256000	512000	1024000
	15-25µm	22	44	89	178	356	712	1425	2850	5700	11400	22800	45600	91200	182400
	25-50µm	4	8	16	32	63	126	253	506	1012	2025	4050	8100	16200	32400
	50-100µm	1	2	3	6	11	22	45	90	180	360	720	1440	2880	5760
	>100µm	0	0	1	1	2	4	8	16	32	64	128	256	512	1024
maximum particles	>5µm	152	304	609	1217	2432	4864	9731	19462	38924	77849	155698	311396	622792	1245584
	>15µm	27	54	109	217	432	864	1731	3462	6924	13849	27698	55396	110792	221584

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	>5µm	250	500	1000	2000	4000	8000	16000	32000	64000	130000	250000	500000	1000000	2000000	4000000
	>15µm	32	64	130	250	500	1000	2000	4000	8000	16000	32000	64000	130000	250000	500000

NOTES: All measurements are for a 100 ml sample size.

STARTUP PROCEDURE FOR NEW INSTALLATION

- Read and understand the instruction manual. Identify components and their function.
- Visually inspect components and lines for possible damage.
- Check reservoir for cleanliness. Drain and clean as required
- 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.
- Check alignment of drive.
- Check oil cooler and activate it, if included in circuit. Check fluid temperature
- Reduce pressure settings of compensator and relief valve. Make sure accurate

STARTUP PROCEDURE *(continued)*

pressure readings can be made at appropriate places.
- If solenoids in system, check for actuation.
- Start pump drive. Make sure pump fills properly.
- Bleed system of air. Recheck fluid level.
- Cycle unloaded machine at low pressure and observe actuation (at low speed, if possible).
- Increase pressure settings gradually in steps. Check for leaks in all lines especially in pump and motor inlet lines.
- Make correct pressure adjustments.
- Gradually increase speed. Be alert for trouble as indicated by changes in sounds, system shocks and air in fluid.
- Equipment is operational.

TROUBLESHOOTING

Component problems and circuit problems are often interrelated. An improper circuit may operate with apparent success but will cause failure of a particular component within 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 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 rotating group	fluid too cold fluid too viscous fluid too heavy shaft speed too high suction line too small suction strainer too small suction strainer too dirty operating altitude too high boost or replenishment pressure too low replenishment flow too small for dynamic conditions
	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 cavitation	see noisy pump above see noisy pump 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 improper 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 procedures, dimensions, finishes
	unwanted water in fluid	condensation faulty breather/strainer heat exchanger leakage faulty clean-up practice water in makeup fluid

TROUBLESHOOTING
(continued)

effect of trouble	possible cause	fault which needs remedy
pressure shocks	cogging load	mechanical considerations
	worn relief valve	needed repairs
	worn compensator	needed repairs
	slow response in check valves	replace or relocate
	excessive decompression energy rates	improve decompression control
	excessive line capacitance (line volume, line stretch, accumulator effects)	reduce line size or lengths bleed air
	barrel blow-off	re-check 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 improper baffles insulating air blanket that prevents heat rejection heat pickup from adjacent equipment
decrease in set pressure	loose compensator adjusting screw	tighten the adjusting screw 28-11
	defective function of relief valve	overhaul or exchange
	low tank oil level	replenish fluid
	deterioration of pump	check drain flow repair or replace
pressure does not rise	improper direction of rotation	change direction of rotation
	low tank oil level	replenish fluid
	wrong setting of relief valve or compensator	readjust and lock
	faulty relief valve or compensator	repair or replace
	clogging of suction line	check and clean suction strainers
	deterioration in pump function	repair or replace
insufficient flow	low tank oil level	replenish fluid
	leak in suction line	tighten fittings
	improper stroke adjustment	loosen adjusting screw 22 and locknut 45 and set properly
	deterioration in pump function	repair or replace
compensator unstable	check valve missing from pump discharge port	iinstall 30-50 psi 2-3 bar check valve within 12 inches 0.3 meters of pump discharge port

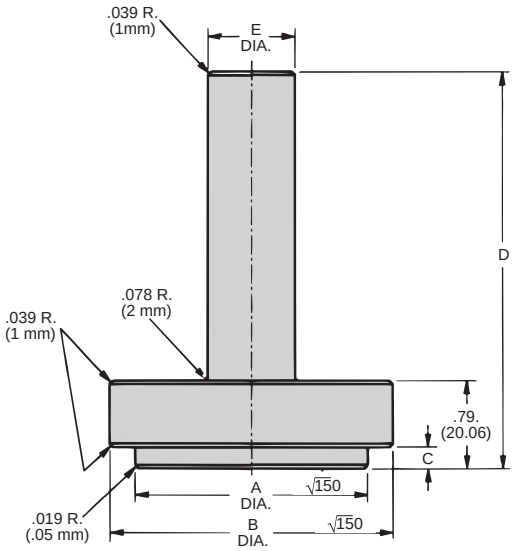


FIGURE 1 SHAFT SEAL INSTALLATION TOOL

SERIES		A*	B	C†	D&E	F
PV6 &	in.	1.75	2.17	.185		.79
PVT6	mm	44.5	55.1	4.7		20
PV10 &	in.	1.75	2.17	.185		.79
PVT10	mm	44.5	55.1	4.7	as	20
PV15 &	in.	1.95	2.36	.197	needed	.79
PVT15	mm	49.5	59.9	5.0		20
PV20 &	in.	2.15	2.56	.204		.79
PVT20	mm	54.6	65.0	5.2		20
PV29 &	in.	2.15	2.56	.204		.79
PVT29	mm	54.6	65.0	5.2		20

Material - steel
*± .008 in,. ± .204 mm
† +.00 -.008 in., +.00 -.204 mm

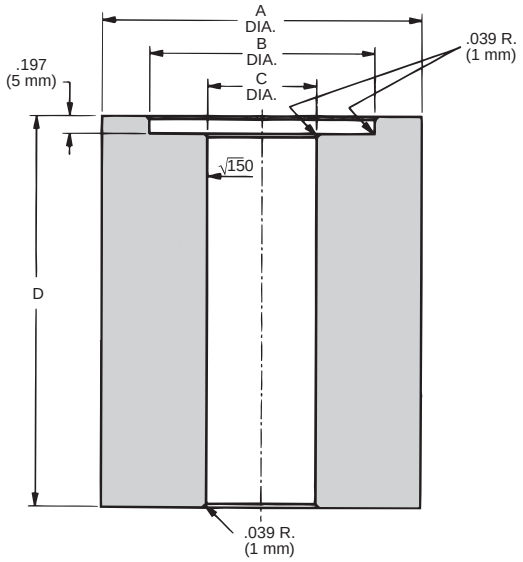


FIGURE 2 BALL BEARING INSTALLATION TOOL

SERIES		A	B	C	D
PV6 &	in.	2.36	2.08	1.02	4.33
PVT6	mm	59.9	52.8	25.9	110
PV10 &	in.	2.76	2.44	1.02	4.52
PVT10	mm	70.1	62	25.9	114.8
PV15 &	in.	3.15	2.83	1.22	5.19
PVT15	mm	80.0	71.9	31	131.8
PV20 &	in.	3.54	3.15	1.42	6.3
PVT20	mm	89.9	80.0	36	160
PV29 &	in.	3.54	3.15	1.42	6.3
PVT29	mm	89.9	80.0	36	160

Material - steel
***** +.012 -.004 in., +.306 -.102 mm

FIGURE 3 SHAFT SEAL INSTALLATION TOOL

SERIES & SHAFT		A*	B†	C	D	E
PV & PVT 6 -2	in.	1.00	.750	2.24	1.65	1.57
	mm	25.4	19.1	56.9	41.9	39.9
PV & PVT6 -1	in.	1.00	.875	2.68	2.08	2.00
PV & PVT 10	mm	25.4	22.2	68	52.8	50.8
PV & PVT 15	in.	1.20	.875	2.68	2.08	2.00
-1 & -2	mm	30.5	22.2	68	52.8	50.8
PVT15	in.	1.20	1.00	2.68	2.08	2.00
-4 & -5	mm	30.5	25.4	68	52.8	50.8
PV & PVT 20	in.	1.40	1.250	2.68	2.08	2.00
PV & PVT 29	mm	35.6	31.8	68	52.8	50.8

Material - Teflon (preferred) or steel heat treated to Rc 40-45, chromium plated.
*± .004 in,. ± .102 mm
† +.008 -.004 in., +.204 -.102 mm

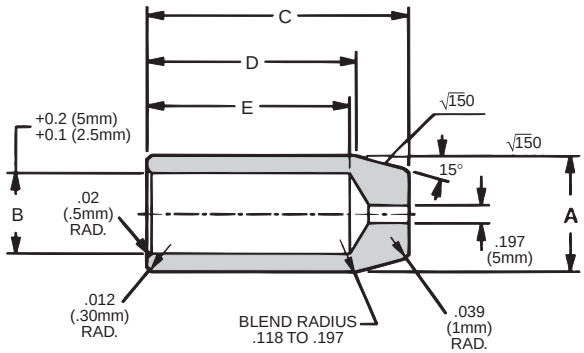


FIGURE 4 TRUNNION ASSEMBLY TOOL

SERIES		A*	B†	C	REF.
PV6 &	in.	1.75	.997/.996	1/2-13 x 3/4 dp.	039-91348
PVT6	mm	44.45	25.32/25.30		
PV10 &	in.	1.75	.997/.996	1/2-13 x 3/4 dp.	039-91348
PVT10	mm	44.45	25.32/25.30		
PV15 &	in.	2.00	1.247/1.246	3/4-10 x 1.00 dp.	039-91349
PVT15	mm	50.8	31.67/31.65		
PV20 &	in.	2.25	1.497/1.496	3/4-10 x 1.00 dp.	039-91350
PVT20	mm	57.15	38.02/38.00		
PV29 &	in.	2.25	1.497/1.496	3/4-10 x 1.00 dp.	039-91350
PVT29	mm	57.15	38.02/38.00		

Material - steel, or rework ref. trunnion to B diameter

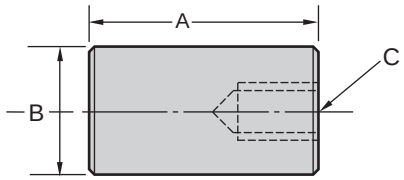
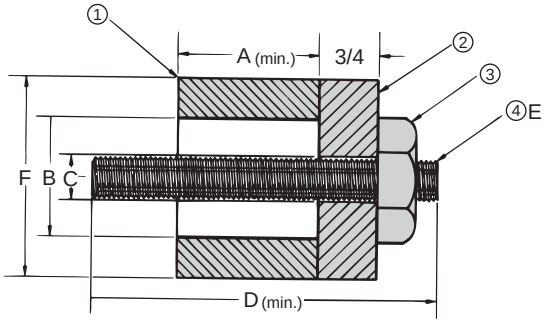


FIGURE 5 TRUNNION REMOVAL TOOL

SERIES		A	B DIA	C DIA	D	E THD.	F DIA
PV6 &	in.	1.75	1.50	.56	4.25	1/2-13	2.50
PVT6	mm	44.45	38.1	14.2	10.8		63.5
PV10 &	in.	1.75	1.50	.56	4.25	1/2-13	2.50
PVT10	mm	44.45	38.1	14.2	10.8		63.5
PV15 &	in.	2.00	1.75	.81	4.50	3/4-10	2.75
PVT15	mm	50.8	44.5	20.6	11.4		69.8
PV20 &	in.	2.25	2.00	.81	4.75	3/4-10	3.00
PVT20	mm	57.15	50.8	20.6	12.1		76.2
PV29 &	in.	2.25	2.00	.81	4.75	3/4-10	3.00
PVT29	mm	57.15	50.8	20.6	12.1		76.2

item	description	material
1	sleeve	steel
2	washer	steel
3	nut	hardened steel GR-5
4	all-thread rod	hardened steel GR-5



DISASSEMBLY PROCEDURE

Disassemble the pump according to the instructions in this section. Please refer to the exploded view (Fig. 6).

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 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 screw 22 on the pump, items 11 and 18 (as applicable) on the control 28 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. For tandem pumps, remove the external pump, adapter 69 and the coupling, 70.

4. Loosen nut 45 and remove the adjusting screw 22 and thread seal 54.

5. Remove four screws 28 or 28 item 13 and then remove valve assembly 28 with O-ring 28 item 10. If pump contains a torque limiter, remove tube line from torque limiter to compensator. Remove four screws holding torque limiter to pump housing, then remove torque limiter asembly.

6. 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 and housing, 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.

7. Remove port plate 4 gently from barrel face.

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

9. Place barrel 3 on a clean cloth or plastic film. Before removing pistons, check for excess play. Hold the side of retainer plate 15 and gently remove the piston assembly 5.

10. It is recommended that the retainer 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 and retainer plate 15.

11. Remove holddown ball 14 and dowels 56.

Note: With the given procedures (1) through (11), 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 dustproof plastic film.

b) Place port block 2 on the work bench with the assembled guide sleeve 23 and needle

DISASSEMBLY PROCEDURE
continued

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. If unit contains a torque limiter, place torque limiter in a plastic bag.

proceed to INSPECTION

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

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 (12) through (14).

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 (15) through (17).

c) If oil seal leakage or excessive ball bearing play is apparent, perform steps (18) through (22).

d) If PC valve functions irregularly, perform the following steps (23) through (28).

e) If "J" or "K" torque limiter valve functions irregularly, perform the following steps (29) through (33).

f) If "T" torque limiter valve functions irregularly, perform the following steps (34) through (36).

g) If guide sleeve is worn excessively, perform the following steps (37) and (38).

12. 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.

13. Remove washer 27 and spring 18

14. Remove cylinder barrel from fixture.

Proceed to INSPECTION.

spring load and spring deflection as follows:

item	model	PV/PVT-6	PV/PVT-10	PV/PVT-15	PV/PVT-20	PV/PVT-29
spring load	lbs.	55	68	99	111	133
	N	244	304	440	495	591
spring deflection	in.	0.66	0.61	0.62	0.67	0.71
	mm	16.8	15.6	15.7	16.9	18.0

15. Refer to Fig. 5, trunnion removal tool. Insert threaded rod into threaded hole in trunnion.

16 Tighten nut to withdraw trunnion from housing. Repeat on the other side.

TRUNNION REMOVAL

17. Remove the hanger 9, spring seat 20 and spring 19 in this order.

Proceed to INSPECTION.

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

19. Remove retaining ring 41.

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

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

22. 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/PVT-6	PV/PVT-10	PV/PVT-15	PV/PVT-20	PV/PVT-29
O.D. of seal	in.	1.77	1.77	1.97	2.16	2.16
	mm	45	45	50	55	55

Proceed to INSPECTION.

COMPENSATOR DISASSEMBLY

23. Loosen hex. nut 28-12 and remove adjusting screw 28-11 from cap 28-3.

24. Remove cap 28-3.

25. Remove spring 28-6 and spring seat 28-5.

26. Remove spool 28-2.

'F' AND 'L' COMPENSATOR

27. If control is F or L compensator, loosen hex. nut 28-12 and remove adjusting screw 28-18 from body 28-1 . Remove spring 28-7 and cone 28-16.

Proceed to INSPECTION.

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

28. Remove plug 28-20. Using a rod, tap seat out from the opposite end ('F' & 'L' compensator).

"J" & "K" TORQUE LIMITER

29. **See figure 10.** Remove tube line connecting torque limiter assembly to "F" compensator. Remove screws 28-12 and remove torque limiter assembly from pump housing.

30. Remove plug 28-1 with attached parts. Note if feedback arm 28-7 rotates freely from side to side, and that the spring returns it to the full stroke position.

31. Remove seal piston 28-4 with spring and spring hat 28-5 and 28-8.

32. Remove elbow fitting 28-21 . Push the spool 28-8 back and forth to check for free motion in bushings and sleeve 28-6

Proceed to INSPECTION

"T" POWER LIMITER

33. Fitting 28-27 along with the adjusting screw 28-18 can be removed from body as an assembly.

34. Remove pin 28-24 and ball 28-17.

35. Remove fiting 28-29. Using a rod, tap seat out from the opposite end.

GUIDE SLEEVE REMOVAL

36. Insert a pin in drain hole—Item 23.

37. Turn in Item 22 against this pin to draw out the guide sleeve.

REWORK LIMITS OF WEAR PARTS

		max.	min. dimension after rework				
item		rework	PV/PVT-6	PV/PVT-10	PV/PVT-15	PV/PVT-20	PV/PVT-29
shoe face	in.	.004	.1136	.1333	.1530	.1727	.1923
	mm	.102	2.885	3.386	3.886	4.387	4.884
port plate	in.	.006	.144	.167	.184	.204	.224
	mm	.153	3.658	4.242	4.674	5.182	5.690

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 .005 mm.

3. Pistons—measure each piston at 4 places,. If the difference in measurements exceeds .0004," or .010 mm 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 shoe retainer 15 in place.

6. Port plate—may be lapped .006", or .153 mm, maintain flatness to 200 µ inches, or 5 microns.

7. Wear plate 16—replace if worn.

8. Shoe retainer 15—do not lap. If thickness measured at several points varies more than .004", or .102 mm, replace the retainer.

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 0.001 in. or 0.025 mm on several random points. When there is excessive play with the drive shaft 8 inserted into the needle bearing 36. (Maximum radial play is 0.003 in. or 0.076 mm.)	Replace Replace guide sleeve 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 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 satisfactory. Measure piston diameter at several random points. If the difference is over .0006 in., or .015 mm replace both piston assembly 5 and barrel 3.
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.
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. Visual check of shoe face. Minute, slight trace or localized polished portion. Random radial marks are clearly visible. burrs on shoe flange. Visual check of piston outer diameter. Measure several points with a micrometer. Visual check of piston's outer surface. Slight discoloration or cross hatch trace. Localized scratch marks apparent in longitudinal direction.	 Replace part. Check suction pressure (when below -5 in. Hg, improve suction pressure), clean strainer. Repair by lapping (difference in flange thickness between the 9 shoes should not be more than 0.0012 in., or .03 mm. This also applies to the following repairs: Repair by lapping. (Flush reservoir and circuit.) Check suction pressure and if less than -5 in. Hg, improve suction pressure. If slight, repair by lapping. If severe, replace part. Replace if dimensional difference is more than 0.0006 in,. or .015 mm. Can be used as is. (Recommend polishing with emery paper). If the marks cannot be removed, replace. (Flush reservoir and circuit).

no.	part	inspection procedure	corrective action
5	piston assembly	seizure, scoring or discoloring.	Replace both piston ass'y. 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. Pitting or corrosion over entire surface or partial surface. Visual check of oil seal surface. Lip contact marks, bright polish. Contact marks width over 0.04 in., or 1 mm and can be detected with fingernail. Visual check of key groove bottom end. (if in doubt, check for cracks with dye-color). Needle bearing 36 rolling contact surface. Apparent wear on contact surface. Visual check of spline for external pump (PVT only). Apparent wear on spline teeth	Remove with emery paper. Check fitting to coupling hub. If loose, remake to force fit. Replace part. Check fitting to coupling hub. If loose, remake to force fit. Check alignment between prime mover and pump and correct as required. Can be used as is. Replace part. (Check oil seal lip for wear and hardening and replace oil seal if worn or hard). If cracked, replace drive shaft 8. Check alignment with prime mover and correct as required. If dimensional difference with non-contact surface is more than 0.0008 in., or .020 mm replace part. Replace drive shaft 8.
9	hanger	Visual check of trunnion bearing 10. When contact surface is not excessively worn. When contact surface shows apparent wear, uneven contact and localized nicks. Visual check of contact surface with plunger 21. Wear Marks: Up to width 0.2 in,. or 5 mm. Over width 0.2 in,. or 5 mm.	 Can be used as is. When inside diameter difference is directionally more than 0.0008 in,. or .020 mm, replace part. Can be used as is. 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. Localized seizure, scoring or discoloring.	 Re-use after polishing with emery cloth. 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. Stepped wear.	 Re-use after removing discoloration with emery paper. Measure and if worn over 0.002 in., or .051 mm, 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	shoe retainer	Contact condition with flange surface of shoe. Contact surface is brightly polished. Contact surface is apparently indented and shoe flange is brightly polished or slightly deformed.	 Re-use as is. 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. Replace Replace
18	spring	Measure free heights. PV-6 1.38 in,. or 35 mm PV-10 1.57 in., or 40 mm PV-15 1.79 in., or 45.5 mm	 Replace when height is decreased more than 5% from the given heights.

no.	part	inspection procedure	corrective action
18	spring (continued)	PV-20 1.97 in., or 50 mm PV-29 2.05 in,. or 52 mm	Replace when height is decreased more than 5% from the given heights.
19	spring	Measure free heights. PV-6 2.44 in., or 62 mm PV-10 2.60 in., or 66 mm PV-15 2.99 in., or 76 mm PV-20 2.99 in., or 76 mm PV-29 3.19 in., or 81 mm	Replace when height is decreased more than 3% from the given heights.
21	plunger	Check contact condition of spherical surface, Wear up to width 0.2 in., or 5 mm. Wear over width 0.2 in., or 5 mm.	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. Seizure, scoring or discoloring.	Re-use as is. Take micrometer reading at several points and if difference more than 0.0008 in., or .020 mm, replace. Check hydraulic fluid type, temperature rise, excessive pressure and correct as required. Replace. Check hydraulic fluid type, oil temperature, excessive pressure and correct as required.
28	'C' compensator 'F','L' compensator	O-Ring 28-8,28-9, 28-10 Cross sectional condition. Surface condition. Spring 28-6 Measure free height. Visual check of spool 28-2. 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 1.8 in., or 45.7 mm. Replace when dimensional difference is more than .0004 in, or .010 mm. Replace PC valve if rounded off either in localized areas or over the entire circumference. Spool 28-2 is fitted to valve body 28-1 .
	'F','L' compensator 'T' power limiter	Visual check of cone 28-16. Wear condition of cone and seat contact area. Visual check of spring 28-7.	 Replace if worn or pitted in this area. Replace if distorted.
	'J' & 'K' torque limiter	Gasket 28-17 O-ring 28-19, 28-23, 28-27 Visual check of arm 28-7 Excessive wear at contact with hanger Check of spring 28-5 Check of spring 28-15 Check of spool 28-8	Replace Replace as a rule. May be reversed Replace if broken Replace if broken or less than 1.82", or 46.2 mm free length Replace if broken, bent or worn
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 it irregular noise audible. Replace when clear discoloration or pittings can be detected visually.
36	needle bearing	Check wear condition.	(See no.2)
24	gasket	Check wear condition.	Replace
25	gasket	Check wear condition.	Replace
38	oil seal	Check wear condition	Replace
54	thread seal	Check wear condition.	Thread seal 54 and O-Rings 55
55	O-ring	Check wear condition.	69-2 and 69-3 can be used unless
68-2	O-ring	Check wear condition	oil leak, deformation, hardening or
69-2	O-ring	Check wear condition	hair cracks are apparent.
69-3	O-ring	Check wear condition	

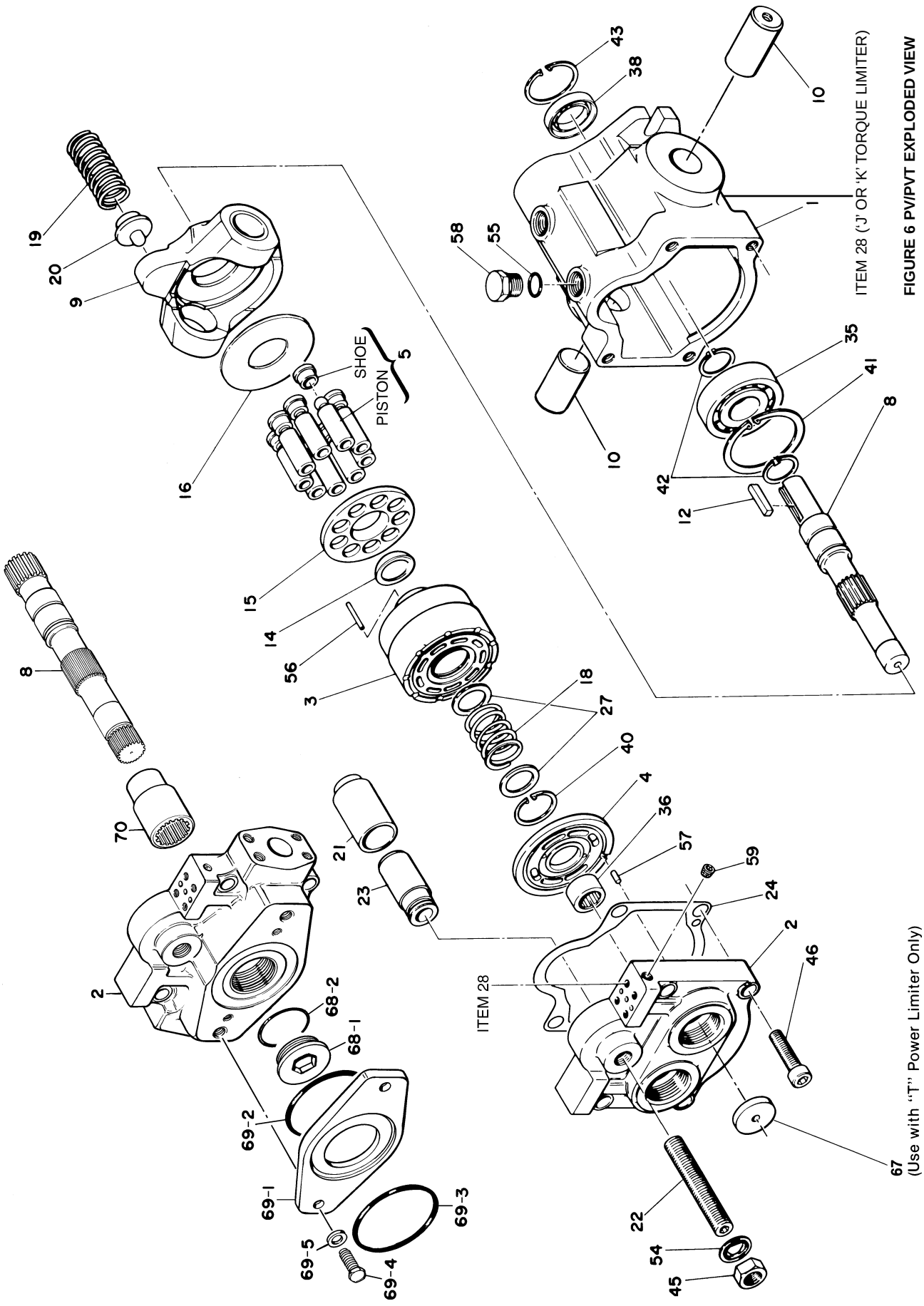


FIGURE 6 PV/PVT EXPLODED VIEW

item	description	PV6/PVT6	PV10/PVT10	PV15/PVT15	PV20/PVT20	PV29/PVT29	qty
1	housing, UNF	039-91366	039-91367	039-91368	039-91369	039-91370	1
	housing, BSPP	039-91371	039-91372	039-91373	039-91374	039-91375	
	housing, UNF for 'J' or 'K' torque limiter	039-92157	039-92158	039-92159	039-92160	039-92161	
	housing, BSPP for 'J' or 'K' torque limiter	039-92177	039-92178	039-92179	039-92180	039-92181	
2	port block assembly-PV, (CW, UNF)	S29-01330	S29-10811	S29-10815	S29-10819	S29-10823	1
	port block assembly-PV, (CCW, UNF)	S29-01335	S29-10812	S29-10816	S29-10820	S29-10824	
	port block assembly-PV, (CW, BSPP)	S29-10891	S29-10813	S29-10817	S29-10821	S29-10825	
	port block assembly-PV, (CCW, BSPP)	S29-10892	S29-10814	S29-10818	S29-10822	S29-10826	
	port block assembly-PVT, (CW)	S29-15439	S29-15440	S29-15441	S29-15442	S29-15443	
	port block assembly-PVT, (CCW)	S29-15434	S29-15435	S29-15436	S29-15437	S29-15438	
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
	port plate, CCW*	039-54045	039-54046	039-54047	039-54048	039-54049	
5	piston & shoe assembly*	S29-01166	S29-01167	S29-01168	S29-01169	S29-01170	9
	shaft, PV, splined, code 1	039-54055	039-54056	039-54057	039-54058	039-54059	
8	shaft, PV, keyed, code 2	039-54050	039-54051	039-54052	039-54053	039-54054	1
	shaft, PVT splined, code 1	039-91958	039-91959	039-91989(2)	039-91961	039-91962	
	shaft, PVT keyed, code 2	039-91963	039-91964	039-91990(1)	039-91966	039-91967	
9	hanger	S29-16587	S29-16588	S29-16589	S29-16590	S29-16455	1
10	trunnion	039-91348	039-91348	039-91349	039-91350	039-91350	2
12	key (keyed shaft only)	039-54075	039-54076	039-54076	039-54078	039-54078	1
14	holddown ball*	039-54254	039-54255	039-54256	039-54257	039-54258	1
15	shoe retainer*	039-54080	039-54081	039-54082	039-54083	039-54084	1
16	wear plate*	039-91351	039-91352	039-91353	039-91354	039-91355	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	adjusting screw	039-91977	039-91977	039-91979	039-91980	039-91980	1
23	guide sleeve (included in port block ass'y)	039-54120	039-54121	039-54122	039-54123	039-54124	
24	gasket♦	039-54125	039-54126	039-54127	039-54128	039-54129	1
27	washer*	039-54135	039-54136	039-54137	039-54138	039-54139	2
28	'C' pressure compensator valve	S29-15104	S29-15104	S29-15104	S29-15104	S29-15104	1
	'F' pressure compensator valve, (UNF)	S29-12120	S29-12120	S29-12120	S29-12120	S29-12120	
	'F' pressure compensator valve, (BSPP)	S29-12121	S29-12121	S29-12121	S29-12121	S29-12121	
	'L' pressure compensator valve, (UNF)	S29-12122	S29-12122	S29-12122	S29-12122	S29-12122	
	'L' pressure compensator valve, (BSPP)	S29-12123	S29-12123	S29-12123	S29-12123	S29-12123	
	'J' torque limiter	S29-15581	S29-15581	S29-16686	S29-15579	S29-15579	
	'K' torque limiter	S29-15526	S29-15525	S29-16687	S29-15523	S29-16686	
	'T' power limiter valve (UNF)	S29-12364	S29-12365	S29-12366	S29-12367	S29-12368	
	'T' power limiter valve (BSPP)	S29-12369	S29-12370	S29-12371	S29-12372	S29-12373	
35	ball bearing	230-03205	230-82054	230-00306	230-82193	230-82193	1
36	needle bearing (included in port block ass'y)	230-82199	230-82200	230-82201	230-82202	230-82203	
38	shaft seal♦	620-82091	620-82091	620-82092	620-82093	620-82093	1
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, SHC	361-10234-8	361-11234-8	361-12254-8	361-10254-8	361-13264-8	4
54	thread seal♦	635-00010	635-00010	635-00006	635-00006	635-00006	1
55	O-ring (for UNF models only)♦	691-00906	691-00908	691-00908	691-00908	691-00908	1
56	dowel	039-57824	039-57825	039-57826	039-57827	039-57828	3
57	pin (included in port block assembly)	324-30015	324-30021	324-30022	324-30022	324-30023	1
58	plug (UNF)	488-35002	488-35002	488-35002	488-35002	488-35002	1
	plug (BSPP)♦	447-01008-2	447-01008-2	447-01008-2	447-01008-2	447-01008-2	
59	plug (included in port block assembly)	447-00026	447-00026	447-00026	447-00026	447-00026	
60	shipping plug-drain (UNF) (not shown)	449-00588	449-00574	449-00574	449-00574	449-00574	1
	shipping plug-drain (BSPP)	449-00599	449-00601	449-00601	449-00601	449-00601	
61	nameplate (not shown)	039-54241	039-54241	039-54241	039-54241	039-54241	1
62	drive screw (not shown)	320-65018	320-65018	320-65018	320-65018	320-65018	4
63	shipping plug-system port (UNF) (not shown)	449-00525	449-00584	449-00584	449-00584	449-00584	1
	shipping plug-system port (BSPP)	449-00600	449-00602	449-00602	449-00602	449-00602	
	shipping plug-system inlet port PVT	S14-08795	S14-08796	S15-08794	S15-08794	S14-09338	
64	shipping plug-system port (UNF) (not shown)	449-00525	449-00584	449-00584	449-00584	449-00584	1
	shipping plug-system port (BSPP)	449-00600	449-00602	449-00602	449-00602	449-00602	
	shipping plug-system outlet port PVT	S14-47691	S14-08795	S14-08795	S14-08795	S14-08795	
66	caution tag (not shown)	FORM 2435	FORM 2435	FORM 2435	FORM 2435	FORM 2435	1
67	inspection tag (not shown)	039-54253	039-54253	039-54253	039-54253	039-54253	1
68-1	plug, PVT less rear mount	488-35019	488-35019	488-35062	488-35062	488-35062	1
68-2	O-ring, PVT less rear mount♦	691-00920	691-00920	691-00924	691-00924	691-00924	1
	shipping cover, PVT/rear mount (not shown)	S24-10537	S24-10538	S24-10538	S24-10539	S24-10539	

(1) SAE 22-1 (SAE B keyed) (2) SAE 22-4 (SAE B splined) (3) SAE 25-1 (SAE B-B keyed) (4) SAE 25-4 (SAE B-B splined)

item	description	PV6/PVT6	PV10/PVT10	PV15/PVT15	PV20/PVT20	PV29/PVT29	qty
69	PVT rear adapter kit, SAE-A	S29-15433	S29-15430	S29-15430	S29-15430	S29-15430	1
	PVT rear adapter kit, SAE-B	N.A.	S29-15431	S29-15431	S29-15431	S29-15431	
	PVT rear adapter kit, SAE-C	N.A.	S29-15432	S29-15432	S29-15432	S29-15432	
69-1	rear mount adapter, PVT/SAE 82-2 (SAE-A)	039-91974	N.A.	N.A.	N.A.	N.A.	1
	rear mount adapter, PVT/SAE 101-2 (SAE-B)	N.A.	039-91975	039-91975	039-91975	039-91975	
	rear mount adapter, PVT/SAE-127-2 (SAE-C)	N.A.	039-91976	039-91976	039-91976	039-91976	
69-2	O-ring, PVT/rear mount adapter♦	671-00140	671-00152	671-00152	671-00152	671-00152	1
69-3	O-ring, PVT/SAE 82-2 (SAE-A)♦	671-00152	671-00152	671-00152	671-00152	671-00152	1
	O-ring, PVT/SAE 101-2 (SAE-B)♦	N.A.	671-00155	671-00155	671-00155	671-00155	
	O-ring, PVT/SAE 127-2 (SAE-C)♦	N.A.	671-00159	671-00159	671-00159	671-00159	
69-4	screw, PVT/SAE 82-2 (SAE-A)	306-40108	306-40026	306-40026	306-40026	306-40026	2
	screw, PVT/SAE 101-2 (SAE-B)	N.A.	306-40018	306-40018	306-40018	306-40018	
	screw, PVT/SAE 127-2 (SAE-C)	N.A.	306-40008	306-40008	306-40008	306-40008	
69-5	washer, PVT/SAE 82-2 (SAE-A)	350-10145	350-10145	350-10145	350-10145	350-10145	2
	washer, PVT/SAE 101-2 (SAE-B)	N.A.	350-10146	350-10146	350-10146	350-10146	
	washer, PVT/SAE 127-2 (SAE-C)	N.A.	350-10147	350-10147	350-10147	350-10147	
70	coupling, PVT/SAE 16-4 on SAE 82-2 rear pad (SAE-A splined on SAE-A rear pad)	039-91985	039-91986	039-91986	039-91987	039-91987	1
	coupling, PVT/SAE 22-4 on SAE 82-2 rear pad (SAE-B splined on SAE-A rear pad)	039-91968	039-91981	039-91981	039-91988	032-91988	
	coupling, PVT/SAE 22-4 on SAE 101-2 rear pad (SAE-B splined on SAE-B rear pad)	N.A.	039-91969	039-91969	039-91971	039-91971	
	coupling, PVT/SAE 25-4 on SAE 101-2 rear pad (SAE-B-B splined on SAE-B rear pad)	N.A.	N.A.	039-91970	039-91972	039-91972	
	coupling, PVT/SAE 32-4 on SAE 127-2 rear pad (SAE-C splined on SAE-C rear pad)	N.A.	N.A.	N.A.	039-91973	039-91973	
	S-1 seal kit (SAE)	S29-15454-0	S29-15455-0	S29-15456-0	S29-15457-0	S29-15458-0	
	S-5 seal kit (SAE)	S29-15454-5	S29-15455-5	S29-15456-5	S29-15457-5	S29-15458-5	
	S-1 seal kit (BSPP)	S29-15459-0	S29-15460-0	S29-15461-0	S29-15462-0	S29-15463-0	
	S-5 seal kit (BSPP)	S29-15459-5	S29-15460-5	S29-15461-5	S29-15462-5	S29-15463-5	
	rotating group parts kit (CW rotation)	S29-12833	S29-12835	S29-12837	S29-12839	S29-12841	
	rotating group parts kit (CCW rotation)	S29-12834	S29-12836	S29-12838	S29-12840	S29-12842	

ITEM 28 'C' PRESSURE COMPENSATOR VALVE

28-1	body and spool	S29-15170	S29-15170	S29-15170	S29-15170	S29-15170	1
28-2	spool (part of 28-1)						
28-3	cap	039-54142	039-54142	039-54142	039-54142	039-54142	1
28-4	spring seat	039-91558	039-91558	039-91558	039-91558	039-91558	1
28-5	spring seat	039-91560	039-91560	039-91560	039-91560	039-91560	1
28-6	spring	039-91557	039-91557	039-91557	039-91557	039-91557	1
28-8	O-ring♦	605-10056	605-10056	605-10056	605-10056	605-10056	1
28-9	O-ring♦	691-00111	691-00111	691-00111	691-00111	691-00111	1
28-10	O-ring♦	605-10058	605-10058	605-10058	605-10058	605-10058	3
28-11	adjusting screw, 3/8-16 UNCx7/8	311-45053	311-45053	311-45053	311-45053	311-45053	1
28-12	hex nut, 3/8-16 UNC	335-16001	335-16001	335-16001	335-16001	335-16001	1
28-13	screw	361-08704-8	361-08704-8	361-08704-8	361-08704-8	361-08704-8	4
28-14	plug	431-90104	431-90104	431-90104	431-90104	431-90104	1

ITEM 28 'F' & 'L' PRESSURE COMPENSATOR VALVE

28-1	body and spool (UNF)	S29-11822	S29-11822	S29-11822	S29-11822	S29-11822	1
	body and spool (BSPP)	S29-11823	S29-11823	S29-11823	S29-11823	S29-11823	
28-2	spool (part of 28-1)						
28-3	cap	039-54142	039-54142	039-54142	039-54142	039-54142	1
28-4	spring seat	039-54143	039-54143	039-54143	039-54143	039-54143	1
28-5	spring seat	033-57530	033-57530	033-57530	033-57530	033-57530	1
28-6	spring	039-57806	039-57806	039-57806	039-57806	039-57806	1
28-7	spring	039-59945	039-59945	039-59945	039-59945	039-59945	1
28-8	O-ring♦	605-10056	605-10056	605-10056	605-10056	605-10056	1
28-9	O-ring♦	691-00111	691-00111	691-00111	691-00111	691-00111	1
28-10	O-ring♦	605-10058	605-10058	605-10058	605-10058	605-10058	3
28-11	adjusting screw, 3/8-16 UNCx7/8	311-45053	311-45053	311-45053	311-45053	311-45053	2
28-12	hex nut, 3/8-16 UNC	335-16001	335-16001	335-16001	335-16001	335-16001	1
28-13	screw	361-08284-8	361-08284-8	361-08284-8	361-08284-8	361-08284-8	4
28-14	plug	431-90104	431-90104	431-90104	431-90104	431-90104	1
28-15	seat	039-57952	039-57952	039-57952	039-57952	039-57952	1
28-16	cone	039-59948	039-59948	039-59948	039-59948	039-59948	1
28-18	setscrew, 3/8-16	039-59949	039-59949	039-59949	039-59949	039-59949	1
28-19	seal♦	635-00002	635-00002	635-00002	635-00002	635-00002	1
28-20	plug	431-90400	431-90400	431-90400	431-90400	431-90400	1
28-21	plug	488-35001	488-35001	488-35001	488-35001	488-35001	1
28-22	acorn nut, 3/8-16 UNC	327-16000	327-16000	327-16000	327-16000	327-16000	1
28-23	washer	350-10122	350-10122	350-10122	350-10122	350-10122	1
28-24	pin **(used in 'L' compensator valves only)**	324-30016	324-30016	324-30016	324-30016	324-30016	1
28-25	orifice	039-91181	039-91181	039-91181	039-91181	039-91181	1
28-26	O-ring♦	691-00904	691-00904	691-00904	691-00904	691-00904	1

ITEM 28, 'J' AND 'K' TORQUE LIMITER VALVE (USE WITH 'F' OR 'L' COMPENSATOR VALVE)

item	description	PV6/PVT6	PV10/PVT10	PV15/PVT15	PV20/PVT20	PV29/PVT29	qty
	assembly no. 'J' torque limiter	S29-15581	S29-15581	S29-16686	S29-15523	S29-15579	1
	assembly no. 'K' torque limiter	S29-15526	S29-15525	S29-16687	S29-15523	S29-16686	
28-1	plug	039-92273	039-92273	039-92273	039-92273	039-92273	1
28-2	screw, 5/16-24	312-13200	312-13200	312-13200	312-13200	312-13200	1
28-3	acorn nut, 5/16-24	327-25006	327-25006	327-25006	327-25006	327-25006	1
28-4	seal piston	032-59367	032-59367	032-59367	032-59367	032-59367	1
28-5	main spring, 'J' torque limiter	225-92098	225-92098	225-92100	225-92110	033-70512	1
	main spring, 'K' torque limiter	225-92101	225-92096	225-92098	225-92110	225-92100	
28-6	sleeve	032-91437	032-91437	032-91437	032-91437	032-91437	1
28-7	feedback arm	032-92136	032-92136	032-92137	032-92137	032-92137	1
28-8	spool	032-91438	032-91438	032-91438	032-91438	032-91438	1
28-9	spring hat	033-92139	033-92139	033-92139	033-92139	033-92139	1
28-10	dowel, 1/4 x 2-1/4	324-21636	324-21636	324-21636	324-21636	324-21636	1
28-11	plug, 1/16 NPT	431-90104	431-90104	431-90104	431-90104	431-90104	1
28-12	screw, SHC	361-08255	361-08255	361-08255	361-08255	361-08255	4
28-13	pivot plug	039-92156	039-92156	039-92156	039-92156	039-92156	2
28-14	washer	033-92144	033-92144	033-92144	033-92144	033-92144	1
28-15	return spring	225-92114	225-92114	225-92114	225-92114	225-92114	1
28-16	body	033-92135	033-92135	033-92135	033-92135	033-92135	1
28-17	gasket	033-92138	033-92138	033-92138	033-92138	033-92138	1
28-18	dowel rod, 1/8 x 1.75	324-20828	324-20828	324-20828	324-20828	324-20828	1
28-19	O-ring♦	691-00012	691-00012	691-00012	691-00012	691-00012	1
28-20	nut, 5/16-24	335-13100	335-13100	335-13100	335-13100	335-13100	1
28-21	elbow	033-91702	033-91702	033-91702	033-91702	033-91702	1
28-22	washer	345-10012	345-10012	345-10012	345-10012	345-10012	4
28-23	O-ring♦	671-00010	671-00010	671-00010	671-00010	671-00010	4
28-24	bushing	216-10010	216-10010	216-10010	216-10010	216-10010	2
28-25	dowel, 3/32 x 3/4	324-20610	324-20610	324-20610	324-20610	324-20610	1
28-26	orifice, .047," 1.2 mm	035-25528	035-25528	035-25528	035-25528	035-25528	1
28-27	O-ring♦	691-00904	691-00904	691-00904	691-00904	691-00904	1
28-28	O-ring♦	691-00903	691-00903	691-00903	691-00903	691-00903	1
28-29	tube, (connects 'F' control to torque limiter) CW	039-92174	039-92175	039-92176	039-92167	039-92168	1
	tube, (connects 'F' control to torque limiter) CCW	039-92169	039-92170	039-92171	039-92172	039-92173	

ITEM 28, T' POWER LIMITER VALVE

	assembly no., UNF	S29-12364	S29-12365	S29-12366	S29-12367	S29-12368	
	assembly no., BSPP	S29-12369	S29-12370	S29-12371	S29-12372	S29-12373	
28-1	body and spool	S29-12226	S29-12226	S29-12226	S29-12226	S29-12226	1
28-2	spool (part of 28-1)						
28-3	cap	039-54142	039-54142	039-54142	039-54142	039-54142	1
28-4	spring seat	039-91558	039-91558	039-91558	039-91558	039-91558	1
28-5	spring seat	033-91560	033-91560	033-91560	033-91560	033-91560	1
28-6	spring	225-92094	225-92094	225-92094	225-92094	225-92094	1
28-7	spring	039-59945	039-59945	039-59945	039-59945	039-59945	1
28-8	O-ring♦	605-10056	605-10056	605-10056	605-10056	605-10056	1
28-9	O-ring♦	691-00111	691-00111	691-00111	691-00111	691-00111	1
28-10	O-ring♦	605-10058	605-10058	605-10058	605-10058	605-10058	3
28-11	adjusting screw, 3/8-16 UNCx7/8	311-45053	311-45053	311-45053	311-45053	311-45053	1
28-12	hex nut, 3/8-16 UNC	335-16001	335-16001	335-16001	335-16001	335-16001	3
28-13	screw	361-08284-8	361-08284-8	361-08284-8	361-08284-8	361-08284-8	4
28-14	plug	431-90104	431-90104	431-90104	431-90104	431-90104	1
28-15	seat	039-57952	039-57952	039-57952	039-57952	039-57952	1
28-16	cone	039-59948	039-59948	039-59948	039-59948	039-59948	1
28-17	ball	201-10001	201-10001	201-10001	201-10001	201-10001	1
28-18	setscrew, 3/8-16	039-59949	039-59949	039-59949	039-59949	039-59949	2
28-19	seal♦	635-00002	635-00002	635-00002	635-00002	635-00002	2
28-20	plug	449-00510	449-00510	449-00510	449-00510	449-00510	1
28-21	O-ring♦	691-00904	691-00904	691-00904	691-00904	691-00904	1
28-22	acorn nut, 3/8-16 UNC	327-16000	327-16000	327-16000	327-16000	327-16000	2
28-23	washer	350-10122	350-10122	350-10122	350-10122	350-10122	1
28-24	pin	324-20818	324-20818	324-20818	324-20818	324-20818	1
28-25	seat	039-57953	039-57953	039-57953	039-57953	039-57953	1
28-26	spring	039-57982	039-57982	039-57982	039-57982	039-57982	1
28-27	fitting	039-57950	039-57950	039-57950	039-57950	039-57950	1
28-28	orifice (in 'P' port of pump)	039-57983	039-57984	039-57985	039-57986	039-57987	1
28-29	fitting (UNF)	039-57997	039-57997	039-57997	039-57997	039-57997	1
	fitting (BSPP)	039-57998	039-57998	039-57998	039-57998	039-57998	
28-30	orifice, .0625", 1.59 mm	036-20641	036-20641	036-20641	036-20641	036-20641	1

* part of rotating group part kit

♦Items included in seal kit. Seals must be ordered as a complete kit

NOTE: For rotation change, both port block (2) and port plate (4) must be changed.

NOTE: Spool and body, 28-1 & 28-2, are a matched set. Change entire assembly, do not attempt to change separately.

CLEANING AND INSPECTION

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.

Check the disassembled parts with the exploded view given in Fig. 6 for any missing parts or irregularities. Use emery paper #600 to #800 to remove any slight corrosion.

HOUSING AND SHAFT SEAL

Check deformation of retaining rings. If deformed, replace.

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

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.

Use push rod and slowly press the oil seal into the housing 1 until seated. Use tool (Fig. 1). Install retaining ring 43.

SHAFT AND BEARING

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.

Assemble the first retaining ring 42 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.

Press ball bearing onto the drive shaft 8. Install the other retaining ring 42.

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

series	bearing number	pressing force	
		lb.	N
PV/PVT6	230-03205	1330	5900
PV/PVT10	230-82054	1500	6700
PV/PVT15	230-03206	1690	7500
PV/PVT20	230-82193	2200	9800
PV/PVT29	230-82193	2200	9800

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

HOUSING AND SHAFT

Fit a protective cone (Fig. 3) for oil seal on the shaft end and apply a light coat of lithium grease on the outer surface. Carefully assemble the drive shaft 8 into the housing 1.

Assemble retaining ring 41 into the housing.

HOUSING AND HANGER

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

Lightly coat the wear plate 16 with grease and mate to hanger 9. Fit into the housing.

Install undersize trunnion pin, (Fig. 4) into one side of hanger housing, aligning with bore in hanger.

Apply a very, very light coating (almost transparent) of anaerobic pipe sealant (Loctite Pipe Sealant with Teflon, Prolok Pipe Sealant with Teflon, or equal) to the opposite trunnion bore in the housing. This is to seal any slight imperfections of the bores or trunnion pin.

Using 6 ton max. force, press the trunnion pin flush with the housing boss.

Remove the assembly pin from the opposite side and repeat above steps on that side.

BARREL HOLDDOWN

Place the cylinder barrel 3 on a fixture and insert washers 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. 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.

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 holddown ball 14 on top.

Compress manually and ascertain spring 18 force.

BARREL, PISTON/SHOE/RETAINER

Hold the shoe retainer 15 horizontally with one hand, insert the 9 piston assemblies 5 into the bores of the shoe retainer, in order of disassembly. The shoes should freely move on the piston.

Support the shoe retainer horizontally and insert the piston assemblies 5 carefully into the cylinder barrel bores 3.

HOUSING AND ROTATING GROUP

Place the housing 1 so that the drive shaft 8 is horizontal. Assemble the cylinder barrel 3, piston assembly 5, holddown ball 14 and shoe retainer 15 together onto the drive shaft.

Do not force the drive shaft spline into the cylinder barrel groove but carefully rotate to engage, 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.

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.

PORT BLOCK ASSEMBLY

Press needle bearing 36 into port block,till bearing bottoms in the bore. Press on the stamped side of the needle bearing.

Place port block on press with support under adjusting screw pad. Press guide sleeve 23 into port block.

Assemble the plunger 21 and port plate 4 onto the port block 2. Note Figure 7 for correct location and placement of port plate.

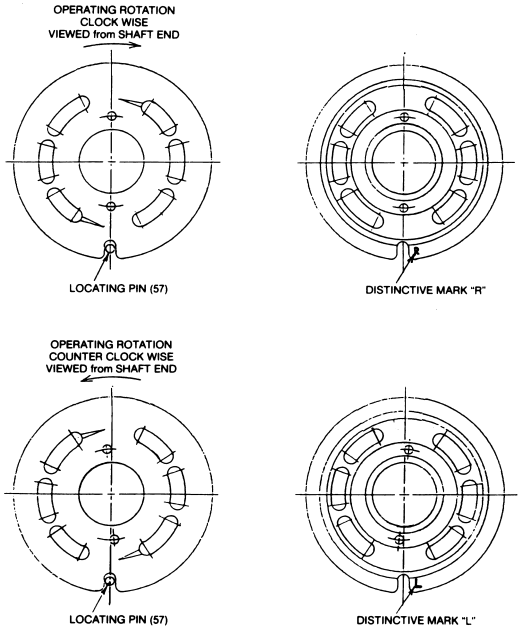


FIGURE 7
port plate installation

FIGURE 7

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 6).

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

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.

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

TORQUE ON HOUSING BOLTS

The final tightening torque should be as follows:

series	lb.-ft		Nm	
	min.	max.	min.	max
PV/PVT6	14.0	16.0	19.0	21.7
PV/PVT10	**2**5.0	29.0	33.9	39.3
PV/PVT15	**56**.0	61.0	75.9	82.7
PV/PVT20	**56**.0	61.0	75.9	82.7
PV/PVT29	100.0	110.0	135.6	149.1

'C' COMPENSATOR

'C' Compensator valve 28 is assembled as follows: (See figure 8)

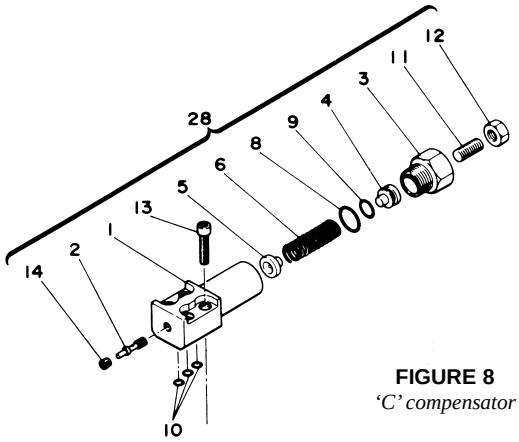
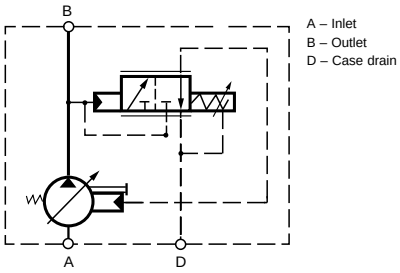


FIGURE 8
'C' compensator

FIGURE 8
'C' compensator assembly



'C' COMPENSATOR CIRCUIT

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

Check O-Rings 28-8 and 28-9 for deformation and wear (as given in no. 28 of "INSPECTION") and when determined to be in good condition, assemble 28-8 to cap, 28-3, and 28-9 to spring seat 28-4.

Carefully insert spool 28-2 into the bore in the valve body 28-1. (Spool and body are matched set.) Install plug 28-14 in body.

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

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.
After checking the O-ring 28-10 for deformation and wear, coat the mounting surface facing the valve body with lithium grease and install the O-ring.

'F' & 'L' COMPENSATOR

'F' and 'L' Compensator valve 28 is assembled as follows: (See figure 9)

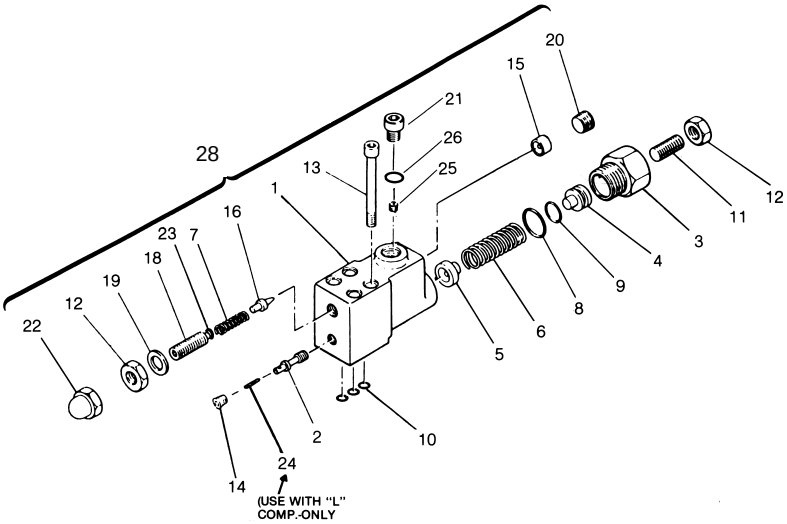
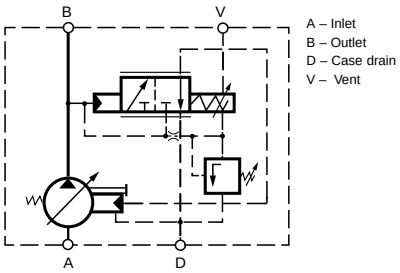
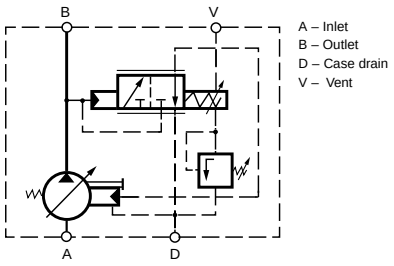


FIGURE 9
'F' & 'L' compensator

FIGURE 9
'F' & 'L' compensator assembly



'F' COMPENSATOR CIRCUIT



'L' COMPENSATOR CIRCUIT

Carefully clean the valve body 28-1 and spool 28-2 and soak in clean hydraulic fluid. Check O-Rings 28-8 and 28-9 for deformation and wear (as given in no. 28 of "INSPECTION") and when determined to be in good condition, assemble 28-8 to cap, 28-3, and 28-9 to spring seat 28-4.

For the 'L' compensator only, install pin 28-4 into spool 28-2.

Carefully insert spool 28-2 into the bore in the valve body 28-1. (Spool and body are matched set.) Install plug 28-14 in body.

Assemble spring seats 28-4 and spring seat 28-5 on both ends of the spring 28-6 and assemble into the valve body.

With adjusting screw 28-11 and nut 28-22 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.

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

Assemble washer 28-19 and spring 28-7 on adjusting screw 28-18, assemble cone 28-16 in spring and assemble into the valve body.

Set adjusting screw to measurement taken at disassembly and lock in place with nut 28-12 Cover with acorn nut 28-22.

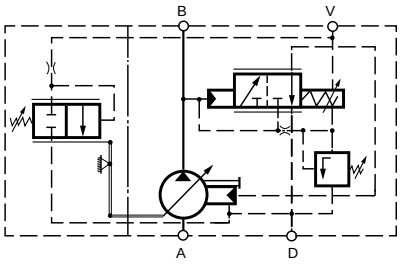
After checking the O-ring 28-10 for deformation and wear, coat the mounting surface facing the valve body with lithium grease and install the O-ring.

'J' AND 'K' TORQUE LIMITER

The torque limiter functions in conjunction with the 'F' or 'L' compensator described previously.

See figure 10. Place spring hat 9, spring 5, and seal piston 4 with o-ring 19 in bore, then follow with plug 1, screw 2, and nuts 20 and 3.

Press dowel 25 into fedback arm 7.



'J' AND 'K' TORQUE LIMITER CIRCUIT

Using grease to hold it in place, place sleeve 6 on dowel 25 in hole in feedback arm 7, then place feedback arm in body 16 so that spool 8 can be slid thru front bore in body, sleeve and rear bore in body.

With orifice 26 in elbow 21 and o-ring 19 in place on elbow, screw elbow into port.

Carefully slide dowel rod 18 thru feedback arm and then screw pivot plugs into body to retain each end of pivot rod.

Slide dowel 10 into body and thru feedback arm. Put washer 22 on dowel, and follow with spring 15. Push dowel in until it touches rear of body, letting it capture spring 15, then tighten plug 11 into body.

Check that feedback arm can pivot as to touch body at each end of its throw.

Assemble screws 12 with washers 14 and o-rings 23 and place in body. Place gasket 17 over screws and on body.

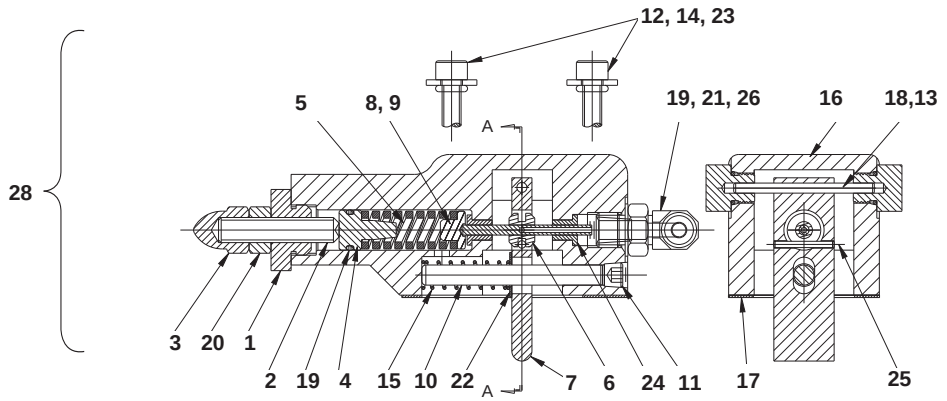


FIGURE 10
'J' and 'K' torque limiter

SECTION A-A

T' POWER LIMITER

'T' power limiter valve 28 is assembled as follows:
See figure 11. Carefully clean the valve body 28-1 and spool 28-2 and soak in clean hydraulic fluid.

Install orifice 28-30 in body as shown.

To install seat 28-15, insert open end into bore and press in place, beyond the threaded hole for fitting, 28-27. Install fitting 28-29, tighten with port offset away from spring cavity, to allow installing the cap, 28-3.

Carefully insert spool 28-2 into the bore in the valve body 28-1. (Spool and body are matched set.) Install plug 28-14 in body.

Check O-Rings 28-8 and 28-9 for deformation and wear (as given in no. 28 of "INSPECTION") and when determined to be in good condition, assemble 28-8 to cap, 28-3, and 28-9 to spring seat 28-4.

Assemble spring seats 28-4 and spring seat 28-5 on both ends of the spring 28-6 and assemble into the valve body.

With adjusting screw 28-11 and nut 28-12 set on the cap, 28-3, 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.

Assemble washer 28-19 and spring 28-7 on adjusting screw 28-18, assemble cone 28-16 in spring and assemble into the valve body.

Set adjusting screw to measurement taken at disassembly and lock in place with nut 28-12 Cover with acorn nut 28-22.

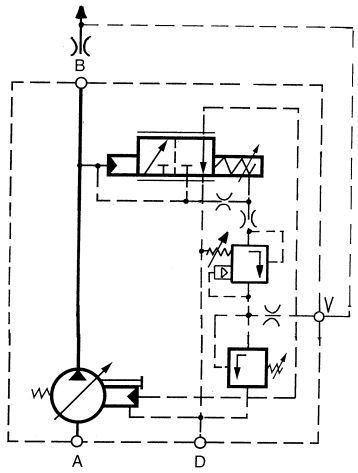
Place ball 28-17 in body above orifice 28-2.

Insert pin 28-24 into fitting assembly 28-27 and tighten in valve body.

Assemble seat 28-25, spring 28-26 washer 28-19 and nut 28-12 on adjusting screw 28-18.

Set adjusting screw to measurement taken at disassembly and lock in place with nut 28-12. Cover with acorn nut 28-22.

After checking the O-ring 28-10 for deformation and wear, coat the mounting surface facing the valve body with lithium grease and install the O-ring.



'T' POWER LIMITER CIRCUIT

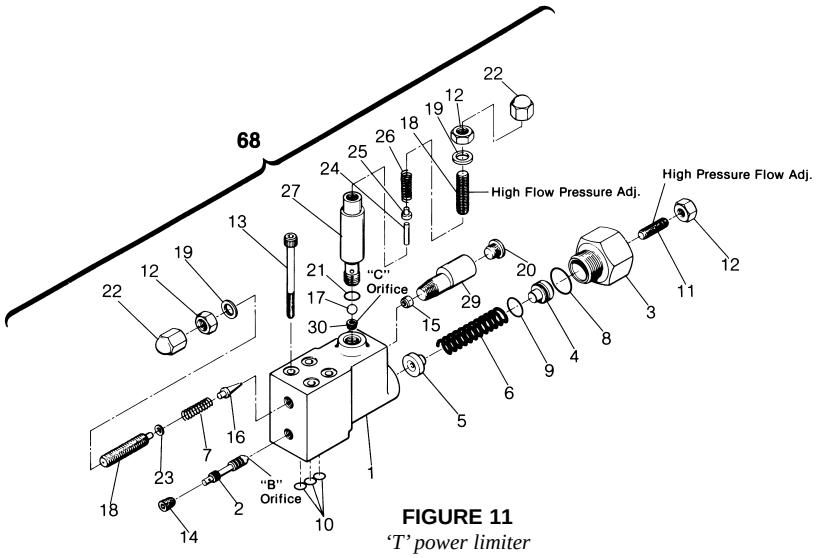


FIGURE 11
'T' power limiter

FINAL ASSEMBLY

Assemble compensator or power limiter valve 28 on the mounting pad of port block. The tightening torque is as follows: 8.3 to 9.7 lbs.-ft., 11 .3 to 13.2 Nm.

If the pump contains the 'J' or 'K' torque limiter, place the control on its mounting pad with the feedback arm on the barrel side of the hanger, with the adjustment facing the same way. The feedback arm will bear against the hanger with the force of the return spring, item 15. Be sure the gasket is positioned and the O-rings are on the cap screws, then tighten the cap screws to 8.3 to 9.7 lbs.-ft., 11 .3 to 13.2 Nm.

Attach the connecting tube to the fitting on the front of the torque limiter body and the other end to the 'F' control on the top of the pump.

Install thread seal 54 and hex nut 45 to adjusting screw 22 and then screw into the hole on port block till screw contacts piston. Set to the desired stroke using table given below and lock with hex nut.

max. volume adjustment screw 22

	unit	PV6 PVT6	PV10 PVT10	PV15 PVT15	PV20 PVT20	PV29 PVT29
number of turns full to zero		8.5	8.5	8.5	9.7	10.5
maximum torque to turn	**in. lbs.**	28	25	41	49	45
adjusting screw	**Nm**	3.2	2.8	4.6	5.5	5.1

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.

For pumps with 'T' power limiter, install orifice 28-28 into the piping port on the side where the power limiter is mounted, and retain with shipping plug.

Screw plug 58 with O-ring 55 to the housing and seal other openings with plastic cap seals or specified covers.

For PVT pumps with auxiliary pump mounted, install coupling 70, adapter 69-1, O-ring 69-2, O-ring 69-3, Install auxiliary pump with screws and washers 69-4 and 69-5. Torque the screws as follows:

rear mount pad	**lb.-ft.**		**Nm**	
	min.	**max.**	**min.**	**max.**
SAE 82-2 (SAE-A)	28	34	38	46
SAE 101-2 (SAE-B)	68	82	90	110
SAE 127-2 (SAE-C)	135	165	180	220

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

TEST CONDITIONS

Operating speed: 1770 ±. 30 RPM
Oil temperature $120^{o} \pm 10^{o}$ F., $49^{o} \pm 5.5^{o}$ C.
Case pressure 3 to 10 PSI, .21 to .69 bar

PUMP TEST

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	PV/PVT6	PV/PVT10	PV/PVT15	PV/PVT20	PV/PVT29
max. rated	psi	3500	3500	3500	3500	3000
continuous pressure	bar	241	241	241	241	241
max. flow at	gpm	7.1	10.3	16.6	21.4	30.4
minimum pressure	l/min.	26.9	39	62.8	81	115
min. flow at max.	gpm	5.9	8.7	14.4	18.6	26.6
rated pressure	l/min.	22.3	32.9	54.5	70.4	100.7
max. case leakage	gpm	.53	.58	.90	1.2	1.5
at rated pressure	l/min.	2.0	2.2	3.4	4.5	5.7

Evaluation Criteria:

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	PV/PVT6	PV/PVT10	PV/PVT15	PV/PVT20	PV/PVT29
max. leakage, ‘C’	gpm	.8	.8	.8	.8	.8
compensator	l/min.	3	3	3	3	3
max leakage,’F’,‘L’,’J’,	gpm	.9	.9	.9	.9	.9
‘K’&‘T’ compensator	l/min.	3.4	3.4	3.4	3.4	3.4

‘C’ COMPENSATOR TEST

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". Flow and leakage readings shall return to rated conditions.

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

‘F’ COMPENSATOR TEST

1. Insert a needle valve in the vent port of ‘F’ compensator. Back main pressure adjustment screw 28-8 out. Set differential adjustment screw 28-11 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 TEST

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 28-18 out. Set differential adjustment screw 28-11 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, re-insert pin into spool.

'J' AND 'K' TORQUE LIMITER

1. Note: on all pump adjustment screws, CW rotation increases the setting, and CCW decreases the setting.

2. On the "F" (or "L") control, back out the maximum pressure adjustment until there is no resistance, and set the differential spool to 250 psi, 17,2 bar. Now the pump will give full flow up to 250 psi, 17,2 bar and then destroke fully.

3. Set the system relief at the desired pressure, and the maximum pressure adjustment on the "F" (or "L") control 250 psi, 17,2 bar lower. It may be necessary to adjust the maximum torque screw in (CW) to keep the pump from destroking before the max. pressure is reached.

4. Set the maximum torque adjustment to obtain the proper torque or flow at the proper pressure.

$$\text{Torque (lbs-in)} = \frac{\text{pressure(psi)} \times \text{flow (gpm)} \times 231}{\text{rpm } 2\pi \times \text{overall. eff.}}$$

$$\text{Flow (gpm)} = \frac{\text{torque (lbs-in)} \times \text{rpm} \times 2\pi \times \text{overall. eff.}}{\text{pressure(psi)} \times 231}$$

or:

$$\text{Torque (Nm)} = \frac{\text{pressure(bar)} \times \text{flow (l/m)} \times 1000}{\text{rpm} \times 20\pi \times \text{overall eff.}}$$

$$\text{Flow (l/m)} = \frac{\text{torque (Nm)} \times \text{rpm} \times 20\pi \times \text{overall. eff.}}{\text{pressure(bar)} \times 1000}$$

5. As an example, settings on a size 20 pump might be as follows:
   Differential spool: 250 psi, 17,2 bar.
   System relief: 3250 psi, 224 bar (relief valve in outlet line)
   Maximum pressure (compensator): 3000 psi, 207 bar
   Maximum torque: 951 lb.-in. at 2500 psi at 1800 rpm, .86 overall efficiency

$$\text{Flow (gpm)} = \frac{951 \times 1800 \times 2\pi \times .86}{2500 \times 231} = 16 \text{ gpm}$$

   or:
   Maximum torque: 107 Nm. at 172 bar at 1800 rpm, .86 overall efficiency

$$\text{Flow (l/m)} = \frac{107 \times 1800 \times 20\pi \times .86}{172 \times 1000} = 60{,}5 \text{ l/m}$$

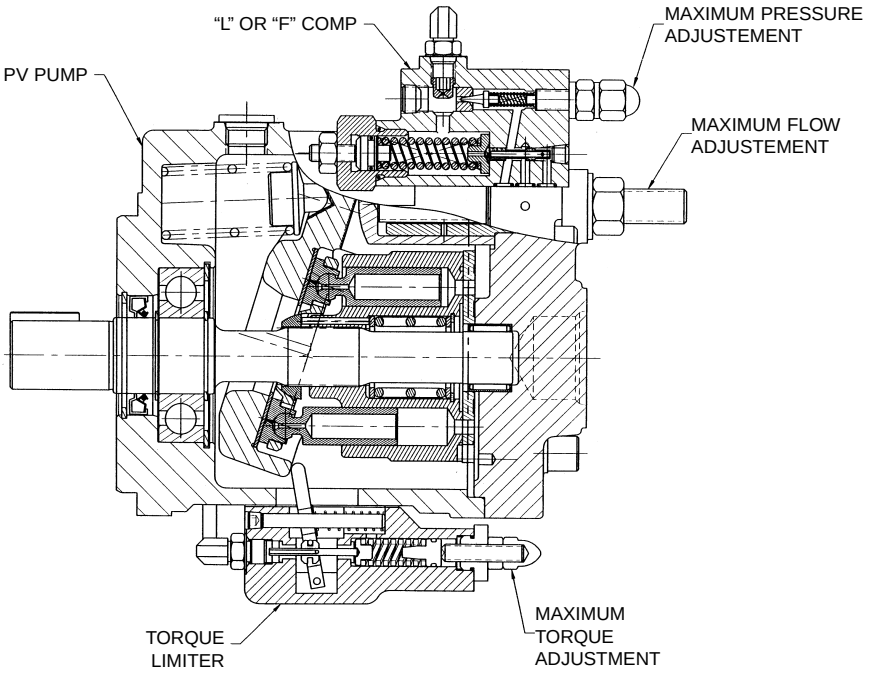


FIGURE 12
'J' and 'K' torque limiter

'T' POWER LIMITER TEST

Power limiter setting consists of first adjusting the flow (1) at the high pressure compensator setting for the required horsepower, then adjusting the high flow pressure adjustment (3) to the required horsepower at full volume. Before plumbing the pressure line to the pump, check for the presence of the orifice 28-28 in the pressure port.

1. Calculate these two settings, (flow at maximum pressure, and pressure at maximum flow) using the equation:

HP= PxQ/ (Eff. x 1714) where P= Pressure in PSI
Q= flow in U.S. GPM

or Kw= PxQ/ (Eff. x 600) where P= Pressure in Bar
Q= flow in LPM

2. Back out adjustment (3) till there is no resistance.

3. Turn in adjustment (2) until it is at least 500 psi, 34,5 bar above the high pressure limit.

4. Start the unit and set the system relief valve to desired high pressure limit.

5. Adjust the flow control setting (1) to achieve the desired flow at the high pressure limit.
6. Set the system relief valve to 200 psi, 14 bar above the desired high pressure compensator setting.

7 Back the compensator adjustment (2) out to the desired setting.

8. Back the system relief valve down to the calculated pressure at maximum flow.

9. Turn the adjustment (3) in until you just reach full flow.

10. Check all adjustments by raising system relief to above the compensator setting. Re-adjust flow control setting (1) if necessary to achieve the calculated high pressure flow.

Note: Electric motor current may be used instead of calculated pressures and flows to set power. In step 5, adjust the flow control setting (1) to achieve the rated motor current. In step 9, turn the adjustment (3) in to achieve rated motor current.

Note: The minimum power setting is normally 30% of full power. (Maximum pressure at full volume.)

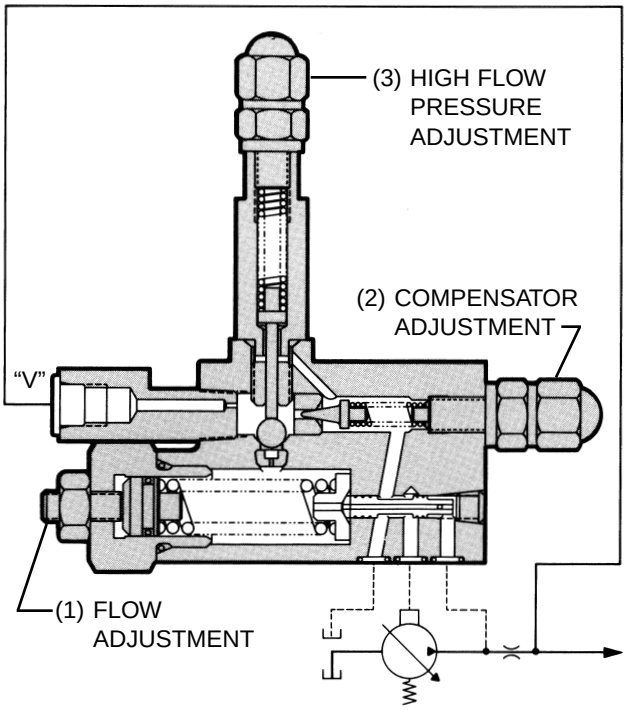
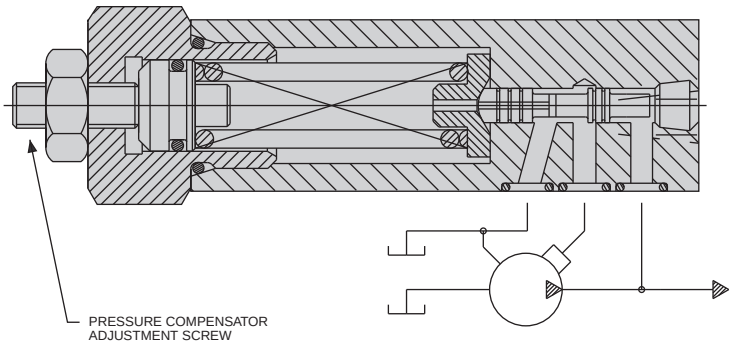
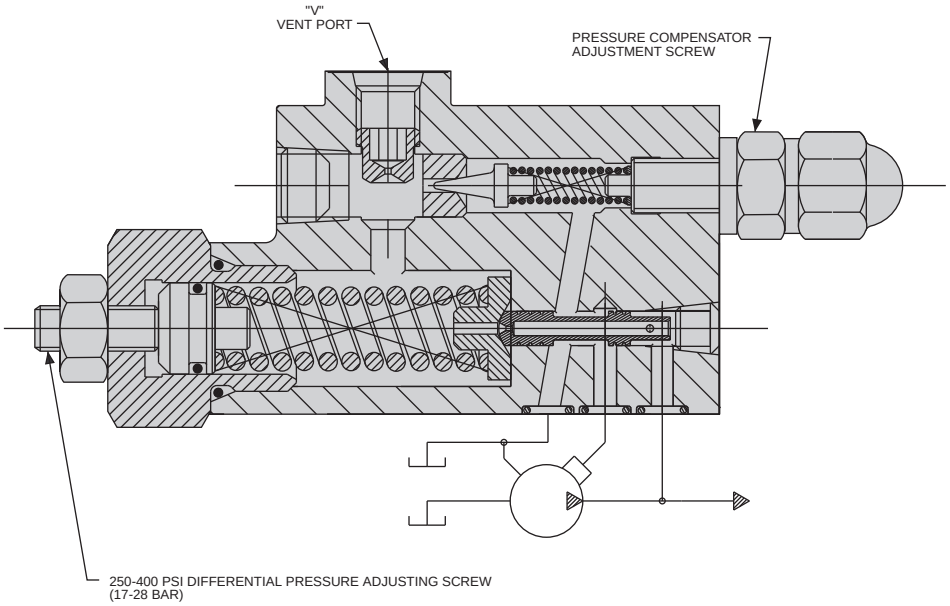


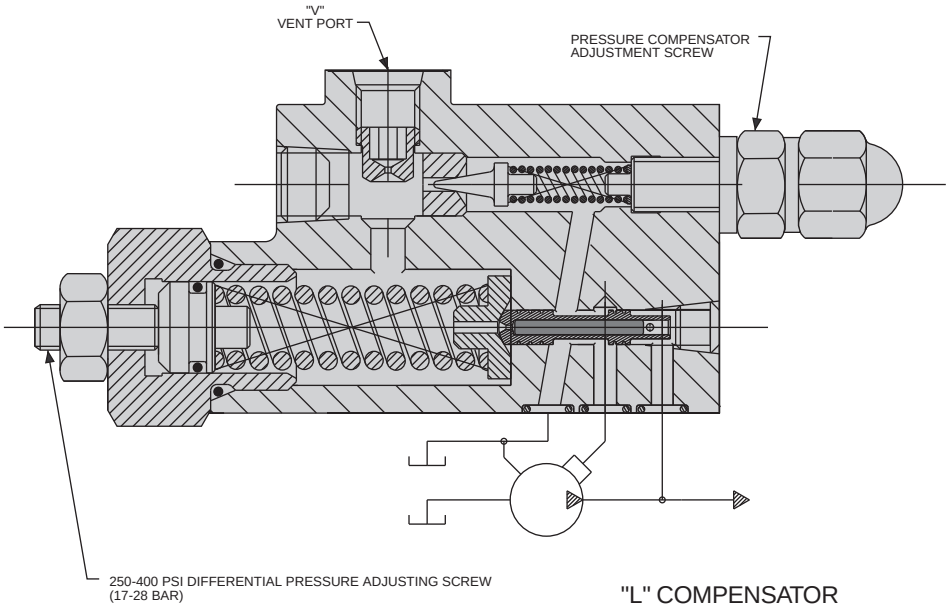
FIGURE 13
'T' power limiter adjustment



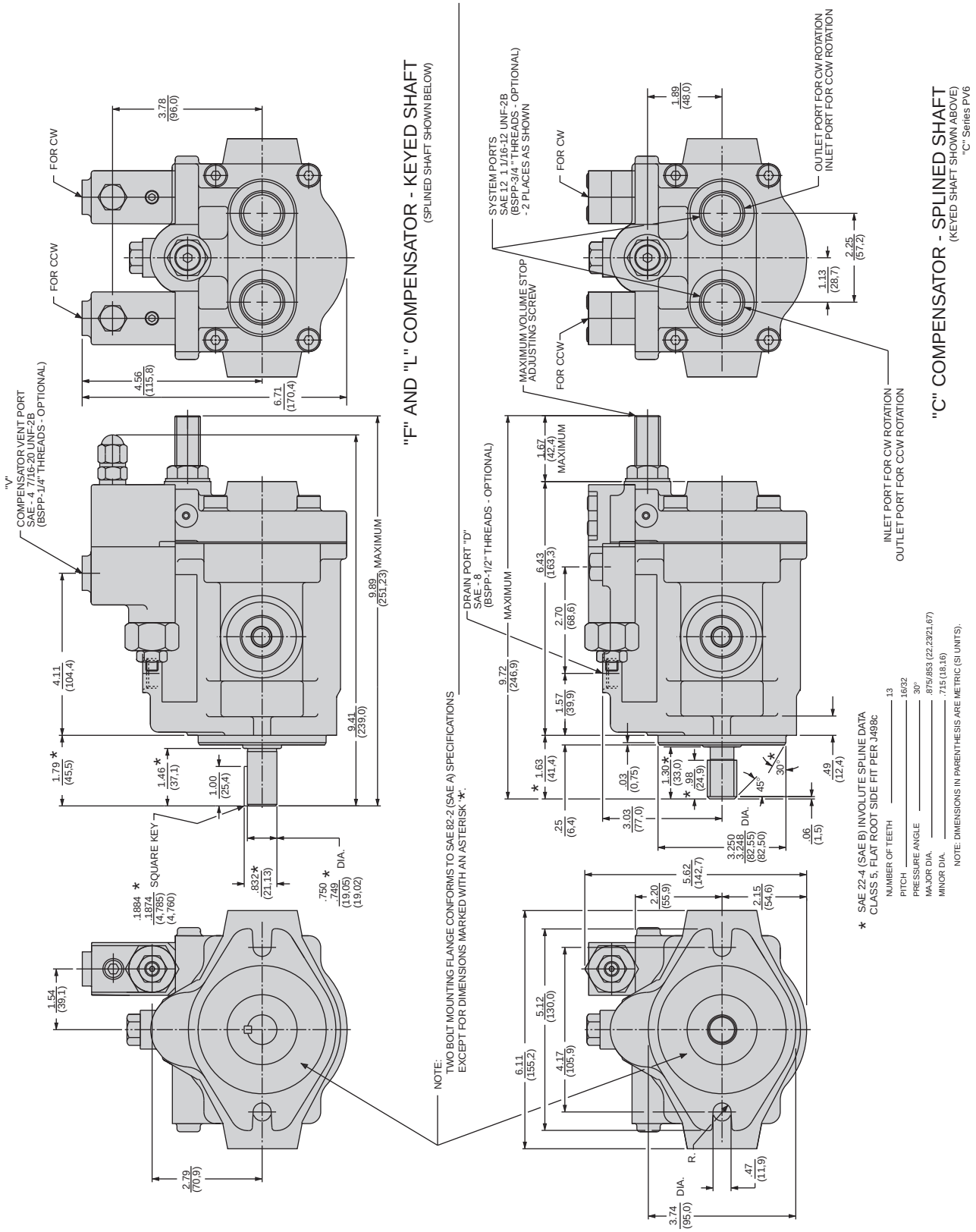
"C" COMPENSATOR

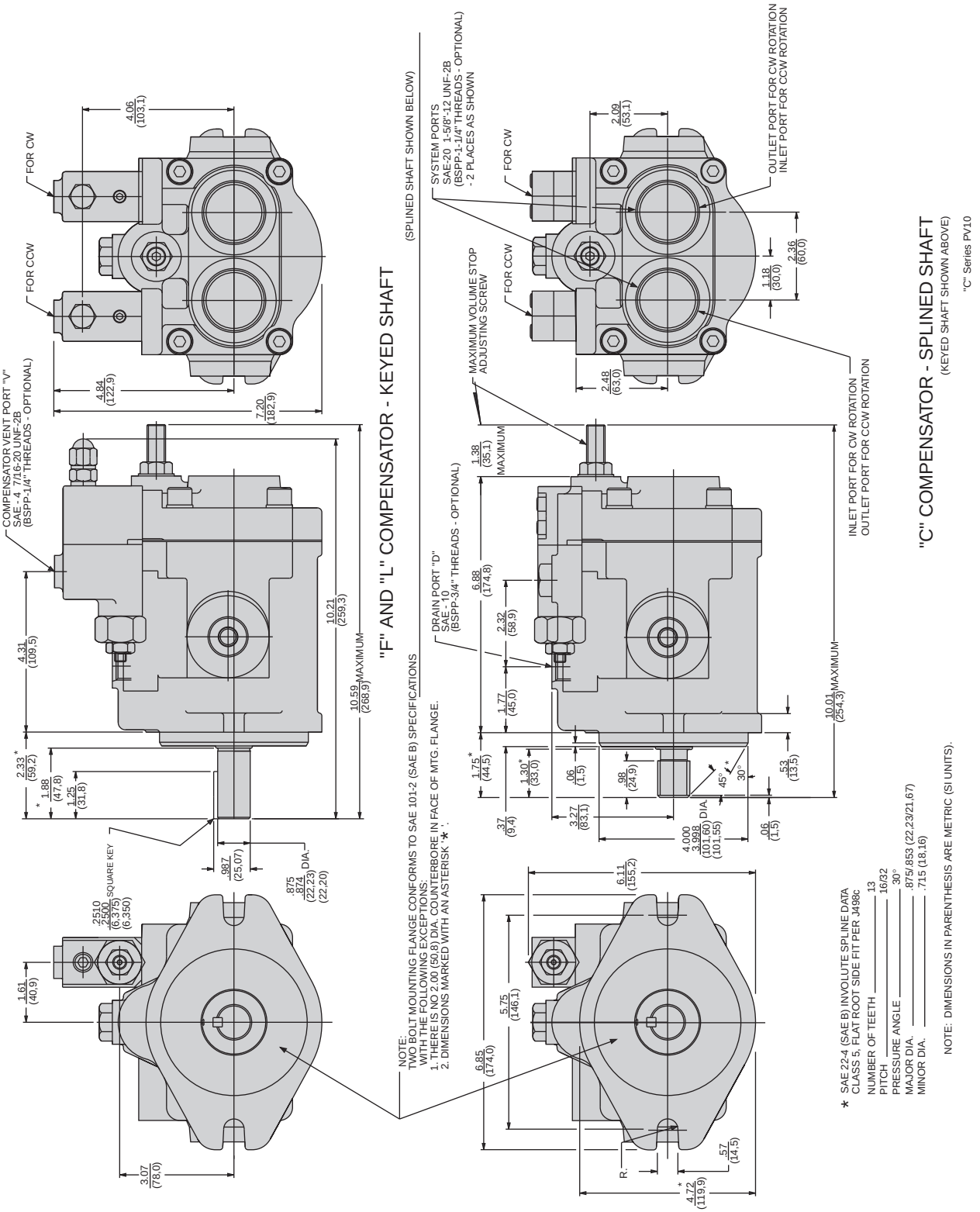


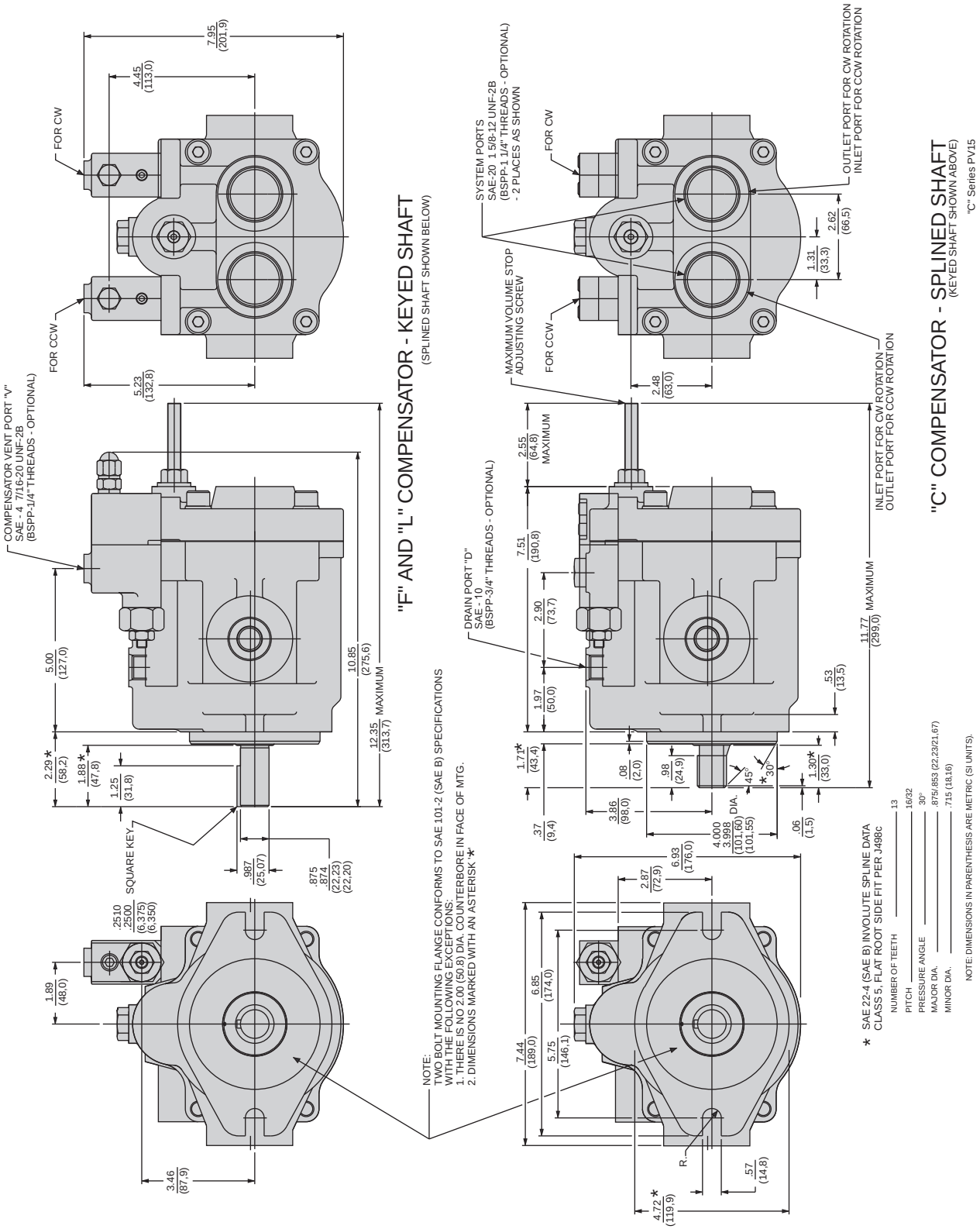
"F" COMPENSATOR

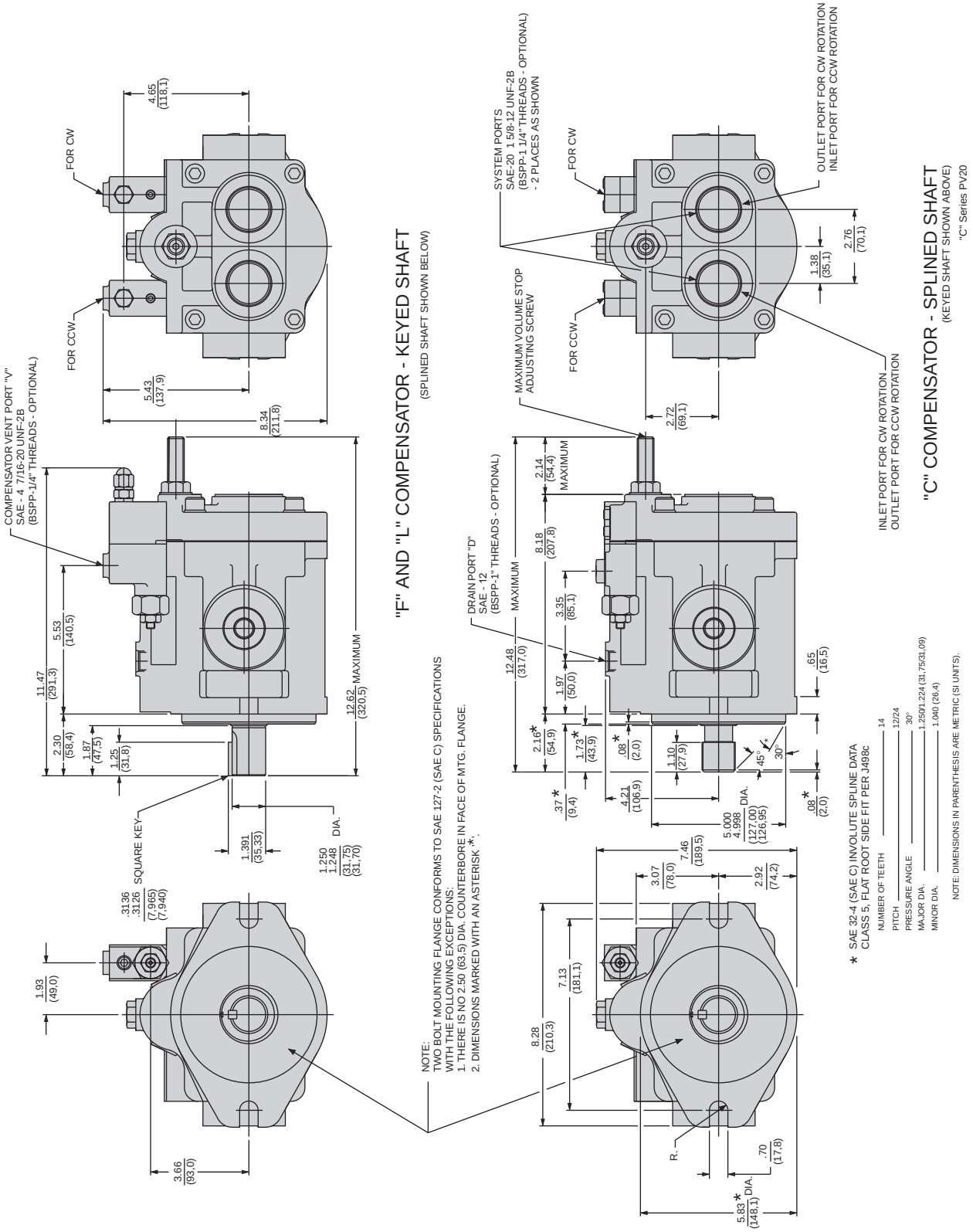


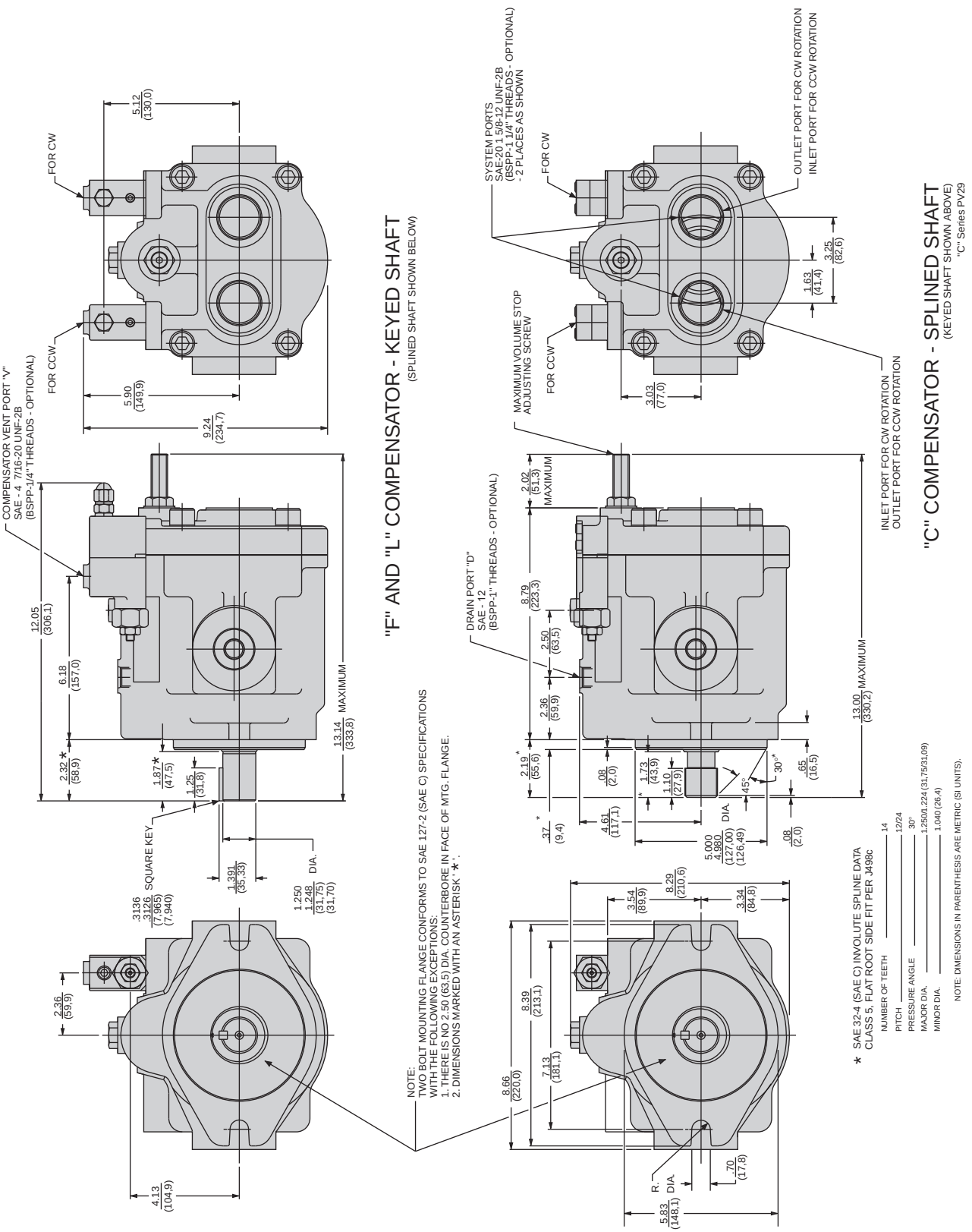
"L" COMPENSATOR

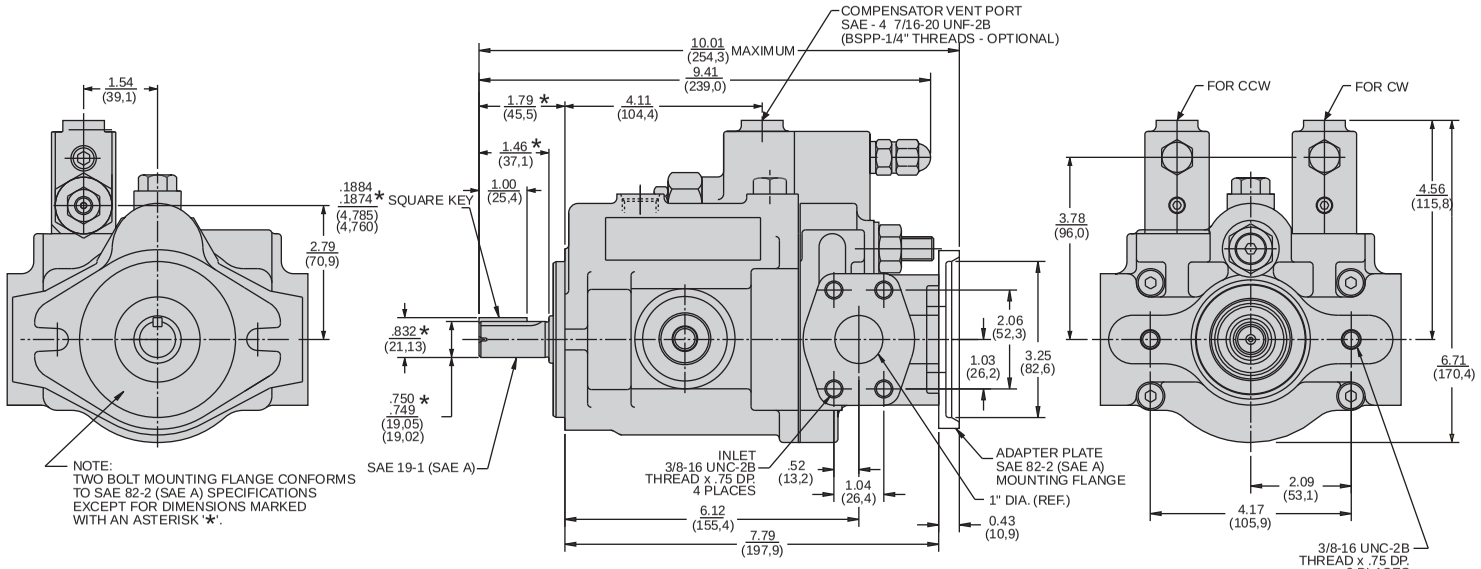

"F" AND "L" COMPENSATOR - KEYED SHAFT
(SPLINED SHAFT SHOWN BELOW)
"C" COMPENSATOR - SPLINED SHAFT
(KEYED SHAFT SHOWN ABOVE)
"C" Series PV6
"V"
COMPENSATOR VENT PORT
SAE - 4 7/16-20 UNF-2B
(BSPP-1/4" THREADS - OPTIONAL)
FOR CW
FOR CCW
3.78 (96,0)
4.56 (115,8)
6.71 (170,4)
4.11 (104,4)
9.89 (251,23) MAXIMUM
9.41 (239,0)
1.79 * (45,5)
1.46 * (37,1)
1.00 (25,4)
.832 * (21,13)
.750 * .749 (19,05) (19,02) DIA.
.1884 * .1874 (4,785) (4,760) SQUARE KEY
1.54 (39,1)
2.79 (70,9)
NOTE:
TWO BOLT MOUNTING FLANGE CONFORMS TO SAE J82-2 (SAE A) SPECIFICATIONS
EXCEPT FOR DIMENSIONS MARKED WITH AN ASTERISK '*'.
SYSTEM PORTS
SAE 12 1 1/16-12 UNF-2B
(BSPP-3/4 "THREADS - OPTIONAL)
- 2 PLACES AS SHOWN
OUTLET PORT FOR CW ROTATION
INLET PORT FOR CCW ROTATION
1.89 (48,0)
2.25 (57,2)
1.13 (28,7)
MAXIMUM VOLUME STOP
ADJUSTING SCREW
DRAIN PORT "D"
SAE - 8
(BSPP-1/2" THREADS - OPTIONAL)
MAXIMUM
1.67 (42,4) MAXIMUM
6.43 (163,3)
2.70 (68,6)
9.72 (246,9)
1.57 (39,9)
* 1.63 (41,4)
.03 (0,75)
1.30 * (33,0)
.98 * (24,9)
45°
30° *
.49 (12,4)
.25 (6,4)
3.03 (77,0)
3.250 3.248 (82,55) (82,50) DIA.
.06 (1,5)
INLET PORT FOR CW ROTATION
OUTLET PORT FOR CCW ROTATION
5.62 (142,7)
2.20 (55,9)
2.15 (54,6)
5.12 (130,0)
6.11 (155,2)
4.17 (105,9)
3.74 (95,0) DIA.
R.
.47 (11,9)
* SAE 22-4 (SAE B) INVOLUTE SPLINE DATA
CLASS 5, FLAT ROOT SIDE FIT PER J498c
NUMBER OF TEETH 13
PITCH 16/32
PRESSURE ANGLE 30°
MAJOR DIA. .875/.853 (22,23/21,67)
MINOR DIA. .715 (18,16)
NOTE: DIMENSIONS IN PARENTHESIS ARE METRIC (SI UNITS).


"F" AND "L" COMPENSATOR - KEYED SHAFT
(SPLINED SHAFT SHOWN BELOW)
"C" COMPENSATOR - SPLINED SHAFT
(KEYED SHAFT SHOWN ABOVE)
"C" Series PV10
NOTE:
TWO BOLT MOUNTING FLANGE CONFORMS TO SAE 101-2 (SAE B) SPECIFICATIONS WITH THE FOLLOWING EXCEPTIONS:
1. THERE IS NO 2.00 (50,8) DIA. COUNTERBORE IN FACE OF MTG. FLANGE.
2. DIMENSIONS MARKED WITH AN ASTERISK (*) :
COMPENSATOR VENT PORT "V"
SAE - 4 (7/16-20 UNF-2B
(BSPP-1/4" THREADS - OPTIONAL)
FOR CW
FOR CCW
4.06 (103,1)
4.84 (122,9)
7.20 (182,9)
4.31 (109,5)
10.21 (259,3)
10.59 (268,9) MAXIMUM
2.33* (59,2)
1.88* (47,8)
1.25 (31,8)
.987 (25,07) DIA.
.875/.874 (22,23/22,20)
2510/2500 (6,375/6,350) SQUARE KEY
1.61 (40,9)
3.07 (78,0)
DRAIN PORT "D"
SAE - 10
(BSPP-3/4" THREADS - OPTIONAL)
6.88 (174,8)
2.32 (58,9)
1.77 (45,0)
1.75* (44,5)
1.30* (33,0)
.06 (1,5)
.98 (24,9)
.37 (9,4)
3.27 (83,1)
4.000/3.998 (101,60/101,55) DIA.
45°
30°
.53 (13,5)
.06 (1,5)
1.38 (35,1) MAXIMUM
10.01 (254,3) MAXIMUM
INLET PORT FOR CW ROTATION
OUTLET PORT FOR CCW ROTATION
6.11 (155,2)
5.75 (146,1)
6.85 (174,0)
.57 (14,5)
R.
4.72* (119,9)
SYSTEM PORTS
SAE-20 1-5/8"-12 UNF-2B
(BSPP-1-1/4" THREADS - OPTIONAL)
- 2 PLACES AS SHOWN
MAXIMUM VOLUME STOP
ADJUSTING SCREW
FOR CW
FOR CCW
2.09 (53,1)
OUTLET PORT FOR CW ROTATION
INLET PORT FOR CCW ROTATION
1.18 (30,0)
2.36 (60,0)
2.48 (63,0)
* SAE 22-4 (SAE B) INVOLUTE SPLINE DATA
CLASS 5, FLAT ROOT SIDE FIT PER J498c
NUMBER OF TEETH 13
PITCH 16/32
PRESSURE ANGLE 30°
MAJOR DIA. .875/.853 (22,23/21,67)
MINOR DIA. .715 (18,16)
NOTE: DIMENSIONS IN PARENTHESIS ARE METRIC (SI UNITS).


"F" AND "L" COMPENSATOR - KEYED SHAFT
(SPLINED SHAFT SHOWN BELOW)
"C" COMPENSATOR - SPLINED SHAFT
(KEYED SHAFT SHOWN ABOVE)
"C" Series PV15
FOR CW
FOR CCW
COMPENSATOR VENT PORT "V"
SAE- 4 7/16-20 UNF-2B
(BSPP-1/4" THREADS - OPTIONAL)
SQUARE KEY
DRAIN PORT "D"
SAE -10
(BSPP-3/4" THREADS - OPTIONAL)
SYSTEM PORTS
SAE-20 1 5/8-12 UNF-2B
(BSPP-1 1/4" THREADS - OPTIONAL)
- 2 PLACES AS SHOWN
MAXIMUM VOLUME STOP
ADJUSTING SCREW
OUTLET PORT FOR CW ROTATION
INLET PORT FOR CCW ROTATION
INLET PORT FOR CW ROTATION
OUTLET PORT FOR CCW ROTATION
NOTE:
TWO BOLT MOUNTING FLANGE CONFORMS TO SAE 101-2 (SAE B) SPECIFICATIONS
WITH THE FOLLOWING EXCEPTIONS:
1. THERE IS NO 2.00 (50.8) DIA. COUNTERBORE IN FACE OF MTG.
2. DIMENSIONS MARKED WITH AN ASTERISK '*'
* SAE 22-4 (SAE B) INVOLUTE SPLINE DATA
CLASS 5, FLAT ROOT SIDE FIT PER J498c
NUMBER OF TEETH 13
PITCH 16/32
PRESSURE ANGLE 30°
MAJOR DIA. .875/.853 (22.23/21.67)
MINOR DIA. .715 (18.16)
NOTE: DIMENSIONS IN PARENTHESIS ARE METRIC (SI UNITS).

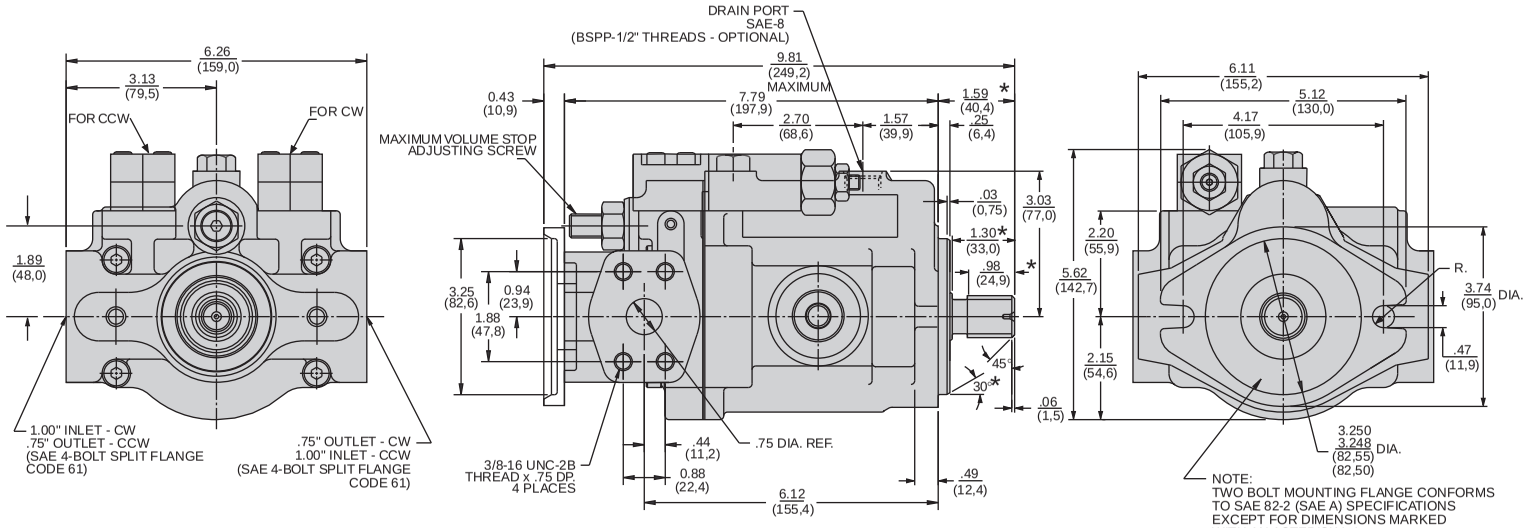

"F" AND "L" COMPENSATOR - KEYED SHAFT
(SPLINED SHAFT SHOWN BELOW)
"C" COMPENSATOR - SPLINED SHAFT
(KEYED SHAFT SHOWN ABOVE)
"C" Series PV20
COMPENSATOR VENT PORT "V"
SAE - 4 7/16-20 UNF-2B
(BSPP-1/4" THREADS - OPTIONAL)
FOR CW
FOR CCW
4.65 (118.1)
5.43 (137.9)
8.34 (211.8)
11.47 (291.3)
5.53 (140.5)
2.30 (58.4)
1.87 (47.5)
1.25 (31.8)
12.62 (320.5) MAXIMUM
SQUARE KEY
1.391 (35.33)
1.250 1.248 (31.75 31.70) DIA.
.3136 .3126 (7.965 7.940)
1.93 (49.0)
3.66 (93.0)
NOTE:
TWO BOLT MOUNTING FLANGE CONFORMS TO SAE 127-2 (SAE C) SPECIFICATIONS
WITH THE FOLLOWING EXCEPTIONS:
1. THERE IS NO 2.50 (63.5) DIA. COUNTERBORE IN FACE OF MTG. FLANGE.
2. DIMENSIONS MARKED WITH AN ASTERISK (*).
DRAIN PORT "D"
SAE - 12
(BSPP-1" THREADS - OPTIONAL)
MAXIMUM
12.48 (317.0)
8.18 (207.8)
2.14 (54.4) MAXIMUM
3.35 (85.1)
1.97 (50.0)
2.16* (54.9)
1.73* (43.9)
.08* (2.0)
.37* (9.4)
4.21 (106.9)
1.10 (27.9)
45°
30°
.65 (16.5)
.08* (2.0)
5.000 4.998 (127.00 126.95) DIA.
8.28 (210.3)
7.13 (181.1)
3.07 (78.0)
7.46 (189.5)
2.92 (74,2)
R.
.70 (17.8)
5.83* (148.1) DIA.
SYSTEM PORTS
SAE-20 1 5/8-12 UNF-2B
(BSPP-1 1/4" THREADS - OPTIONAL)
- 2 PLACES AS SHOWN
FOR CW
FOR CCW
OUTLET PORT FOR CW ROTATION
INLET PORT FOR CCW ROTATION
1.38 (35.1)
2.76 (70,1)
2.72 (69.1)
MAXIMUM VOLUME STOP
ADJUSTING SCREW
INLET PORT FOR CW ROTATION
OUTLET PORT FOR CCW ROTATION
* SAE 32-4 (SAE C) INVOLUTE SPLINE DATA
CLASS 5, FLAT ROOT SIDE FIT PER J498c
NUMBER OF TEETH 14
PITCH 12/24
PRESSURE ANGLE 30°
MAJOR DIA. 1.250/1.224 (31.75/31.09)
MINOR DIA. 1.040 (26.4)
NOTE: DIMENSIONS IN PARENTHESIS ARE METRIC (SI UNITS).


"F" AND "L" COMPENSATOR - KEYED SHAFT
(SPLINED SHAFT SHOWN BELOW)
"C" COMPENSATOR - SPLINED SHAFT
(KEYED SHAFT SHOWN ABOVE)
"C" Series PV29
NOTE:
TWO BOLT MOUNTING FLANGE CONFORMS TO SAE 127-2 (SAE C) SPECIFICATIONS
WITH THE FOLLOWING EXCEPTIONS:
1. THERE IS NO 2.50 (63.5) DIA. COUNTERBORE IN FACE OF MTG. FLANGE.
2. DIMENSIONS MARKED WITH AN ASTERISK '*'.
COMPENSATOR VENT PORT "V"
SAE - 4 7/16-20 UNF-2B
(BSPP-1/4" THREADS - OPTIONAL)
FOR CW
FOR CCW
SQUARE KEY
DRAIN PORT "D"
SAE - 12
(BSPP-1" THREADS - OPTIONAL)
MAXIMUM VOLUME STOP
ADJUSTING SCREW
SYSTEM PORTS
SAE-20 1 5/8-12 UNF-2B
(BSPP-1 1/4" THREADS - OPTIONAL)
- 2 PLACES AS SHOWN
OUTLET PORT FOR CW ROTATION
INLET PORT FOR CCW ROTATION
INLET PORT FOR CW ROTATION
OUTLET PORT FOR CCW ROTATION
* SAE 32-4 (SAE C) INVOLUTE SPLINE DATA
CLASS 5, FLAT ROOT SIDE FIT PER J498c
NUMBER OF TEETH 14
PITCH 12/24
PRESSURE ANGLE 30°
MAJOR DIA. 1.250/1.224 (31.75/31.09)
MINOR DIA. 1.040 (26.4)
NOTE: DIMENSIONS IN PARENTHESIS ARE METRIC (SI UNITS).



"F" AND "L" COMPENSATOR - KEYED SHAFT

(SPLINED SHAFT SHOWN BELOW)



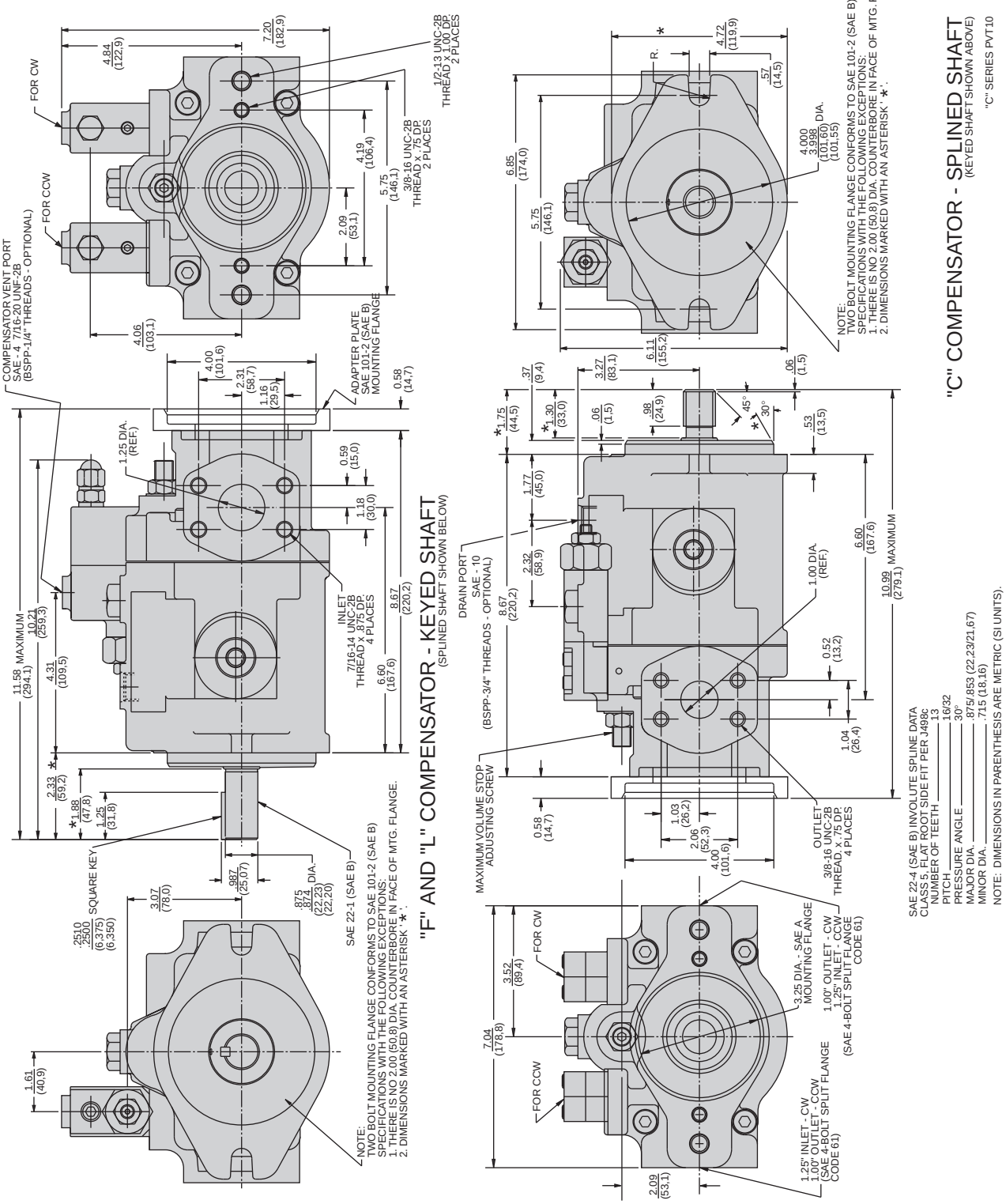
* SAE 22-4 (SAE B) INVOLUTE SPLINE DATA
CLASS 5, FLAT ROOT SIDE FIT PER J498c

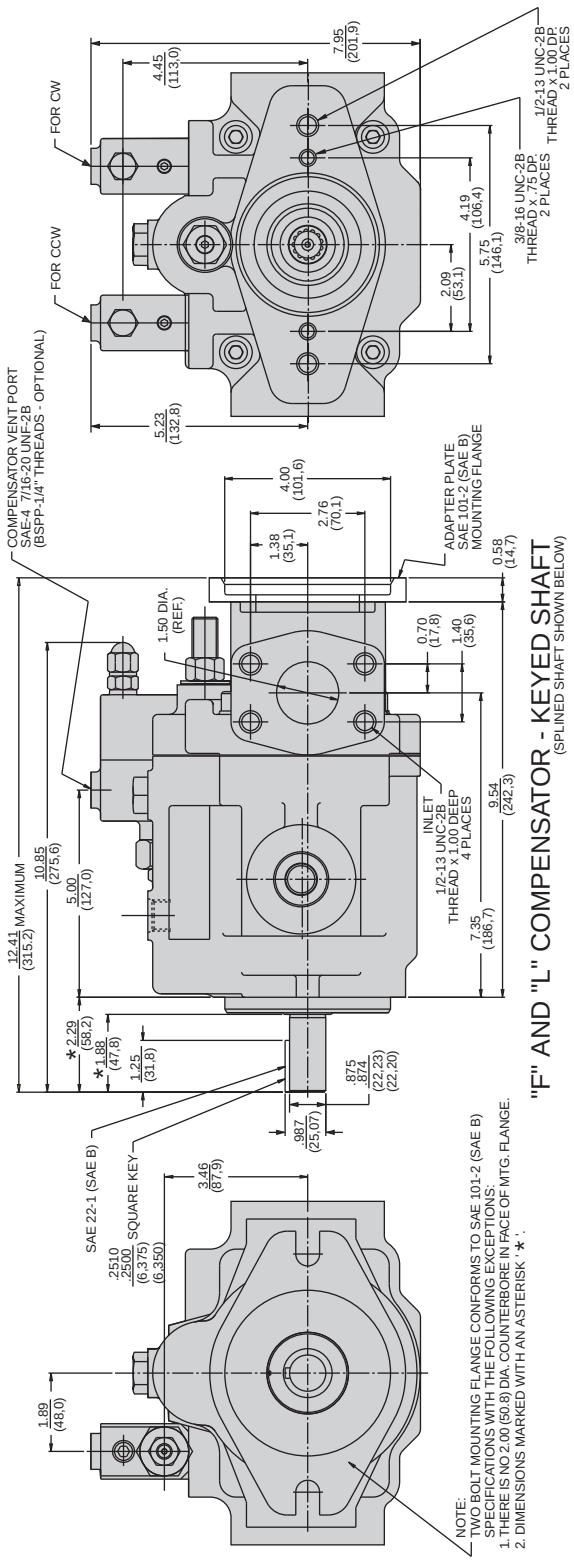
NUMBER OF TEETH	13
PITCH	16/32
PRESSURE ANGLE	30°
MAJOR DIA.	.875/.853 (22,23/21,67)
MINOR DIA.	.715 (18,16) MIN.

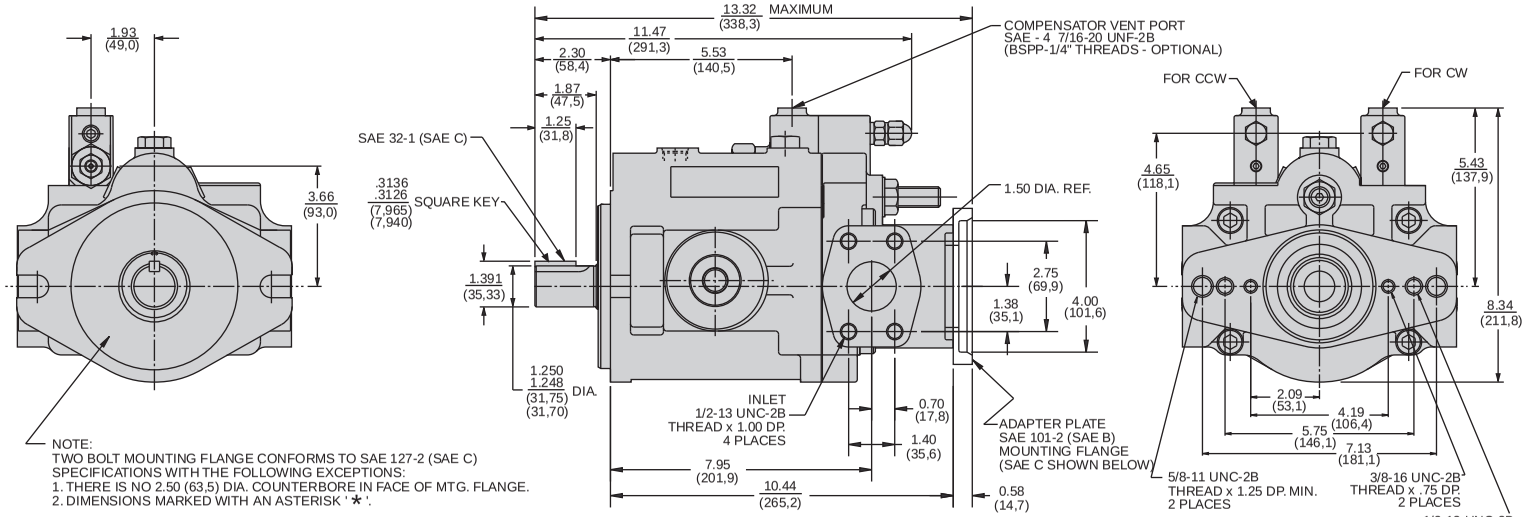
NOTE: DIMENSIONS IN PARENTHESIS ARE METRIC (SI UNITS).

"C" COMPENSATOR - SPLINED SHAFT

(KEYED SHAFT SHOWN ABOVE)

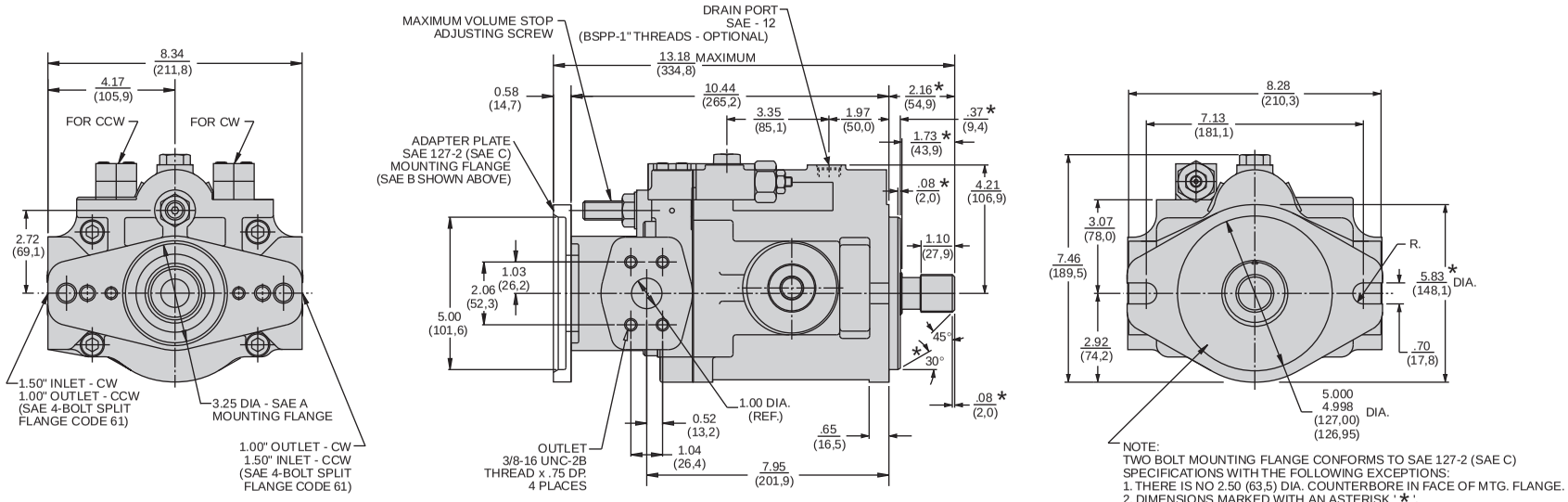

"F" AND "L" COMPENSATOR - KEYED SHAFT
(SPLINED SHAFT SHOWN BELOW)
"C" COMPENSATOR - SPLINED SHAFT
(KEYED SHAFT SHOWN ABOVE)
"C" SERIES PVT10
FOR CW
FOR CCW
COMPENSATOR VENT PORT
SAE - 4 7/16-20 UNF-2B
(BSPP-1/4" THREADS - OPTIONAL)
ADAPTER PLATE
SAE J 744-2 (SAE B)
MOUNTING FLANGE
INLET
7/16-14 UNC-2B
THREAD X .875 DP
4 PLACES
1/2-13 UNC-2B
THREAD X 1.00 DP
2 PLACES
3/8-16 UNC-2B
THREAD X .75 DP
2 PLACES
1.25 DIA.
(REF.)
SQUARE KEY
SAE 22-1 (SAE B)
DRAIN PORT
SAE -10
(BSPP-3/4" THREADS - OPTIONAL)
MAXIMUM VOLUME STOP
ADJUSTING SCREW
OUTLET
3/8-16 UNC-2B
THREAD X .75 DP
4 PLACES
1.00 DIA.
(REF.)
10.99
(279.1)
MAXIMUM
1.25" INLET - CW
1.00" OUTLET - CCW
(SAE 4-BOLT SPLIT FLANGE
CODE 61)
1.00" OUTLET - CW
1.25" INLET - CCW
(SAE 4-BOLT SPLIT FLANGE
CODE 61)
3.25 DIA. - SAE A
MOUNTING FLANGE
NOTE:
TWO BOLT MOUNTING FLANGE CONFORMS TO SAE 101-2 (SAE B)
SPECIFICATIONS WITH THE FOLLOWING EXCEPTIONS:
1. THERE IS NO 2.00 (50.8) DIA. COUNTERBORE IN FACE OF MTG. FLANGE.
2. DIMENSIONS MARKED WITH AN ASTERISK '*'.
SAE 22-4 (SAE B) INVOLUTE SPLINE DATA
CLASS 5, FLAT ROOT SIDE FIT PER J498c
NUMBER OF TEETH 13
PITCH 16/32
PRESSURE ANGLE 30°
MAJOR DIA .875/.853 (22.23/21.67)
MINOR DIA .715 (18.16)
NOTE: DIMENSIONS IN PARENTHESIS ARE METRIC (SI UNITS).


"F" AND "L" COMPENSATOR - KEYED SHAFT
(SPLINED SHAFT SHOWN BELOW)
COMPENSATOR VENT PORT
SAE-4 7/16-20 UNF-2B
(BSPP-1/4" THREADS - OPTIONAL)
FOR CW
FOR CCW
7.95 (201.9)
4.45 (113.0)
1/2-13 UNC-2B
THREAD X 1.00 DP.
2 PLACES
3/8-16 UNC-2B
X .75 DP.
2 PLACES
4.19 (106.4)
5.75 (146.1)
2.09 (53.1)
5.23 (132.8)
ADAPTER PLATE
SAE 101-2 (SAE B)
MOUNTING FLANGE
4.00 (101.6)
2.76 (70.1)
1.38 (35.1)
0.58 (14.7)
1.50 DIA. (REF.)
0.70 (17.8)
1.40 (35.6)
INLET
1/2-13 UNC-2B
THREAD X 1.00 DEEP
4 PLACES
9.54 (242.3)
7.35 (186.7)
12.41 (315.2) MAXIMUM
10.85 (275.6)
5.00 (127.0)
* 2.29 (58.2)
* 1.88 (47.8)
1.25 (31.8)
.875 .874 (22.23) (22.20)
.987 (25.07)
SAE 22-1 (SAE B)
SQUARE KEY
2510 .2500 (6.375) (6.350)
3.46 (87.9)
1.89 (48.0)
NOTE:
TWO BOLT MOUNTING FLANGE CONFORMS TO SAE 101-2 (SAE B)
SPECIFICATIONS WITH THE FOLLOWING EXCEPTIONS.
1. THERE IS NO 2.00 (50.8) DIA. COUNTERBORE IN FACE OF MTG. FLANGE.
2. DIMENSIONS MARKED WITH AN ASTERISK '*'.
"C" COMPENSATOR - SPLINED SHAFT
(KEYED SHAFT SHOWN ABOVE)
"C" SERIES PVT15
*4.72 R. (119.9)
.57 (14.8)
6.85 (174.0)
7.44 (189.0)
5.75 (146.1)
4.000 3.998 DIA. (101.60) (101.55)
2.87 (72.9)
6.93 (176.0)
NOTE:
TWO BOLT MOUNTING FLANGE CONFORMS TO SAE 101-2 (SAE B)
SPECIFICATIONS WITH THE FOLLOWING EXCEPTIONS:
1. THERE IS NO 2.00 (50.8) DIA. COUNTERBORE IN FACE OF MTG. FLANGE.
2. DIMENSIONS MARKED WITH AN ASTERISK '*'.
DRAIN PORT
SAE-10
(BSPP-3/4" THREADS - OPTIONAL)
MAXIMUM VOLUME STOP
ADJUSTING SCREW
11.86 (301.2) MAXIMUM
9.54 (242.3)
2.90 (73.7)
1.97 (50.0)
1.74 (44.2)
0.37 (9.4)
0.09 (2.0)
1.30 * (33.0)
1.16 (29.5)
3.86 (98.0)
45°
30° *
0.53 (13.5)
SAE 25-4 (SAE B-B)
1.00 DIA. (REF.)
.52 (13.2)
1.04 (26.4)
7.35 (186.7)
OUTLET
3/8-16 UNC-2B
THREAD X .75 DEEP
4 PLACES
0.58 (14.7)
1.03 (26.2)
2.06 (52.3)
4.00 (101.6)
* SAE 22-4 (SAE B) OR SAE 25-4 (SAE B-B)
INVOLUTE SPLINE DATA
CLASS 5, FLAT ROOT SIDE FIT PER J498c
22-4 (SAE B) 25-4 (SAE B-B)
NUMBER OF TEETH 13 15
PITCH 16/32 16/32
PRESSURE ANGLE 30° 30°
MAJOR DIA. .875/.853 (22.2/21.7) 1.000/.998 (25.4/25.3)
MINOR DIA. .715 MIN. (18.2) .853 MIN. (21.7)
NOTE: DIMENSIONS IN PARENTHESIS ARE METRIC (SI UNITS).
FOR CW
FOR CCW
4.15 (105.0)
8.29 (210.6)
3.25 DIA. - SAE A
MOUNTING FLANGE
1.50" INLET - CW
1" OUTLET - CCW
(SAE 4-BOLT SPLIT FLANGE
CODE 61)
2.48 (63.0)
1" OUTLET - CW
1.50" INLET - CCW
(SAE 4-BOLT SPLIT FLANGE
CODE 61)



"F" AND "L" COMPENSATOR - KEYED SHAFT

(SPLINED SHAFT SHOWN BELOW)



SAE 32-4 (SAE C) INVOLUTE SPLINE DATA
CLASS 5, FLAT ROOT SIDE FIT PER J498c

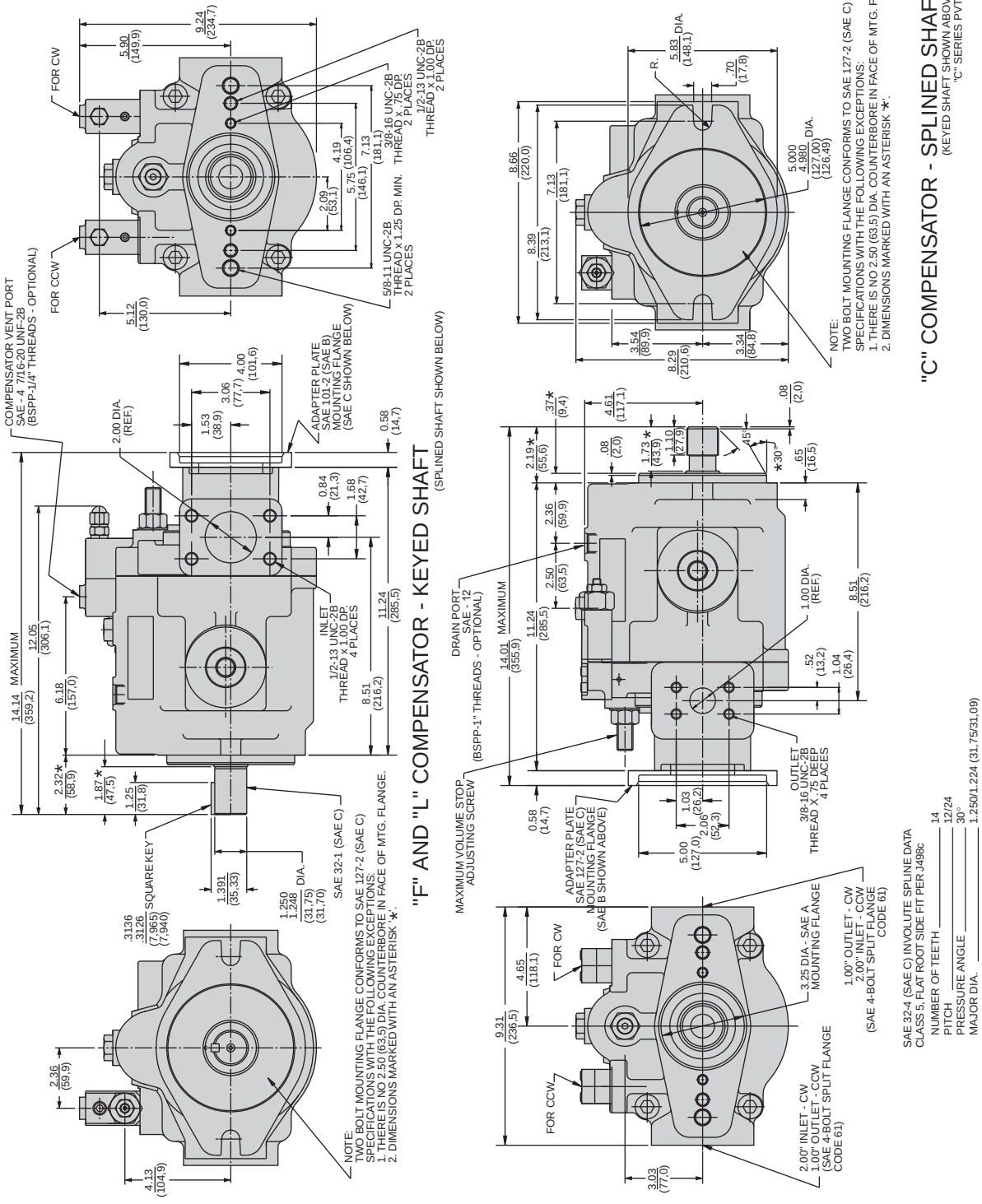
NUMBER OF TEETH	14
PITCH	12/24
PRESSURE ANGLE	30°
MAJOR DIA.	1.250/1.224 (31,75/31,09)
MINOR DIA.	1.040 (26,4)

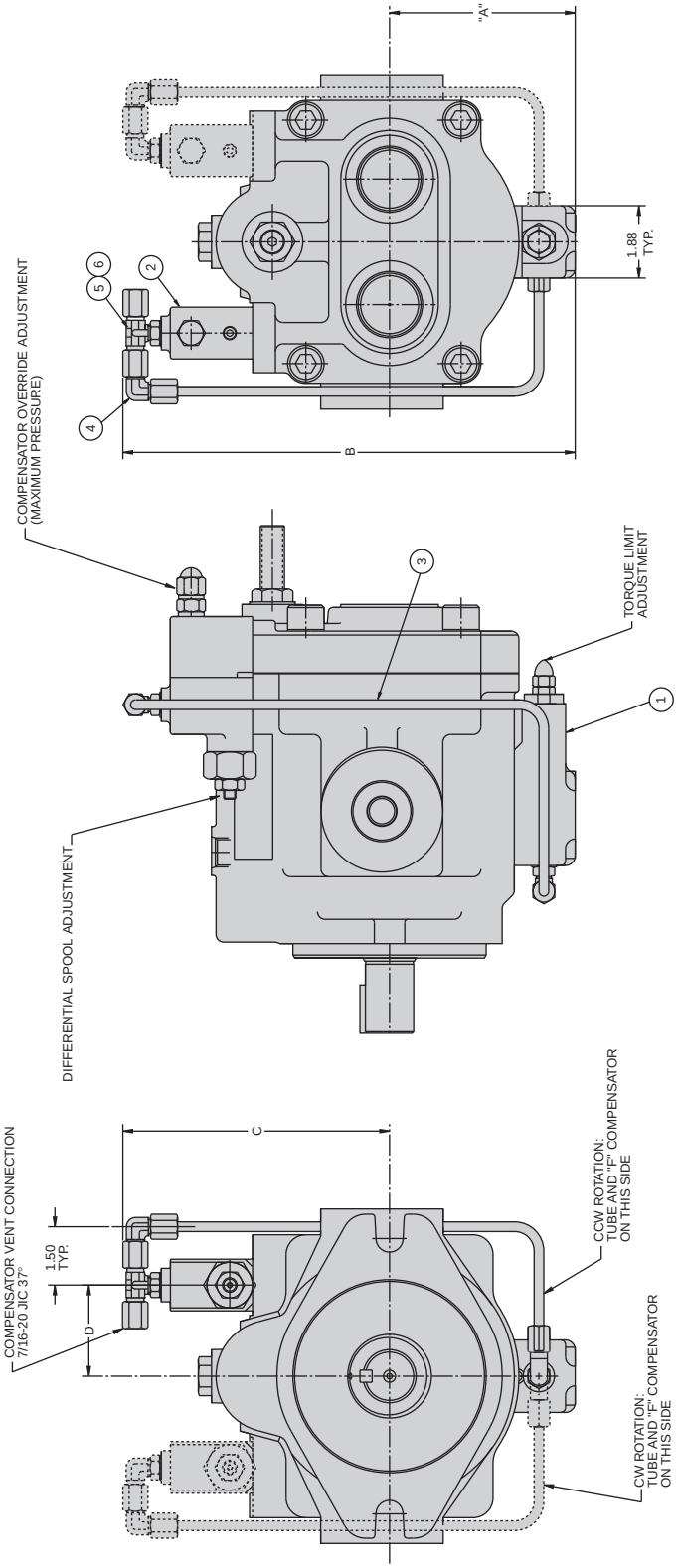
NOTE: DIMENSIONS IN PARENTHESIS ARE METRIC (SI UNITS).

"C" COMPENSATOR - SPLINED SHAFT

(KEYED SHAFT SHOWN ABOVE)

"C" SERIES PVT20


"F" AND "L" COMPENSATOR - KEYED SHAFT
(SPLINED SHAFT SHOWN BELOW)
"C" COMPENSATOR - SPLINED SHAFT
(KEYED SHAFT SHOWN ABOVE)
"C" SERIES PVT29
COMPENSATOR VENT PORT
SAE - 4 7/16-20 UNF-2B
(BSPP-1/4" THREADS - OPTIONAL)
FOR CW
FOR CCW
5/8-11 UNC-2B
THREAD X 1.25 DP. MIN.
2 PLACES
1/2-13 UNC-2B
THREAD X 1.00 DP.
2 PLACES
3/8-16 UNC-2B
THREAD X .75 DP.
2 PLACES
ADAPTER PLATE
SAE 101-2 (SAE B)
MOUNTING FLANGE
(SAE C SHOWN BELOW)
2.00 DIA.
(REF.)
INLET
1/2-13 UNC-2B
THREAD X 1.00 DP.
4 PLACES
SAE 32-1 (SAE C)
.3136
.3126
SQUARE KEY
1.391
(35.33)
1.250
1.248
DIA.
NOTE:
TWO BOLT MOUNTING FLANGE CONFORMS TO SAE 127-2 (SAE C)
SPECIFICATIONS WITH THE FOLLOWING EXCEPTIONS:
1. THERE IS NO 2.50 (63.5) DIA. COUNTERBORE IN FACE OF MTG. FLANGE.
2. DIMENSIONS MARKED WITH AN ASTERISK ✶.
MAXIMUM VOLUME STOP
ADJUSTING SCREW
DRAIN PORT
SAE - 12
(BSPP-1" THREADS - OPTIONAL)
MAXIMUM
ADAPTER PLATE
SAE 127-2 (SAE C)
MOUNTING FLANGE
(SAE B SHOWN ABOVE)
OUTLET
3/8-16 UNC-2B
THREAD X .75 DEEP
4 PLACES
1.00 DIA.
(REF.)
2.00" INLET - CW
1.00" OUTLET - CCW
(SAE 4-BOLT SPLIT FLANGE
CODE 61)
3.25 DIA - SAE A
MOUNTING FLANGE
1.00" OUTLET - CW
2.00" INLET - CCW
(SAE 4-BOLT SPLIT FLANGE
CODE 61)
R.
NOTE:
TWO BOLT MOUNTING FLANGE CONFORMS TO SAE 127-2 (SAE C)
SPECIFICATIONS WITH THE FOLLOWING EXCEPTIONS:
1. THERE IS NO 2.50 (63.5) DIA. COUNTERBORE IN FACE OF MTG. FLANGE.
2. DIMENSIONS MARKED WITH AN ASTERISK ✶.
SAE 32-4 (SAE C) INVOLUTE SPLINE DATA
CLASS 5, FLAT ROOT SIDE FIT PER J498c
NUMBER OF TEETH 14
PITCH 12/24
PRESSURE ANGLE 30°
MAJOR DIA. 1.250/1.224 (31.75/31.09)
MINOR DIA. 1.040 (26.4)
NOTE: DIMENSIONS IN PARENTHESIS ARE METRIC (SI UNITS).

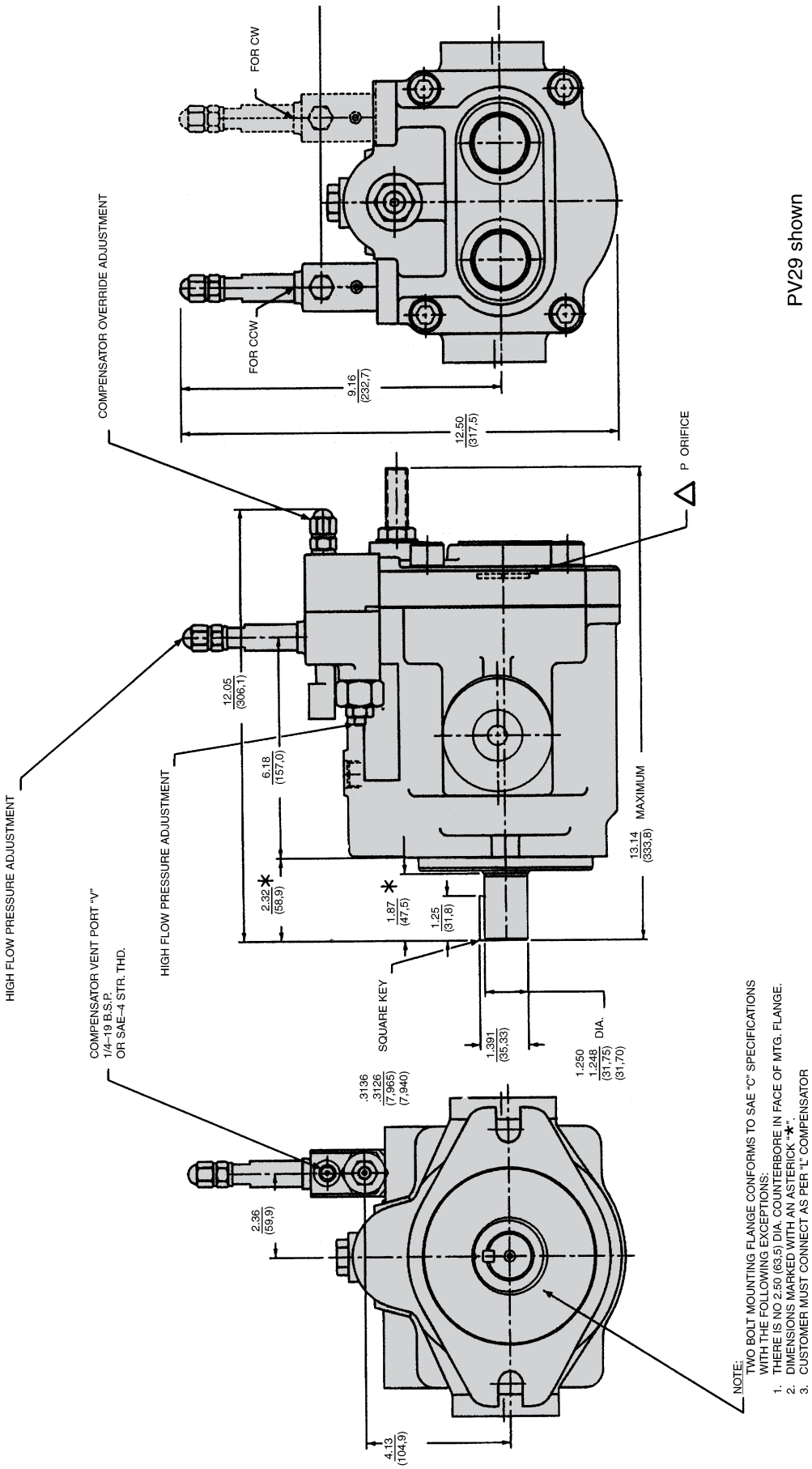


"J" TORQUE LIMITER (LOW RANGE)
"K" TORQUE LIMITER (HIGH RANGE)
"C" SERIES PV/PVT
(PV SHOWN)

Drawing #23-9996

Ⓐ

PV/PVT	"A"	"B" REF.	"C"	"D"
6	3.50	9.06	5.56	1.54
10	4.00	9.84	5.84	1.61
15	4.38	10.61	6.23	1.89
20	4.63	11.06	6.43	1.93
29	5.00	11.90	6.90	2.36



TORQUE LIMITER – KEYED SHAFT

PV29 shown

NOTE:
TWO BOLT MOUNTING FLANGE CONFORMS TO SAE "C" SPECIFICATIONS WITH THE FOLLOWING EXCEPTIONS:
1. THERE IS NO 2.50 (63.5) DIA. COUNTERBORE IN FACE OF MTG. FLANGE.
2. DIMENSIONS MARKED WITH AN ASTERICK "*".
3. CUSTOMER MUST CONNECT AS PER "L" COMPENSATOR

PV pumps

Model number sheet

Revised 6/24/02

Example model code:

	PV	6	-2	R	1	*	-C	0	2	-0	0	0	
Type													
No rear drive, rear ports (sizes 6 through 29 only)	PV												
No rear drive, rear ports, mobile version (size 20 only)	PVM												
Rear drive, side ports, mobile version (size 20 only)	PVR												
Rear drive, side ports (all sizes)	PVT												
No rear drive, rear ports, for use on water glycol only (sizes 6 through 29 only)	PVW												
No rear drive, rear ports, mobile version, for use on water glycol only (size 20	PVX												
Rear drive, side ports, mobile version, for use on water glycol only (size 20 on	PVY												
Rear drive, side ports, for use on water glycol only (sizes 6 through 29 only)	PVZ												
Flow (at 1800 RPM)													
6.8 GPM (26.0 lpm)		6											
10.0 GPM (37.2 lpm)		10											
16.3 GPM (61.6 lpm)		15											
20.4 GPM (77.3 lpm)		20											
29.5 GPM (111.5 lpm)		29											
38.0 GPM (144.0 lpm)		38											
47.6 GPM (180.0 lpm)		47											
61.8 GPM (234.0 lpm)		64											
Shaft													
Splined			-1										
Keyed			-2										
Rotation													
Clockwise				R									
Counter-clockwise				L									
Seals													
Nitrile (Buna N)					1								
EPR (sizes 6 through 29 only)(pump will be unpainted unless otherwise specified)					4								
Flourocarbon (Viton)					5								
Design letter (assigned by manufacturer)						*							
Controls													
Compensator							-C						
Compensator - pilot operated with vent port							-F						
Load sensing compensator							-L						
Low torque limiter							-J						
High torque limiter							-K						
Load sensing compensator (L) + low torque limiter (J)							-V						
Load sensing compensator (L) + high torque limiter (K)							-W						
Control type													
Max. volume adjustment screw								0					
Fluid connections													
SAE threaded ports (PV & PVM units only)									0				
BSPP threaded ports (PV & PVM units only)									2				
SAE 4-bolt flange ports with SAE case drain ports (PVR & PVT units only)									3				
SAE 4-bolt flange ports with BSPP case drain ports (size 6 through 29 PVR & PVT units only)									4				
External drive													
None (PV & PVM units only)										-0			
Blanking plug (PVR & PVT units only)										-S			
SAE-A (SAE 82-2)(PVR & PVT units only)										-A			
SAE-B (SAE 101-2)(size 10 through 64 PVR & PVT units only)										-B			
SAE-C (SAE 127-2)(SAE 127-4 for PVT38/47/64 with SAE-CC coupling)(size 10 through 64 PVR & PVT units only)										-C			
SAE-D (SAE 152-4)(PVT64 only)										-D			
Coupling													
None											0		
SAE-A (SAE 16-4)(PVR & PVT units only)											A		
SAE-B (SAE 22-4)(size 10 through 64 PVR & PVT units only)											B		
SAE-BB (SAE 25-4)(size 10 through 64 PVR & PVT units only)											Q		
SAE-C (SAE 32-4)(size 10 through 64 PVR & PVT units only)											C		
SAE-CC (SAE 38-4)(size 38 through 64 PVT units only)											R		
SAE-D (SAE 44-4)(PVT64 only)											D		
External mounting													
No external pump mounted												0	
External pump mounted (requires special modification "-M2")(must be separately specified)												1	
Special modification													
None													omit
No paint													-NP
Other special modification (example: tandem pumps)													-M2

Allowable controls

C00, C02, C03, C04, F00, F02, F03, F04
L00, L02, L03, L04, J00, J02, J03, J04, K00, K02, K03, K04
V00, V02, V03, V04, W00, W02, W03, W04

DEFINITION & UNIT

displacement	in^3/rev x 16.387 = cm^3/rev	cm^3/rev x 0.06102 = in^3/rev
flow	U.S.gpm x 3.78 = L/min	L/min x 0.264 =U.S. gpm
power	hp x 0.7457 = kW	kW x 1.341 = hp
torque	lb-ft x 1.3558 = Nm	Nm x 0.7376 = lb-ft
pressure	lbs/in^2 (psi) x 0.0690 = bar lbs/in^2 (psi) x 6.90 = kPa	bar x 14.50 = lbs/in^2 (psi) kPa x 0.1450 = lbs/in^2 (psi)
weight	lb x 0.4535 = kg	kg x 2.205 = lbs
force	lb x 4.448 = N	N x 0.2248 = lbs
volume	in^3 x 16.387 = cm^3	cm^3 x 0.06102 = in^3
area	in^2 x 6.452 = cm^2	cm^2 x 0.1550 = in^2
length	in x 25.4= mm	mm x 0.03937 = in
temperature	$\frac{\text{degree F-32}}{1.8}$ = °C	1.8 x °C+32 = °F
viscosity	*c*St x 1.0 = mm^2/sec	mm^2/sec x 1.0 = *c*St
	$\frac{\text{(SSU-14)}}{4.25} \cong$ cSt	cSt x 4.25 + 14≅ SSU

FLUID POWER FORMULAS

Pump input torque	*lbs. in.*	$\frac{\text{pressure(psi) x displacement (in}^3\text{/rev)}}{2\pi \text{ x mech. eff.}}$
Pump input power	*hp*	$\frac{\text{rpm x (in}^3\text{/rev) x (psi)}}{395934 \text{ x overall eff.}}$
Pump output flow	*U.S. gpm*	$\frac{\text{rpm x (in}^3\text{/rev) x volumetric eff.}}{231}$
Fluid motor speed	*rpm*	$\frac{\text{231 x flow rate(U.S. gpm) x volumetric eff.}}{\text{displacement (in}^3\text{/rev)}}$
Fluid motor torque	*lbs. in.*	$\frac{\text{pressure(psi) x displacement (in}^3\text{/rev) x mech. eff.}}{2\pi}$
Fluid motor power	*hp*	$\frac{\text{rpm x (in}^3\text{/rev) x (psi) x overall eff.}}{395934}$
(metric)		
Pump input torque	*Nm*	$\frac{\text{pressure(bar) x displacement (cm}^3\text{/rev)}}{20\pi \text{ x mech. eff.}}$
Pump input power	*kW*	$\frac{\text{rpm x (cm}^3\text{/rev) x (bar)}}{600000 \text{ x overall eff.}}$
Pump output flow	*Lpm*	$\frac{\text{rpm x (cm}^3\text{/rev) x volumetric eff.}}{1000}$
Fluid motor speed	*rpm(min^{-1}) (tr/mn)*	$\frac{\text{1000 x flow rate (Lpm) x volumetric eff.}}{\text{displacement (cm}^3\text{/rev)}}$
Fluid motor torque	*Nm*	$\frac{\text{pressure(bar) x displacement (cm}^3\text{/rev) x mech. eff.}}{20\pi}$
Fluid motor power	*kW*	$\frac{\text{rpm x (cm}^3\text{/rev) x (bar) x overall eff.}}{600000}$

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