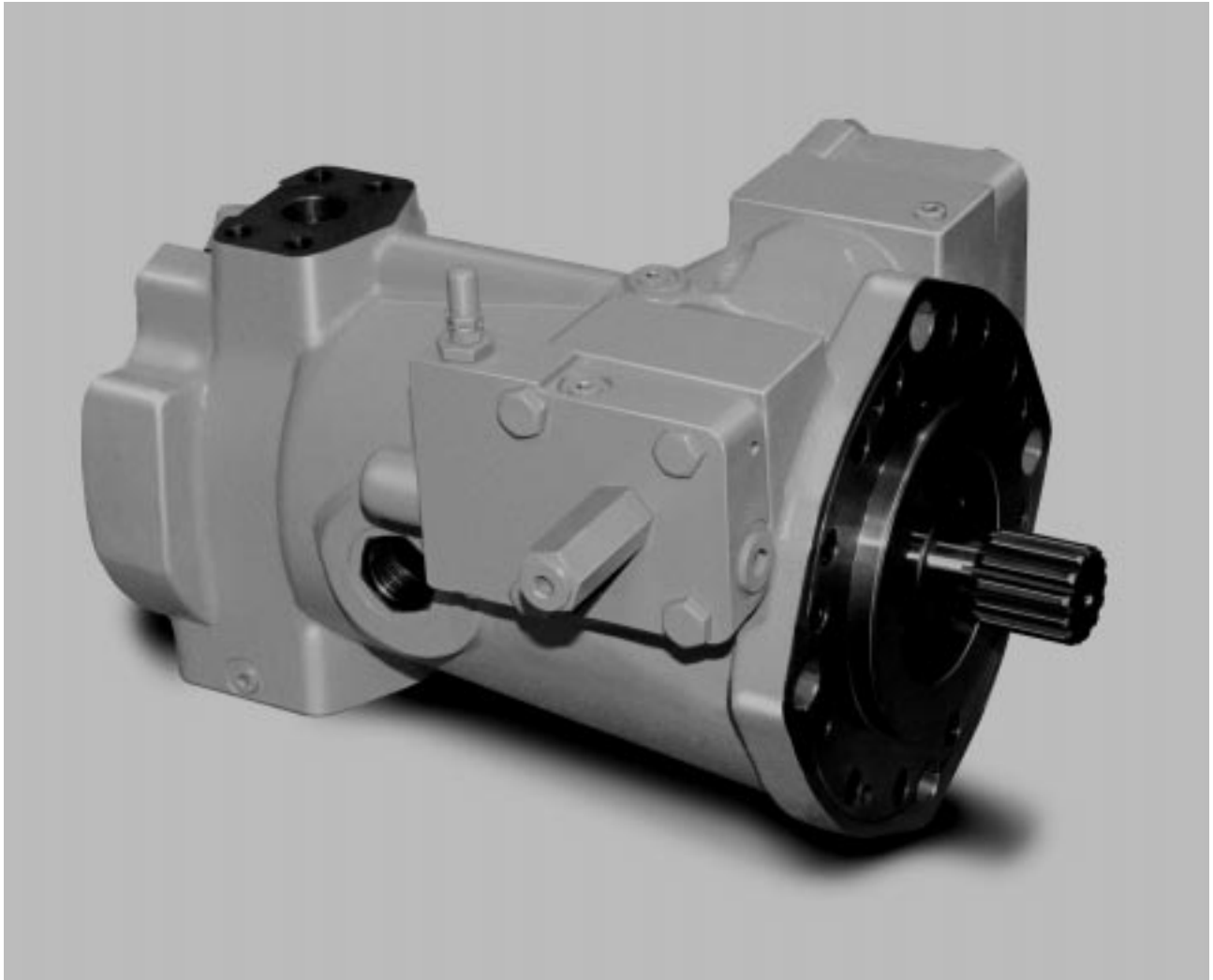


**DENISON HYDRAULICS**  
*open circuit piston pumps*  
*Premier series P07 & 110 C-mod.*

**service information**



Publ. LT2-00038-2 replaces S1-AM0018

Revised 5/03



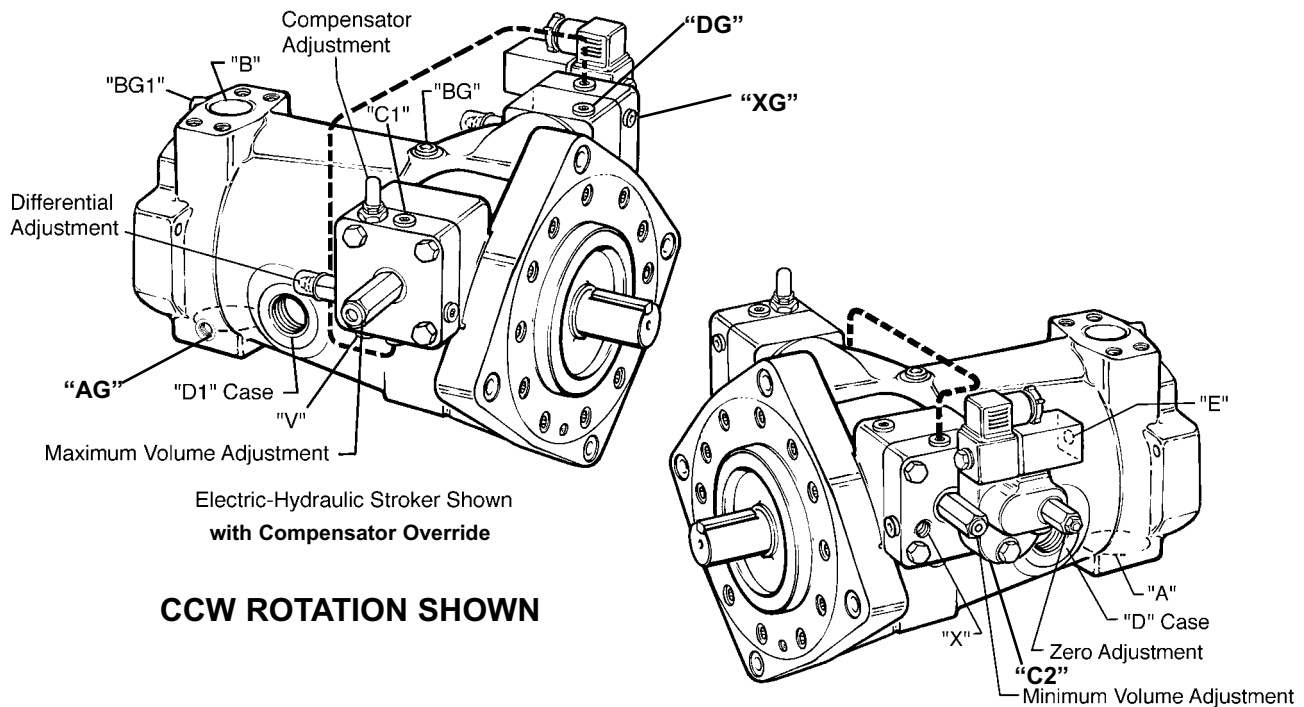
Internet <http://www.denisonhydraulics.com> E-mail: [denison@denisonhydraulics.com](mailto:denison@denisonhydraulics.com)

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Seal kit .....	P07	S22-15646-0
.....	P110	S22-15647-0

The shaft seal and all "O" rings necessary for total seal replacement may be obtained by ordering Seal Kit . These seals are suitable for petroleum base fluids. For fire resistant fluids contact **DENISON HYDRAULICS**, Inc. or their authorized distributors to obtain the appropriate seal kit number.

"The product information specifications and descriptions contained in this catalog have been compiled for the use and convenience of our customers from information furnished by the manufacturer, and we cannot and do not accept any responsibility for the accuracy or correctness of any description, calculation, specification or information contained herein. No such description, calculated, specified or information regarding the products being sold has been made part of the basis of the bargain nor has same created or amounted to an express warranty that the products would conform thereto. **We are selling the goods and merchandise illustrated and described in this catalog on an as is basis and disclaim any implied warranty, including any warranty of merchantability or warranty of fitness for any particular purposes whatsoever, with respect to the goods and merchandise sold.** All manufacturer warranties shall be passed on to our customers, but we shall not be responsible for special, indirect, incidental or consequential damages resulting from the use of any of the products or information contained or described in the catalog."

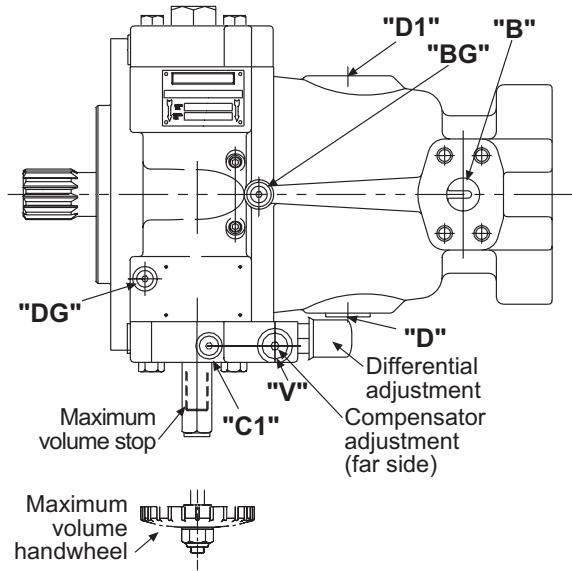


## FLUID CONNECTIONS

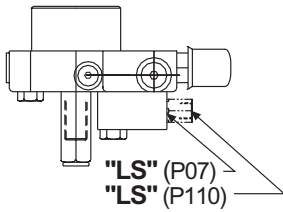
DESCRIPTION	P07	P110
PORT A .....INLET	3" SAE CODE 61 5/8-11 SCREWS	3" SAE CODE 61 M16-2 SCREWS
PORT B .....SYSTEM	1-1/4" SAE CODE 62 1/2-13 SCREWS	1-1/4" SAE CODE 62 M14-2 SCREWS
PORT C1 .....OFF-STROKE CYLINDER GAGE	SAE-4	1/4 BSPP
PORT C2 .....ON-STROKE CYLINDER. GAGE	SAE-4	1/4 BSPP
PORT D .....CASE DRAIN	SAE-16	1 BSPP
PORT D1 .....CASE DRAIN	SAE-16	1 BSPP
PORT DG.....DRAIN GAGE, AIR BLEED PORT	SAE-4	3/8 BSPP
PORT AG.....INLET GAGE	SAE-4	1/4 BSPP
PORT BG.....SYSTEM GAGE	SAE-4	1/4 BSPP
PORT BG1....ALTERNATE SYSTEM GAGE	SAE-6	1/4 BSPP
PORT E .....ELECTROHYDRAULIC STROKER SERVO SUPPLY	SAE-4	1/4 BSPP
PORT H .....HYDRAULIC STROKER SIGNAL	SAE-4	1/4 BSPP
PORT LS ....LOAD SENSING LINE	SAE-4	1/4 BSPP
PORT V .....COMPENSATOR, TORQUE LIMITER, LOAD SENSING VENT	SAE-8	3/8 BSPP
PORT V1 .....SERVO VENT	SAE-4	1/4 BSPP
PORT X .....SERVO SUPPLY	SAE-6	3/8 BSPP
PORT XG .....SERVO GAGE	SAE-10	1/2 BSPP

PRIMARY CONTROLS

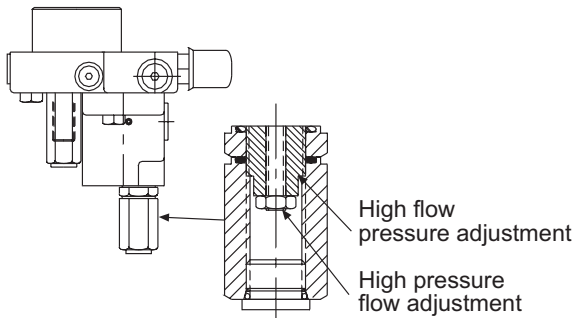
CLOCKWISE  
ROTATION



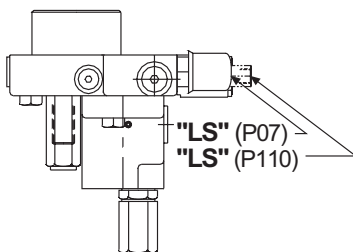
"C1", "C2" COMPENSATOR



"L1", "L2" LOAD SENSING

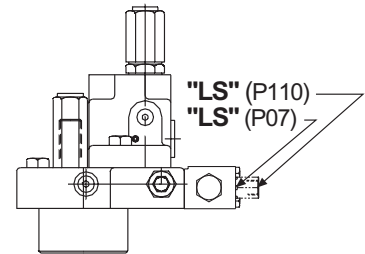


"J1/K1", "J2/K2" TORQUE LIMITER

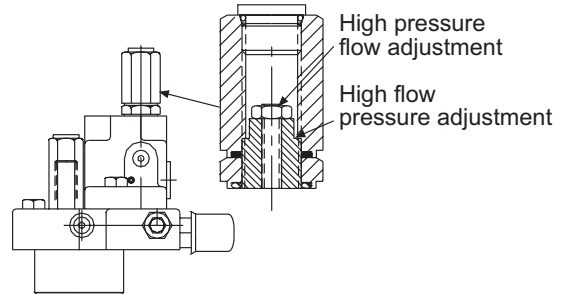


"V1/W1", "V2/W2" LOAD SENSING  
TORQUE LIMITER

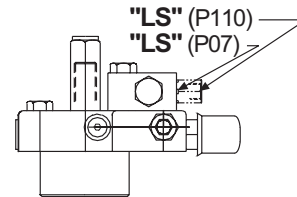
COUNTERCLOCKWISE  
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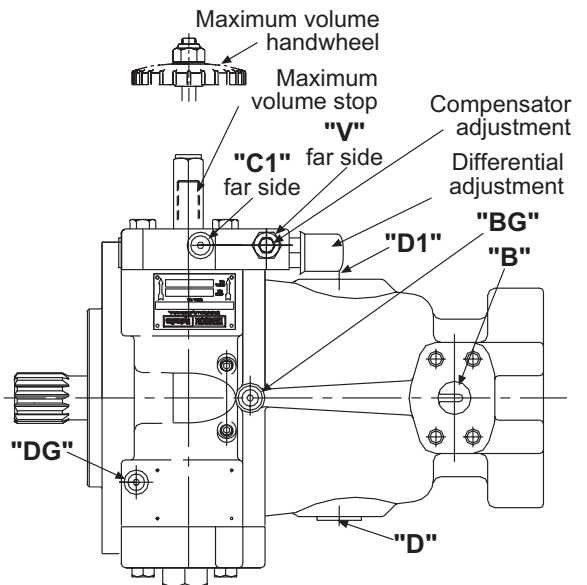
"V1/W1", "V2/W2" LOAD SENSING  
TORQUE LIMITER



"J1/K1", "J2/K2" TORQUE LIMITER



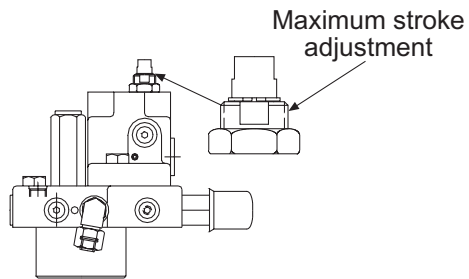
"L1", "L2" LOAD SENSING



"C1", "C2" COMPENSATOR

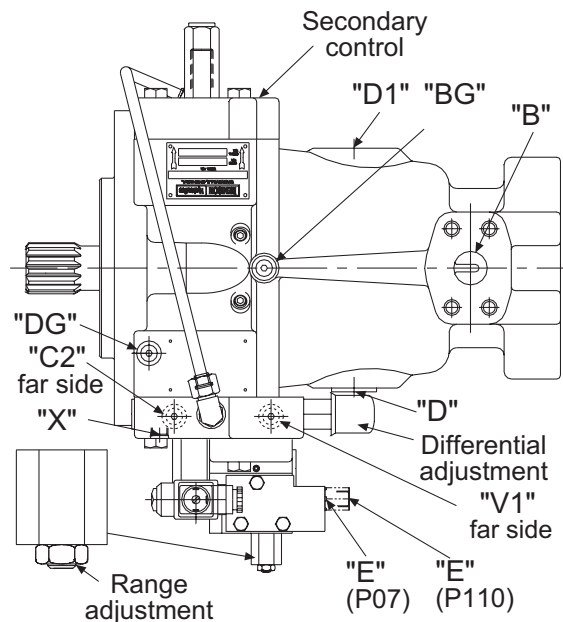
PRIMARY CONTROLS

CLOCKWISE  
ROTATION

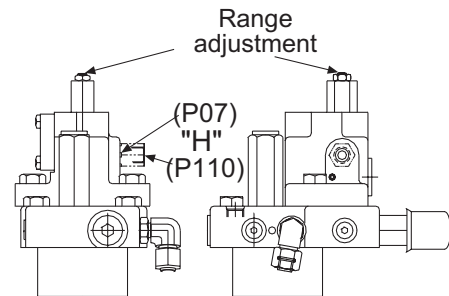


"R" ROTARY SERVO

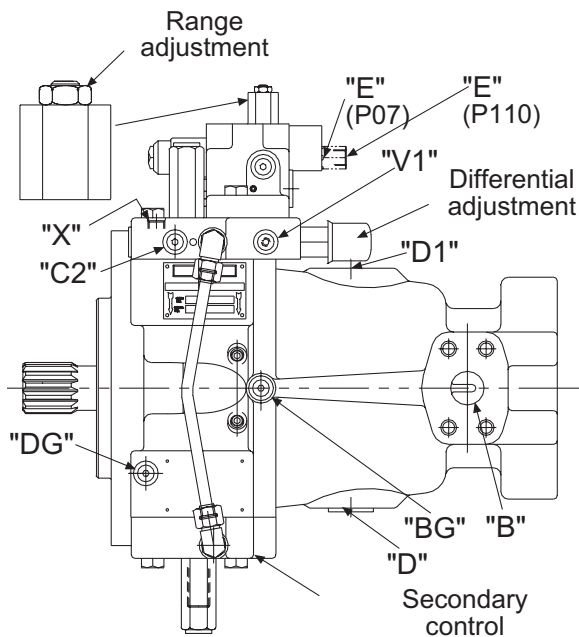
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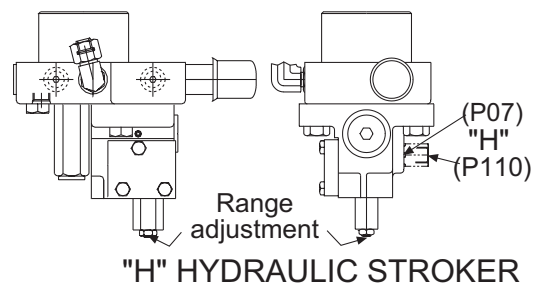
"E" ELECTROHYDRAULIC STROKER



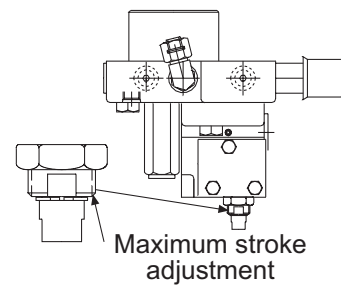
"H" HYDRAULIC STROKER



"E" ELECTROHYDRAULIC STROKER



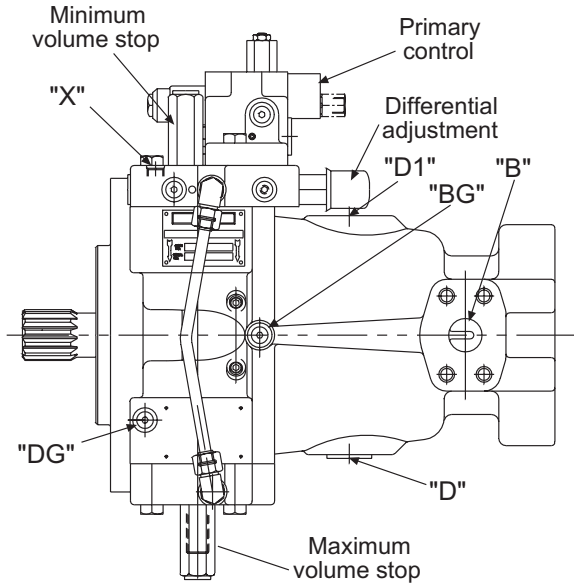
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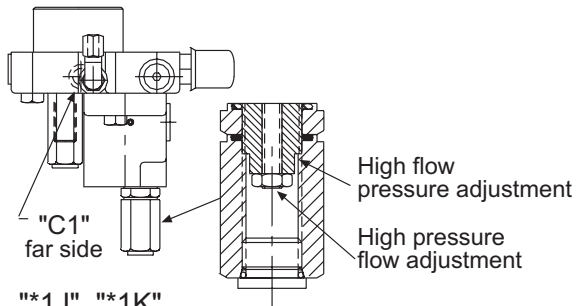
"R" ROTARY SERVO

SECONDARY CONTROLS

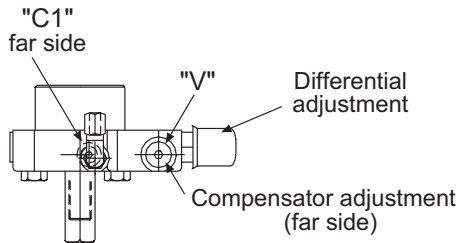
CLOCKWISE  
ROTATION



"\*10"  
CONTROL CAP WITH  
MAXIMUM VOLUME STOP

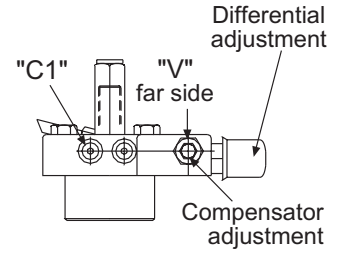


"\*1J", "\*1K"  
TORQUE LIMITER OVERRIDE WITH  
MAXIMUM VOLUME STOP

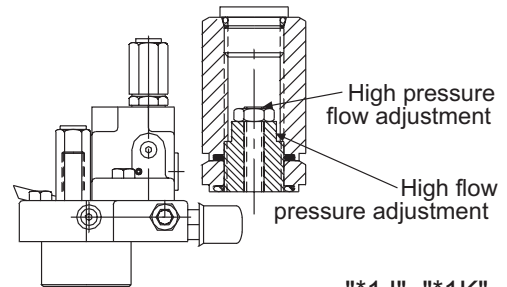


"\*1P"  
COMPENSATOR OVERRIDE WITH  
MAXIMUM VOLUME STOP

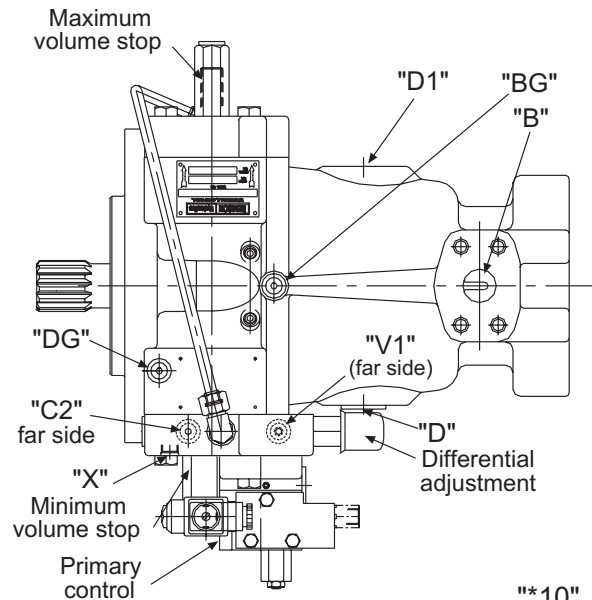
COUNTERCLOCKWISE  
ROTATION



"\*1P"  
COMPENSATOR OVERRIDE WITH  
MAXIMUM VOLUME STOP



"\*1J", "\*1K"  
TORQUE LIMITER OVERRIDE WITH  
MAXIMUM VOLUME STOP



"\*10"  
CONTROL CAP WITH  
MAXIMUM VOLUME STOP

### START UP 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. If pump is mounted vertically with shaft up, bleed air from case by removing plug from port "DG" till fluid runs clear.
- 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 pressure readings can be made at appropriate places.
- If solenoids are in system, check for actuation.
- Start pump drive. Observe for correct shaft rotation. 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 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

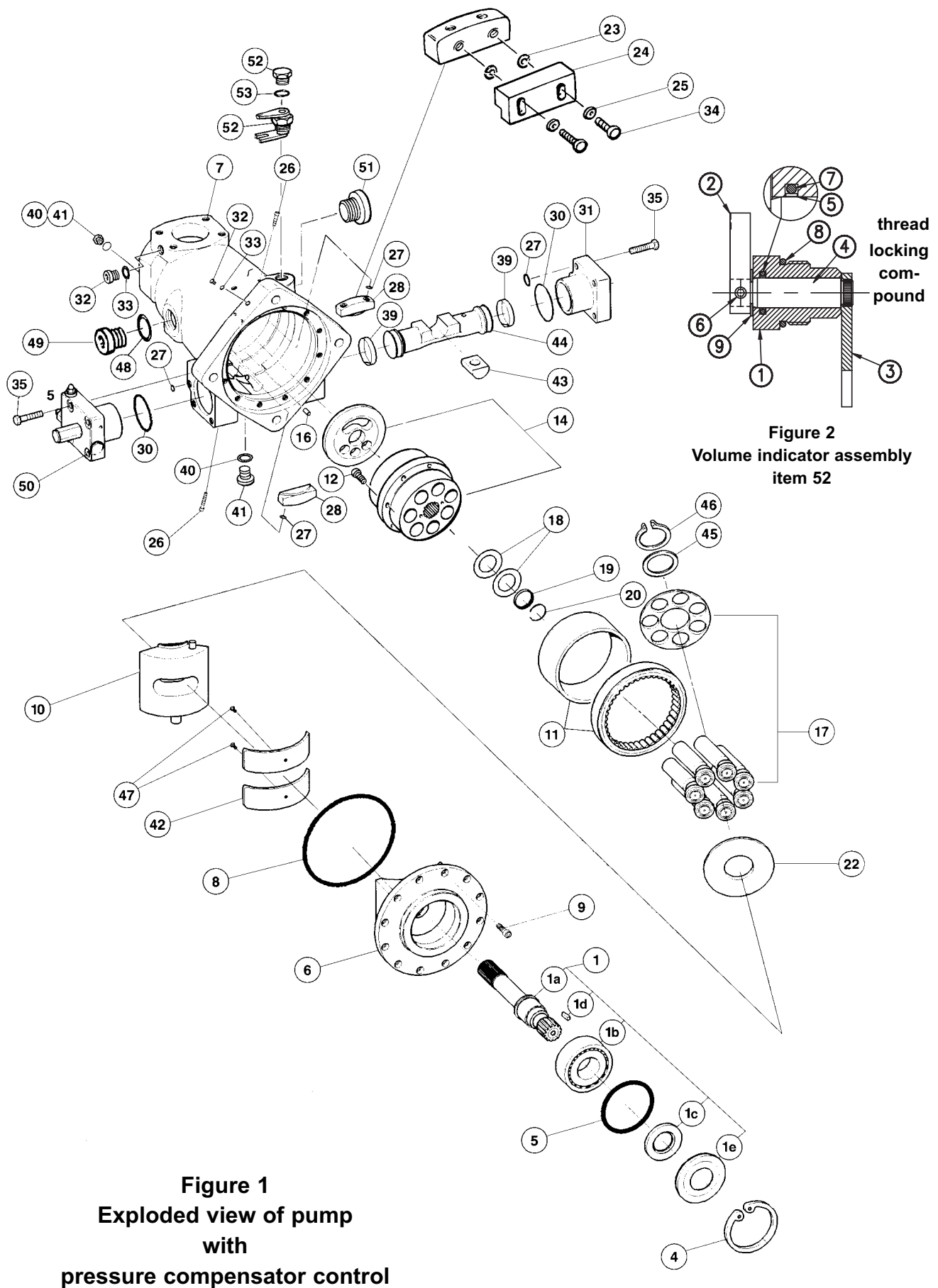
Component problems and circuit problems are often interrelated. An improper circuit may operate with apparent success but will cause failure of a particular component within it. The component failure is the effect, not the cause of the problem. This general guide is offered to help in locating and eliminating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

Effect of Trouble	Possible Cause	Fault Which Needs Remedy
pump noisy	air in system	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, too viscous, or too heavy. shaft speed too high. suction line strainer too small, or strainer too dirty. operating altitude too high. boost pressure too low. inlet 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.	see noisy pump above.
	cavitation.	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, procedures, dimensions, finishes.
	unwanted water in fluid.	condensation. faulty breather/strainer. heat exchanger leakage. faulty clean-up practice. water in makeup fluid.
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. eliminate hose.
	barrel blow-off.	re-check pump holddown, 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, too hot or too little flow. 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..



## TROUBLESHOOTING

Effect of Trouble	Possible Cause	Fault Which Needs Remedy
<b>Compensator, Compensator Override</b>		
Low system pressure	Compensator malfunction	Dirt in spool orifice Damaged cone or seat Broken differential spring Improperly adjusted differential spring
Failure to compensate	Differential adjustment	Differential set too high
Sluggish response	Differential adjustment	Differential set too low
Wide pressure fluctuations (hunting)	Excessive line capacitance	Install check valve near pump outlet
<b>Load Sensing Control</b>		
Low system pressure	Compensator malfunction	Dirt in spool orifice Damaged cone or seat Broken differential spring Improperly adjusted differential spring
Failure to compensate	Differential adjustment	Differential set too high
Sluggish response	Differential adjustment Modulating valve	Differential set too low Air in load sensing line
Wide pressure fluctuations (hunting)	Excessive line capacitance Modulating valve	Install check valve near pump outlet Air in load sensing line
Excessive pressure drop across control valve	Differential adjustment	Differential set too high
Poor control of flow	Differential adjustment	Differential set too low
<b>Torque Limiter, Torque Limiter Override</b>		
Torque setting erratic	Torque limiter cap malfunction	Sticking pin
Torque incorrect at high flows	Incorrect torque setting	Outer adjustment screw
Torque incorrect at low flows	Incorrect torque setting	Inner adjustment screw
Too much torque variation	Wrong torque limiter for range	Replace inner/outer springs with correct springs
Low system pressure	Compensator malfunction	Dirt in spool orifice Damaged cone or seat Broken differential spring Improperly adjusted differential spring
Failure to compensate	Differential adjustment	Differential set too high
Sluggish response	Differential adjustment	Differential set too low
Wide pressure fluctuations (hunting)	Excessive line capacitance	Install check valve near pump outlet
<b>Rotary Servo</b>		
Failure to stroke	Differential adjustment	Differential set too low
Goes to full	Differential adjustment	Differential set too high
Sluggish response	Low servo pressure	Check servo pressure
Strokes in steps	Servo cap malfunction	Sticking pin Wear on linkages or input cam surface
<b>Hydraulic Stroker</b>		
Failure to stroke	Differential adjustment	Differential set too low
Goes to full	Differential adjustment	Differential set too high
Strokes in steps	Servo cap malfunction	Wear on linkages, Sticking stroker piston
<b>Electric Stroker</b>		
Failure to stroke	Differential adjustment	Differential set too low
Goes to full	Differential adjustment	Differential set too high
Excessive hysteresis	Electric proportional valve	Change dither on electrical signal
No response	Electric proportional valve	Faulty wiring, Filter screen plugged
Strokes in steps	Servo cap malfunction	Wear on linkages Sticking stroker piston
Instability	Air in control	Bleed air from control Check for air in servo supply



**Figure 1**  
Exploded view of pump  
with  
pressure compensator control

## Disassembly

Disassemble only as far as necessary to replace or repair worn parts.

If the pump has a rear drive, the mounting adapter and coupling must be removed prior to pump disassembly *Refer to figure 3 page 16.*

Clean outside surface of the pump before disassembly. Disassembly area should be clean. A suitable surface should be used capable of supporting the pump weight of 177 lbs, 80,3 Kg.

*Refer to illustration, see figure 1 and 2*

1. Remove plug (49) and drain oil from pump. Position pump with shaft up.
2. Wind maximum volume screw CW (ref item (50), item 1 page 27) so that piston (44) bottoms out. This positions the cam at approximately zero displacement allowing removal of the drive shaft.
3. Remove socket head cap screws (9). If disassembling PQ Control version, remove tubing and pass thru fitting (56).
4. Remove cradle assembly (6) from the housing. The threaded hole in end of the shaft is provided for lifting this assembly. Threaded hole is 3/8-16 for P07, M10 for ISO and M12 for DIN shaft.
5. Remove snap ring (4).
6. Remove screws (47) to remove cam bearing (42).
7. Remove shaft (1), bearing, and seal retainer. Support flat face of the rocker cradle and press end of shaft opposite the bearing end.
8. Remove the shaft seal (1c) from the retainer (1e) if necessary.
9. Remove retaining ring (20).
10. Press bearing off shaft if necessary. Press against bearing inner race.
11. If pump contains a volume indicator assembly (52): *Refer to Figure 2:* Remove indicator pointer (2), retaining ring (9) and pivot nut (1) from pump housing. Remove pivot shaft and fork assembly (3) and (4) through the hole.
11. Remove two screws (34), two washers (25), clearance bearing (24), and two washers (23) from retainer (28).
12. Wind maximum volume screw CCW until piston (44) bottoms out.
13. Remove control cap (50) and control cap (31). (*Refer to controls section for control disassembly*).
14. The piston must be moved outward (away from pump center) to remove cam assembly.
15. Lift cam assembly (10) from pump. (Link (43), pistons and shoes and retainer plate(17), wear plate (22), and hold-down (45 and 46) are part of the cam assembly.)
16. Remove slide link (43), retaining ring (45), thrust washer (46), pistons, shoes & retainer assembly (17) and wear plate (22). The pins for the slide link and for the indicator have been pressed into the rocker cam and should not be removed.
17. Remove two screws (26), and two retainers (28).
18. Remove Belleville washers (18) and barrel stop (19).
19. Attach tool (T-1) (pg. 76) to barrel assembly (14-1). (Two M6 screws are required.) Lift barrel from port plate and housing.
20. The inner race of bearing (11) has a light press fit with barrel. Do not remove the inner race unless bearing needs to be replaced. If replacement is necessary, remove seven socket head cap screws (12). Replace with 5/16-18 UNC x 6 1/2 in. long soc hd cap screws. Rest assembly on the extended screws. Press barrel from inner race. Care must be taken to avoid damage to barrel face.
21. Remove port plate ref. see item (14), and alignment pin (16), from port block.

The barrel bearing outer race (11) should only be removed from housing if worn, damaged or closer inspection is needed. A bearing puller should be used for removal.

## REWORK LIMITS OF WEAR PARTS

item	maximum rework from original dimension	minimum dimension after rework
wear plate	.005", 0,127 mm	.184", 4.674 mm
piston shoe face(pocket)	*	.4175", 10,605 mm

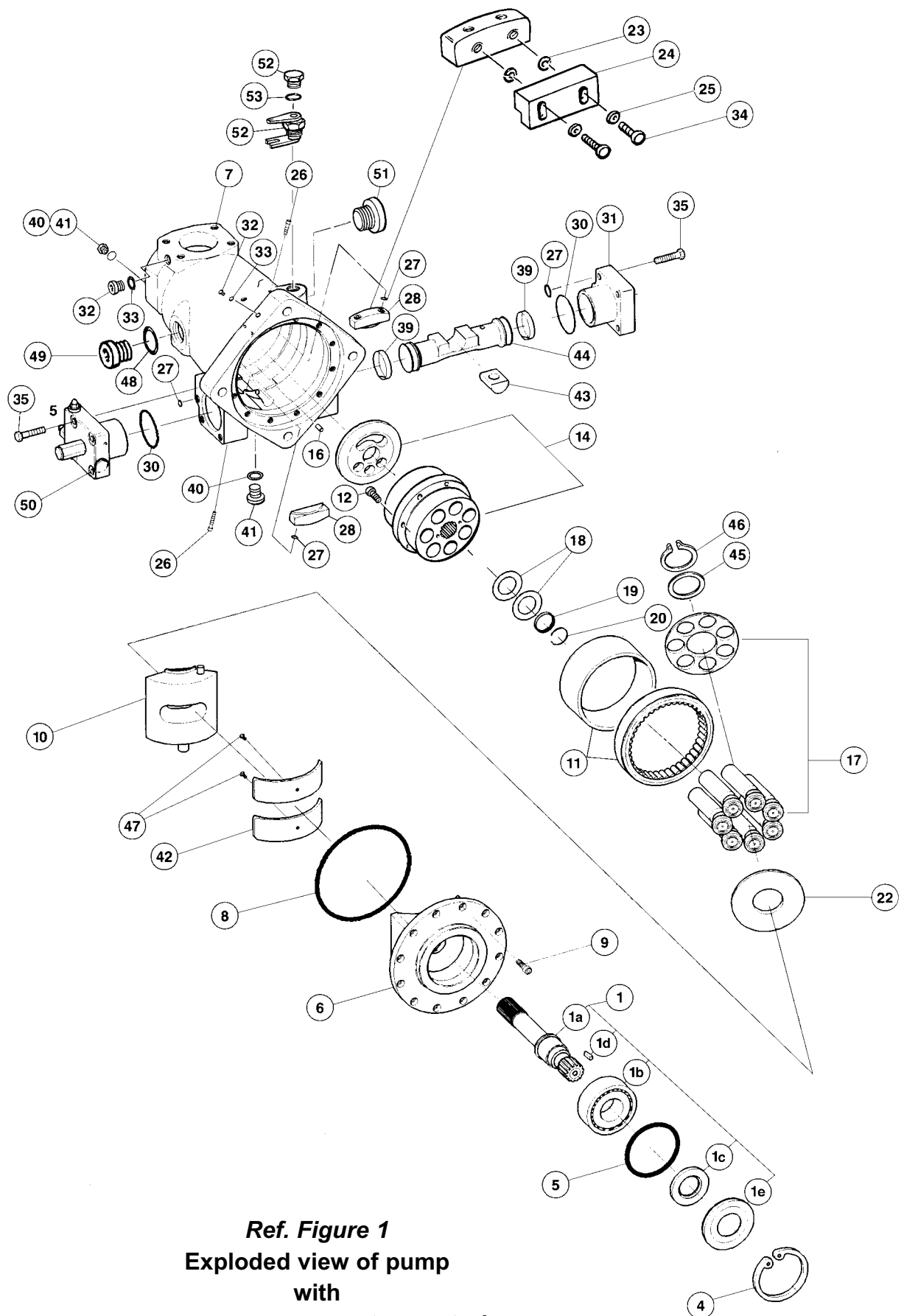
\*shoe face pocket depth must be .004", 0,10 mm minimum

## WEAR PLATE

The wear plate finish must be 10  $\mu$ in., 0,25  $\mu$ m minimum, flat within .0005", 0,0127 mm and parallel to the backside within .001", 0,0254 mm total indicator reading.

## PISTON SHOE

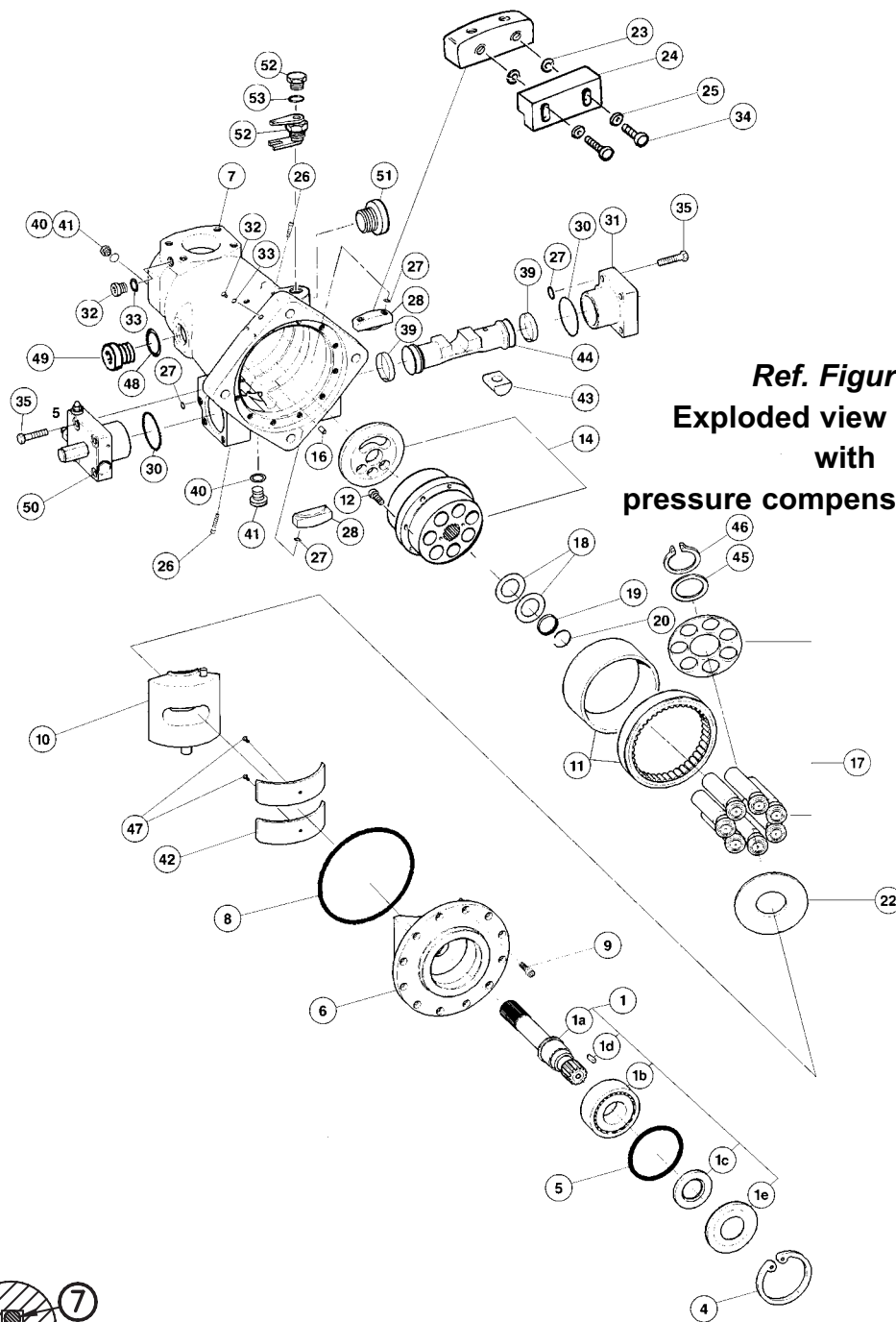
The piston shoe wear face finish must be 45  $\mu$ in., 1,143  $\mu$ m min, and must be lapped in a set with the retainer plate. All shoe sole thicknesses to be within .001", 0,0254 mm after lapping. The maximum permissible shoe and piston axial looseness is .010", 0,254 mm.



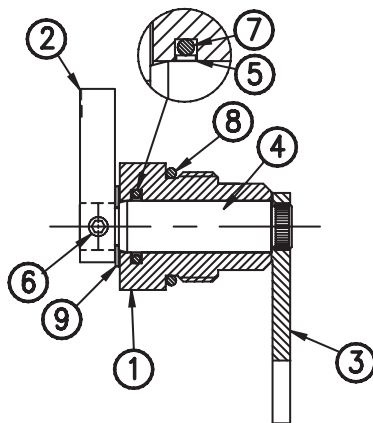
**Ref. Figure 1**  
**Exploded view of pump**  
**with**  
**pressure compensator control**

# PUMP PARTS LISTS

item	description	part no. P07-SAE	part no. P110-ISO	qty.
1	shaft assembly			1
	keyed, no rear drive	S22-15337	S22-15598	
	a (shaft)	032-91829	032-92197	
	b (bearing)	230-82216	230-82216	
	c (seal)	620-82080	230-82080	
	d (key)	033-71514	032-91429	
	e (seal retainer)	032-91835	032-91835	
	keyed, with rear drive	S22-16027	S22-16028	
	a (shaft)	032-92525	032-92526	
	b (bearing)	230-82216	230-82216	
	c (seal)	620-82080	230-82080	
	d (key)	033-71514	032-91429	
	e (seal retainer)	032-91835	032-91835	
	splined, no rear drive	S22-15338	S22-15599	
	a (shaft)	032-91828	032-92198	
	b (bearing)	230-82216	230-82216	
	c (seal)	620-82080	230-82080	
	e (seal retainer)	032-91835	032-91835	
	splined, with rear drive	S22-16025	S22-16026	
	a (shaft)	032-92524	032-92527	
	b (bearing)	230-82216	230-82216	
	c (seal)	620-82080	230-82080	
	e (seal retainer)	032-91835	032-91835	
			<b>P110-DIN</b>	
	keyed, no rear drive		S22-15673	
	a (shaft)		032-92255	
	b (bearing)		230-82216	
	c (seal)		620-82080	
	d (key)		032-92246	
	e (seal retainer)		032-91835	
	keyed, with rear drive		S22-16030	
	a (shaft)		032-92529	
	b (bearing)		230-82216	
	c (seal)		620-82080	
	d (key)		032-92246	
	e (seal retainer)		032-91835	
	splined, no rear drive		S22-15602	
	a (shaft)		032-92212	
	b (bearing)		230-82216	
	c (seal)		620-82080	
	e (seal retainer)		032-91835	
	splined, with rear drive		S22-16029	
	a (shaft)		032-92528	
	b (bearing)		230-82216	
	c (seal)		620-82080	
	e (seal retainer)		032-91835	
4	retainer	356-65086	356-65086	1
5	O-ring, 70 S-1 ARP 155	671-00155	671-00155	1
6	cradle	032-92446	032-92477	1
7	housing, no rear drive	032-92473	032-92579	1
	housing, with rear drive	032-92481	032-92580	
8	O-ring, 70 S-1 ARP 263	671-00263	671-00263	1
9	screw, SHC	361-11213	361-11213	14
10	cam assembly	S22-15903	S22-15903	1
11	bearing	032-92449	032-92449	1
12	screw, SHC	361-10234	361-10234	7
14	barrel & port plate assembly CW	S22-16145	S22-16145	1
	barrel & port plate assembly CCW	S22-16146	S22-16146	



**Ref. Figure 1**  
**Exploded view of pump**  
**with**  
**pressure compensator control**



**Ref. figure 2**  
**Indicator Assembly (52)**  
**S22-16262**

**PARTS LIST FOR INDICATOR ASSEMBLY**

item	description	part no.	qty.
1	Pivot nut	032-92491	1
2	Indicator	033-70624	1
3	fork	032-92653	1
4	pivot shaft	032-92492	1
5	glyd ring	679-00030	1
6	Soc. setscrew, 10-32 x 3/16	312-09030	1
7	O-ring, 70 S-1 ARP 114	671-00114	1
8	O-ring, 90 S-1 ARP 914	691-00914	1
9	Retaining ring	356-65070	1

# PUMP PARTS LISTS

item	description	part no. P07-SAE	part no. P110-ISO	qty.
16	dowel pin	324-21610	324-21610	1
17	pistons, shoes,retainer assembly	S22-16039	S22-16039	1
	(17-1) retainer plate (1 req'd)	032-92453	032-92453	
	(17-2) pistons and shoes (7 req'd)	S22-16031	S22-16031	
18	Belleville washer	032-91827	032-91827	2
19	stop	032-91824	032-91824	1
20	retaining ring	032-91825	032-91825	1
22	wear plate	032-92452	032-92452	1
23	lockwasher	348-10016	348-10016	2
24	bearing	032-91602	032-91602	1
25	washer	345-10012	345-10012	2
26	screw, SHC	361-08200	361-08200	4
27	O-ring, 90 S-1 ARP 013	691-00013	691-00013	6
28	cam/bearing retainer	032-92470	032-92470	2
30	O-ring, 70 S-1 ARP151	671-00151	671-00151	2
31	<b>off stroke control side (see page 17)</b>			1
	buck-up cap (comp, torque limiter, load sensing)	S22-15447	S22-15447	
	electric stoker	S22-16204	S22-16203	
	hydraulic stoker	S22-16202	S22-16201	
	rotary servo	S22-16200	S22-16199	
32	plug	488-35061	447-00032	2
33	O-ring, 90 S-1 ARP 904	691-00904	none	3
34	screw, SHC	361-08704	361-08704	2
35	Screw, HHC, M12 x 1,75 x 55 mm lg.	363-12205	363-12205	*
	Screw, HHC, M12 x 1,75 x 75 mm lg.(E,H,R,J,K)	363-12220	363-12220	*
	Screw, HHC, M12 x 1,75 x 85 mm lg. (L)	363-12233	363-12233	*
39	ring (qty. 1 for servo, electric & hydraulic stoker)	032-91816	032-91816	2
	ring (servo, electric & hydraulic stoker)	032-91811	032-91811	1
40	O-ring, 90 S-1 ARP 906	691-00906	none	2
41	plug	488-35041	447-00032	2
42	bearing	032-92454	032-92454	2
43	slide link	032-91823	032-91823	1
44	control piston (compensator, torque limiter)	032-91836	032-91836	1
	control piston (servo, electric & hydraulic stoker)	032-91848	032-91848	
45	bearing	032-91830	032-91830	1
46	retainer, white, .062", 1,57 mm thick	032-91853	032-91853	1
	retainer, red, .064", 1,63 mm thick	033-91854	033-91854	
	retainer, green, .067", 1,70 mm thick	033-91855	033-91855	
	retainer, yellow, .069", 1,75 m thick	033-91856	033-91856	
	retainer, blue, .071", 1,80 mm thick	033-91857	033-91857	
47	screw, FSHCS	316-50001	316-50001	2
48	O-ring, 90 S-1 ARP 916	691-00916	none	1
49	plug	488-35024	447-01016	1
50	<b>on stroke control side (see page 17)</b>			1
	compensator (C1)	S22-15394	S22-15623	
	compensator (C2)	S22-15626	S22-15633	
	low torque limiter (J1)	S22-15401	S22-15624	
	low torque limiter (J2)	S22-15627	S22-15634	
	high torque limiter (K1)	S22-15629	S22-15631	
	high torque limiter (K2)	S22-15635	S22-15636	
	load sensing (L1)	S22-15402	S22-15625	
	load sensing (L2)	S22-15628	S22-15637	
	low torque limiter w/load sensing (V1)	S22-16186	S22-16188	
	low torque limiter w/load sensing (V2)	S22-16195	S22-16196	
	high torque limiter w/load sensing (W1)	S22-16187	S22-16189	
	high torque limiter w/load sensing (W2)	S22-16197	S22-16198	
	compensator override	S22-16205	S22-16206	
	low torque limiter override	S22-16207	S22-16208	
	high torque limiter override	S22-16209	S22-16210	
	max. volume screw, servo	S22-15325	S22-15613	
51	shipping plug	449-00019	449-00613	
52	plug	488-35030	488-35030	1
	indicator assembly (see figure 2)	S22-16262	S22-16262	
53	O-ring, 90 S-1 ARP 914	691-00914	691-00914	1

\*qty and size depends on control (31) and (50). see controls section, starting pg 25

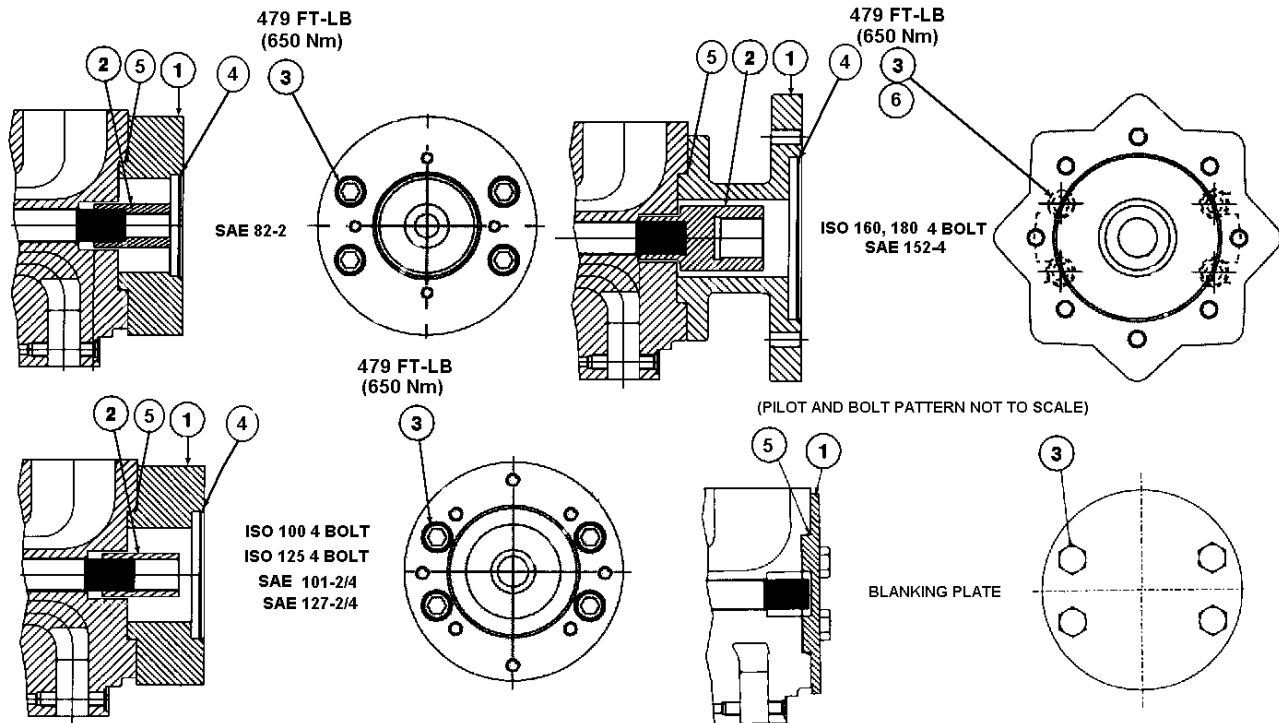


Figure 3

SAE REAR DRIVES									
			code → A	G	B	Q	C	N	D
			flange → SAE 82-2	SAE 82-2	SAE101-2/4	SAE101-2/4	SAE127-2/4	SAE127-2/4	SAE152-4
			coupling → 16-4	22-4	22-4	25-4	32-4	38-4	44-4
item	part	qty	("A")	(modified "A")	("B")	("B-B")	("C")	("C-C")	("D")
1	adapter	1	032-91900	032-91900	032-91309	032-91309	032-91308	032-91649	032-91282
2	coupling	1	032-91901	032-92377	032-91361	032-91362	032-91363	032-91648	032-91634
3	screw	4	361-16304-8	361-16304-8	361-16304-8	361-16304-8	361-16304-8	361-16304-8	361-16304-8
4	O-ring	1	671-00152	671-00152	671-00155	671-00155	671-00159	671-00159	671-00163
5	O-ring	1	671-00159	671-00159	671-00159	671-00159	671-00159	671-00159	671-00159
6	washer	4							350-10109-
	assembly		S22-15372	S22-15809	S22-12867	S22-12868	S22-12869	S22-12920	S22-12870

ISO REAR DRIVES									
			code → Z	Y	X	T	U	L	
			flange → ISO 100	ISO 125	ISO 160	ISO 180	ISO 180	ISO 180	
			coupling → ISO K25N	ISO K32N	ISO K40N	ISO K40N	ISO K50N	DIN 40-18	
item	part	qty							
1	adapter	1	032-91383	032-91384	032-91385	032-92162	032-92162	032-92162	
2	coupling	1	032-91391	032-91390	032-91389	032-91389	032-91388	032-92345	
3	screw	4	361-16304-8	361-16304-8	361-16304-8	361-16304-8	361-16304-8	361-16304-8	
4	O-ring	1	671-00155	671-00159	671-00164	671-00167	671-00167	671-00167	
5	O-ring	1	671-00159	671-00159	671-00159	671-00159	671-00159	671-00159	
6	washer	4			350-10109	350-10109	350-10109	350-10109	
	assembly		S22-12872	S22-12873	S22-12874	S22-15740	S22-15570	S22-15933	

note: code M item (1) blanking plate part no. 032-91468 item (3) blanking plate screws 363-16210-8



**ROTATION CONVERSION**

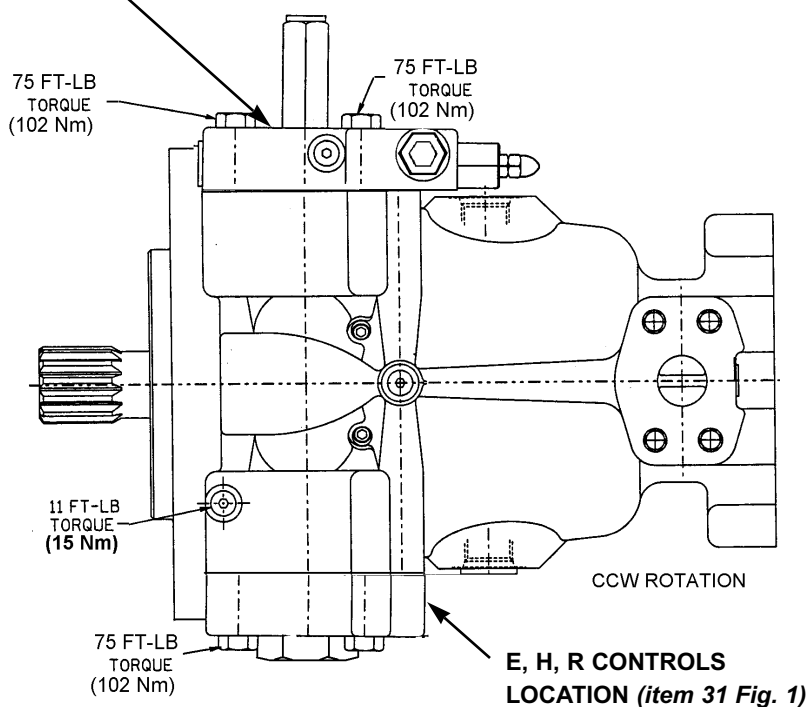
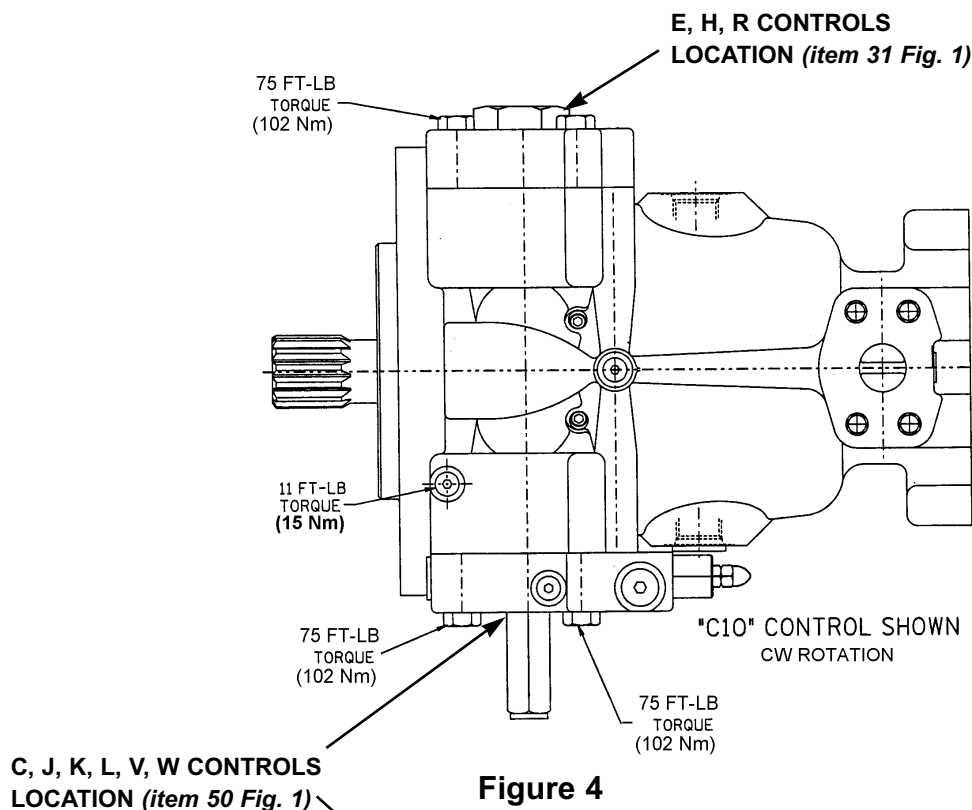
The following parts and assembly are required for changing shaft rotation:

- A different barrel and port plate assembly is required. The barrel and port plate are matched assemblies, and should not be ordered separately. The reference part numbers are:

CW - Barrel and Port Plate Assembly S22- 16145

CCW - Barrel and Port Plate Assembly S22- 16146

- The control piston must be reversed to position it correctly to the control caps. See step 9 pg. 20)
- The control caps location are reversed. *see illustrations below.*



**Figure 5**  
**CONTROL ORIENTATION VERSUS PUMP ROTATION**

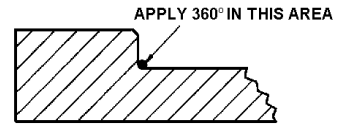
### SHAFT SEAL REPLACEMENT

**See illustration** Remove worn or damaged seal from retainer. Clean gasket sealant from retainer.

Install new seal by applying gasket sealant to retainer and pressing seal in retainer.

**SEAL KITS** ..... P07 S22-15646-0  
 ..... P110 S22-15647-0

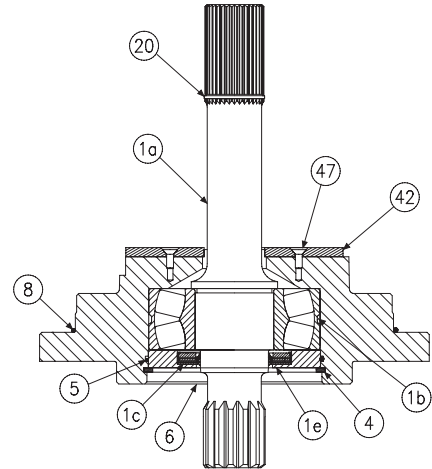
The shaft seal and all "O" rings necessary for total seal replacement may be obtained by ordering the Seal Kit. These seals are suitable for petroleum base fluids. For fire resistant fluids contact **DENISON HYDRAULICS**, Inc. or their authorized distributors to obtain the appropriate seal kit number.



### SHAFT ASSEMBLIES (see parts list, item (1) on page 13)

The following assemblies include shaft, key when applicable, bearing and seal:

	<b>P07-SAE #</b>	<b>P110-ISO #</b>
Keyed, no rear drive assembly	S22-15337	S22-15598
Keyed, with rear drive assembly	S22-16027	S22-16028
Splined, no rear drive assembly	S22-15338	S22-15599
Splined, with rear drive assembly	S22-16025	S22-16026
		<b>P110-DIN #</b>
Keyed, no rear drive assembly		S22-15673
Keyed, with rear drive assembly		S22-16030
Splined, no rear drive assembly		S22-15602
Splined, with rear drive assembly		S22-16029



### PRE-ASSEMBLY

Depending on the repairs, many steps in this section may not be applicable.

The assembly area should be clean and the environment such that foreign matter will not be introduced to the pump during assembly. All parts must be absolutely clean and free from rust, contamination, lint, or any other foreign matter. Critical surfaces must be free of dings or scratches. All "O" rings and seals must be clean and carefully examined for cuts or other damage before installation.

During assembly, occasional reference will be made to the use of lubricating oil for proper assembly. It is important that any oil used be compatible with the seals and fluid to be used in operation. Compatibility is also necessary for grease which should be used on all "O" rings to ensure proper assembly without damage.

### THREAD LOCKING AND SEALANT

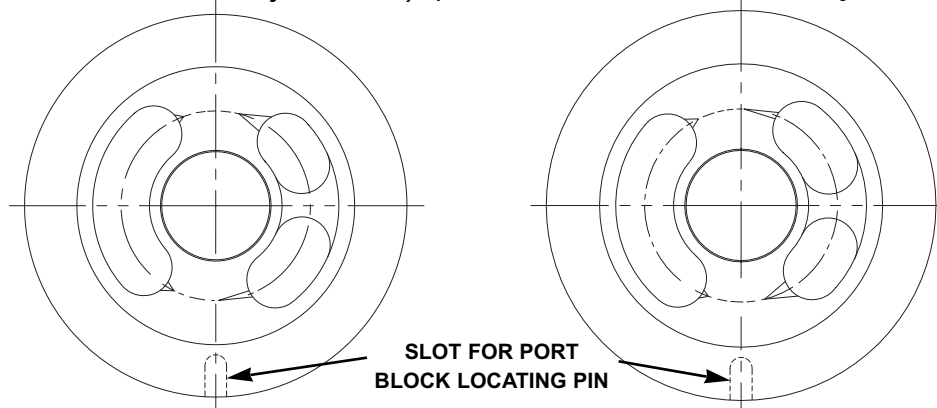
Several screws require a thread locking compound for locking in position. When thread locking compound is required use Loctite® #242 or equivalent. Where hydraulic sealant is specified, use Loctite® Hydraulic Sealant or equivalent. Where gasket sealant is specified, use Loctite® Master Gasket or equivalent.

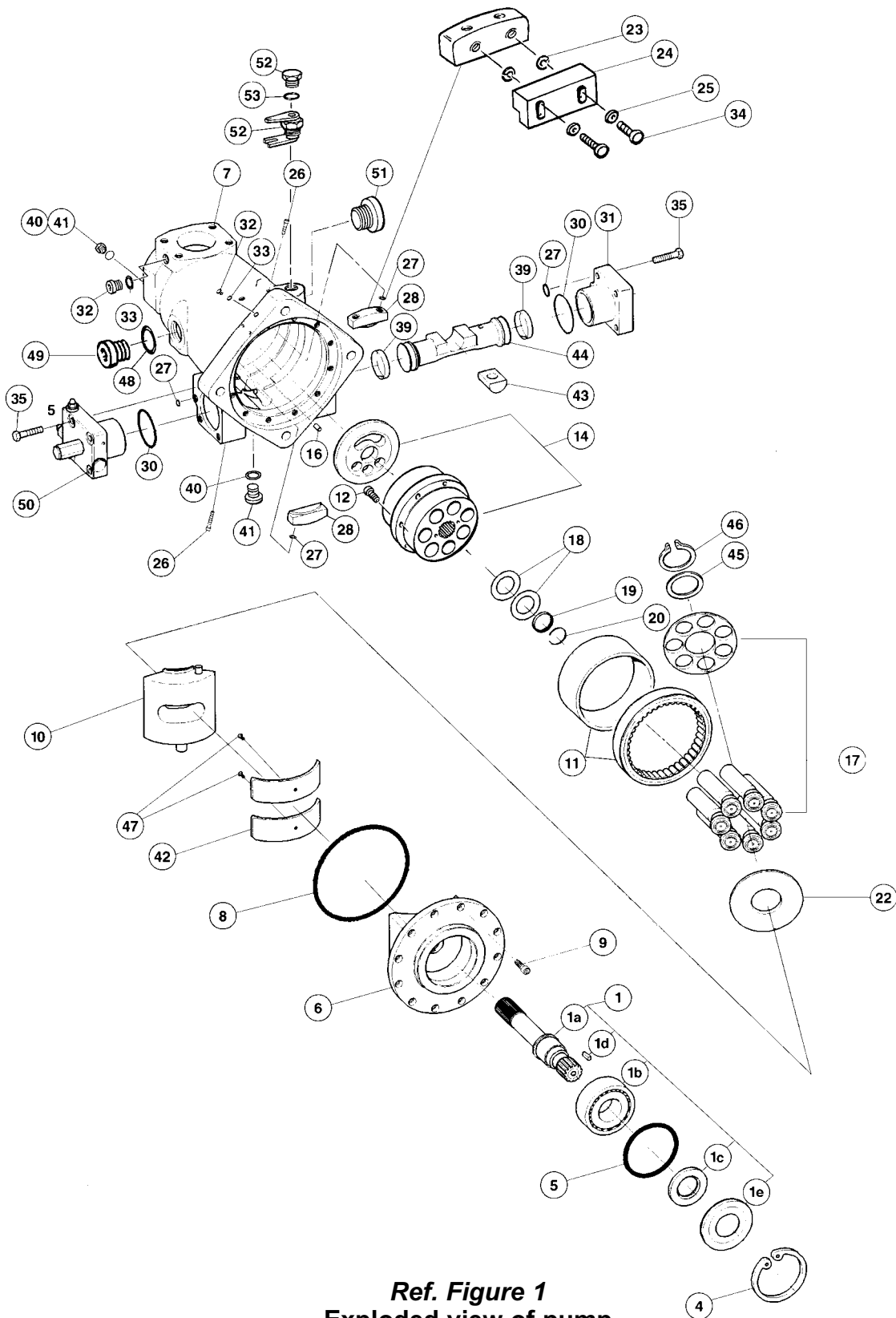
### ASSEMBLY

**Refer to illustration, see figure 1. See page 26 for tightening torque on plugs**

1. Place the port block end of the housing (7) on a suitable surface capable of supporting the pump weight of 177 lbs, 80,3 Kgs.
2. Install plugs (41) with "O" rings into port block. Install plugs (32) with "O" rings into port block.
3. Install pin (16) in port block. Position port plate (14) on port block and over pin. To view correct port plate for shaft rotation specified. **See illustration, below**

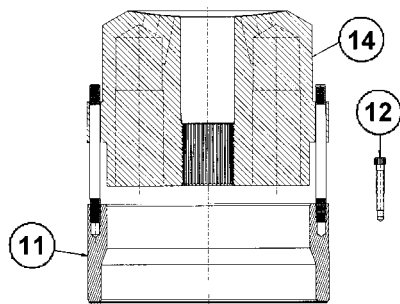
**Port Plate for CW Shaft Rotation** (Ref. Barrel and Port Plate Assembly S22-16145) **Port Plate for CCW Shaft Rotation** (Ref. Barrel and Port Plate Assembly S22-16146)





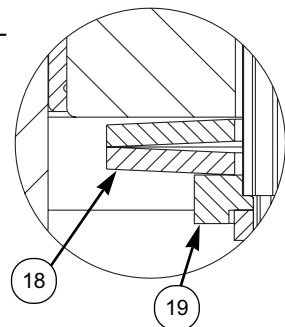
**Ref. Figure 1**  
**Exploded view of pump**  
**with**  
**pressure compensator control**

4. Press bearing outer race (11) into housing (7).



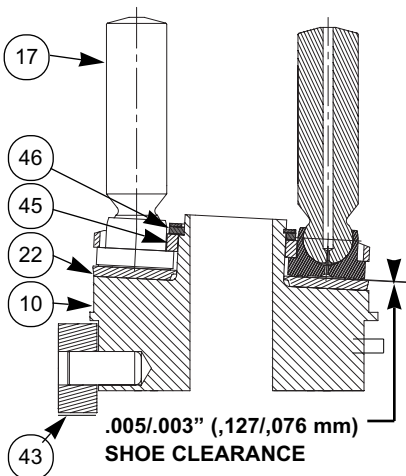
#### BARREL AND INNER RACE ASSEMBLY

5. Thread seven M8-1,25 studs into bearing inner race. Lower barrel (14) over studs and seat. If the inner race is heated to 150°F, 65°C, barrel will slide into position without force. If race is not heated, longer screws (12) can be used to draw the race and barrel together. Insert screws (12) and torque to 30 lbs ft., 40 Nm. **See illustration**
6. Apply oil to face of port plate and inner bearing race. Attach tool T-1 to barrel with two M6 screws. Carefully lower barrel assembly into housing engaging inner race into rollers of outer bearing race, barrel may then be lowered until it has seated on port plate.
7. Insert two "O" rings (27) into each retainer (28). Apply thread locking compound to two screws (26) and secure retainer to housing. Torque to 84 lbs-in., 9,5 Nm.
8. Apply thread locking compound to two screws (26) and assemble the other retainer on opposite side of housing. Torque to 84 lbs-in., 9,5 Nm.
9. Assemble the two piston rings (39) on control piston (44). Insert control piston (44) into housing bore that is used with the control caps. **For CW shaft rotation**, the long end of the piston must be positioned to the right. (**Ref. fig.1**) **For CCW rotation**, the long end of the piston is to the left.
10. Position Belleville washers (18) on barrel, **See illustration**. To insure proper pump operation and correct barrel holddown force they must be assembled exactly as shown. Place barrel stop (19) on Belleville washers and center the washers and stop on barrel.

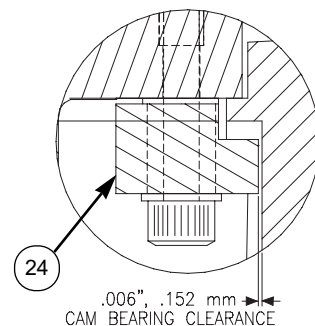


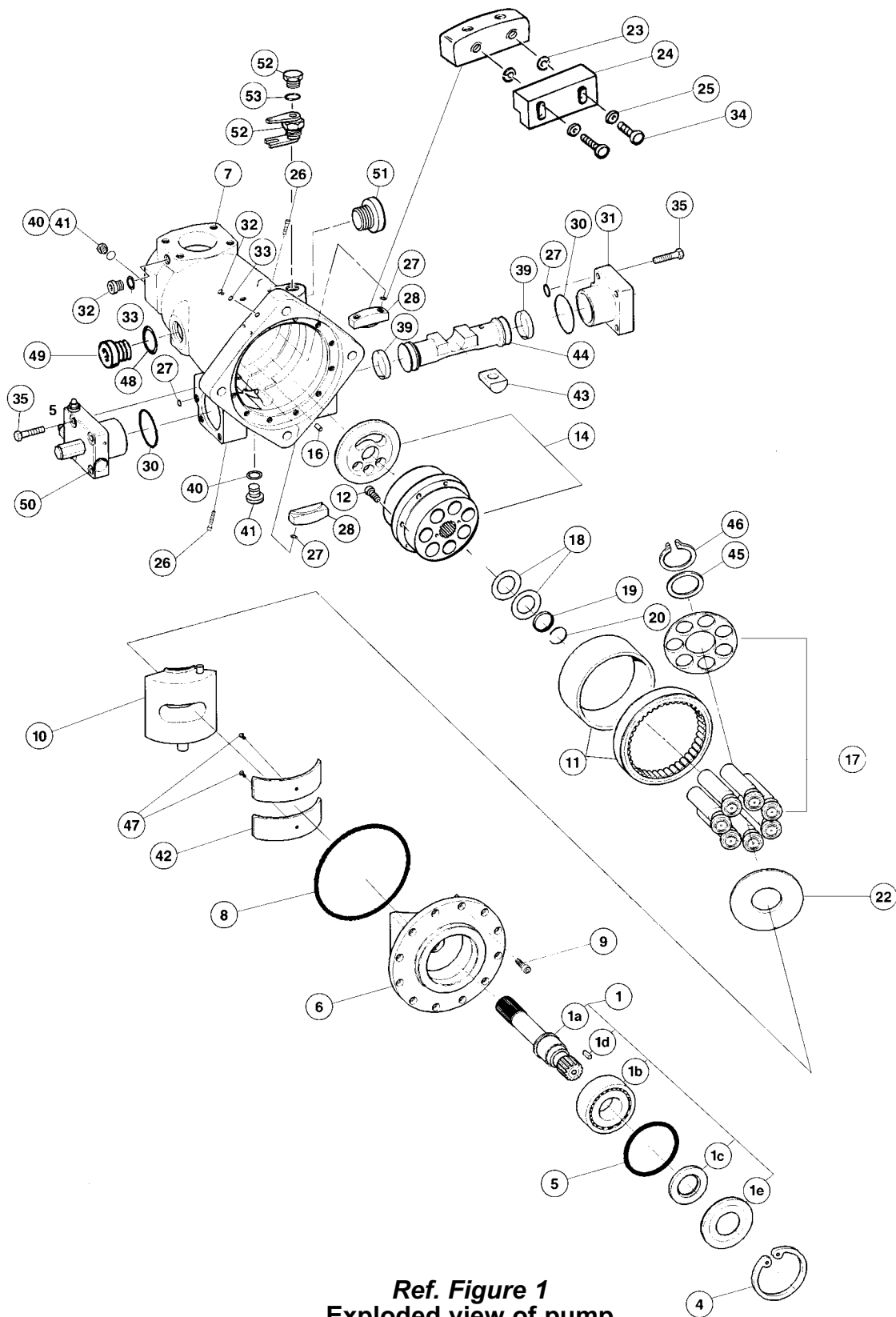
#### CAM ASSEMBLY

11. Set cam assembly (10) on suitable surface protecting cam surfaces from damage during assembly. **See illustration**
12. Place wear plate (22) on cam.
13. Position pistons-shoes-retainer assembly (17) over center post and against wear plate.
14. Install thrust washer (45) over center post.
15. Six different retainers (46) are available for setting the shoe holddown. Each retainer is marked: **white dot** .062", 1,57 mm thick, **red dot** .064", 1,63 mm thick, **green dot** .067", 1,70 mm thick, **yellow dot** .069", 1,75 mm thick, and **blue dot** .071", 1,80 mm thick. Install the thickest retainer with the dot side up, that will fit in the groove on the center post and allow a clearance of .003"-.005", 0,076-0,127 mm between the shoe and wear plate. **A .003", 0,076 mm feeler gage must go completely under any shoe, and a .005", 0,127 mm feeler gage must not go under any shoe while holding a piston and lifting tightly against the shoe retainer.** The piston and shoe assembly must be free to rotate easily by hand. Rotate 360° to confirm there is no binding and that each shoe is free in the retainer plate. Oil the assembly thoroughly.
16. Install slide link (43) on rocker cam pin as shown.
17. Oil barrel bores before installing cam assembly. The piston must be moved outward (*away from pump center*) so that clearance is provided for installing the rocker cam assembly. Lower cam assembly into the housing with the slide link positioned so it will engage into the control piston (44). The seven pistons (17) must first be engaged into the barrel bores. Next the slide link (43) must engage into the control piston (44). Continue lowering rocker cam assembly until it is seated on cam/bearing retainers (28).
18. Apply thread locking compound to two screws (34) and assemble clearance-bearing (24) to cam-bearing retainer (28) using the screws (34), two washers (25) and two washers (23). Move rocker cam to the right until it is against stop. **Set clearance** between clearance bearing (24) and cam at .006", 0,152 mm. Torque screws to 6 lbs-ft., 8,1 Nm maintaining the .006", 0,152 mm clearance.



19. Adjust piston (44) toward the *off stroke* control side (31). This will place the cam at approximately zero displacement and provide clearance for the shaft installation.



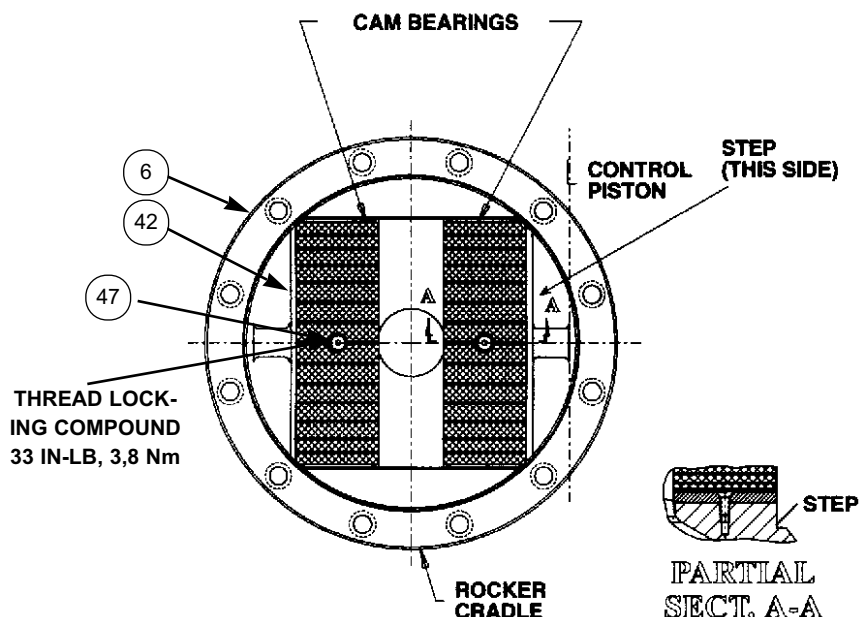


**Ref. Figure 1**  
**Exploded view of pump**  
**with**  
**pressure compensator control**

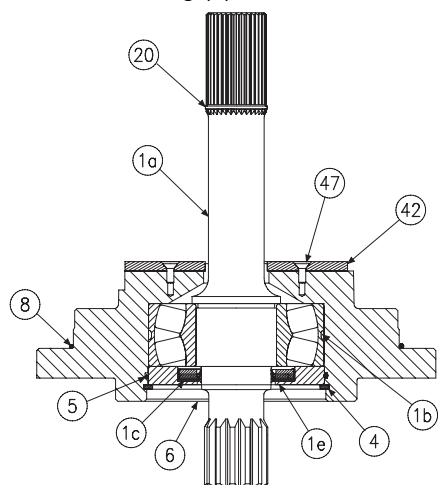
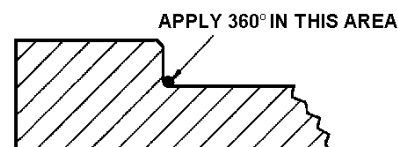
- Continued -

### Rocker cradle assembly

20. Apply thread locking compound to two screws (47) and assemble two cam bearings (42) to cradle (6). Torque to 33 lbs-in., 3,8 Nm.



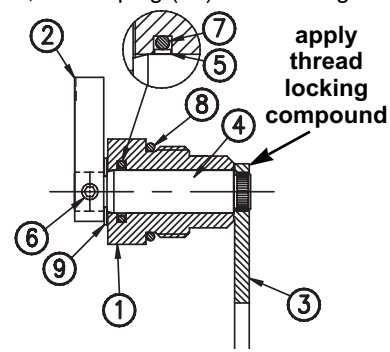
21. Press bearing (1b) on shaft (1a). Press on inner race only.
22. Apply over 360° bead of gasket sealant to seal retainer (1e) per following sketch. Press shaft seal (1c) into seal retainer (1e).
23. Install shaft seal and retainer on shaft using Tool T-3 to protect seal.
24. Install "O" ring (5) in cradle (6).
25. Press seal retainer and bearing and shaft assembly into bore of cradle (6) using Tool T-2.
26. Install snap ring (4) to cradle.
27. Install "O" ring (8) to rocker cradle.



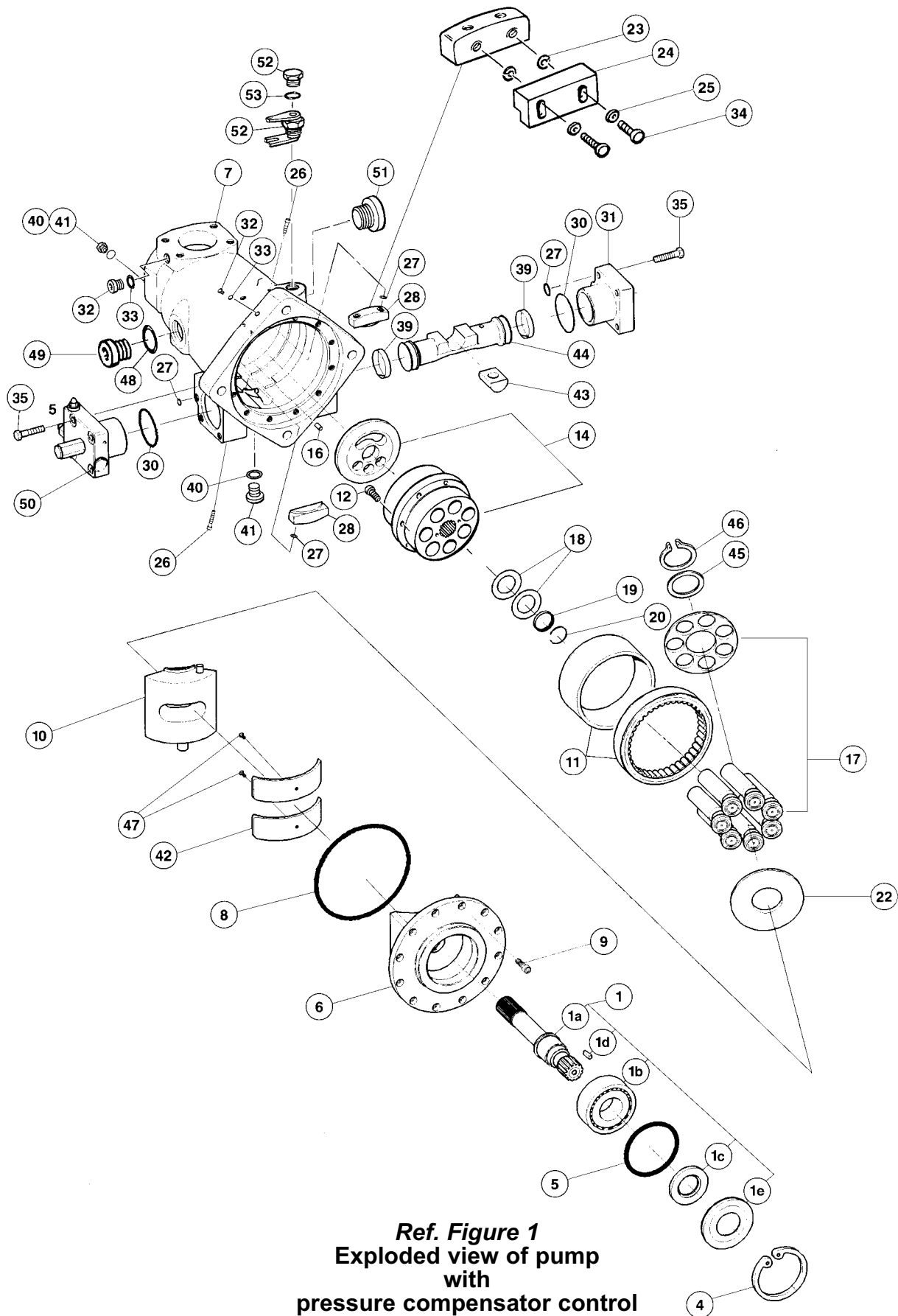
28. Install retaining ring (20) on shaft.
29. Center Belleville washers and barrel stop. Lower rocker cradle assembly into pump housing with the step in the rocker cradle correctly positioned so that clearance is provided for slide link (43). The threaded hole in the end of shaft should be used to support the assembly. SAE shafts use 3/8-16 threads, ISO shafts use M10 threads, DIN shafts use M12 threads. The shaft spline must first engage the splined barrel stop (19), thru the Belleville washers (18) and engage the barrel spline. The assembly will then rest on the cam.
30. Install socket head cap screws (9) as shown. Torque evenly to 57 ft-lb (77 Nm). Install case drain plug (49) and shipping plug (51). If pump does not contain displacement indicator, install plug (52) and "O" ring (53) in indicator hole.

### INDICATOR ASSEMBLY OPTION

See figure 2. To install indicator assembly, loosen setscrew (6), remove indicator (2) and slide shaft out of nut (1). Guide fork into indicator hole in housing to engage the pin on the hanger. a 1/4-20 SHCS or threaded rod may be used to hold the shaft. Slide nut (1) over shaft and tighten nut in threaded hole. Pull shaft out to slip retaining ring (9) into groove in shaft. Use maximum volume stop to set pump on zero displacement (10.2 turns from full). Install indicator, set pointer on "0" and lock in position.



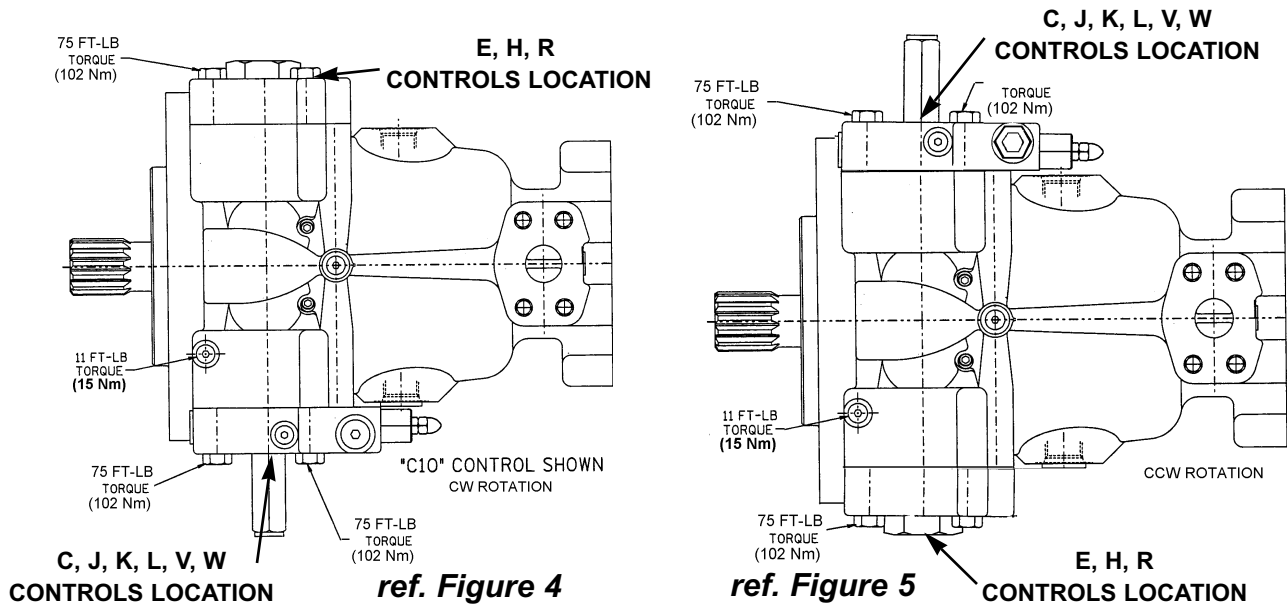
ref. Figure 2  
Indicator assembly



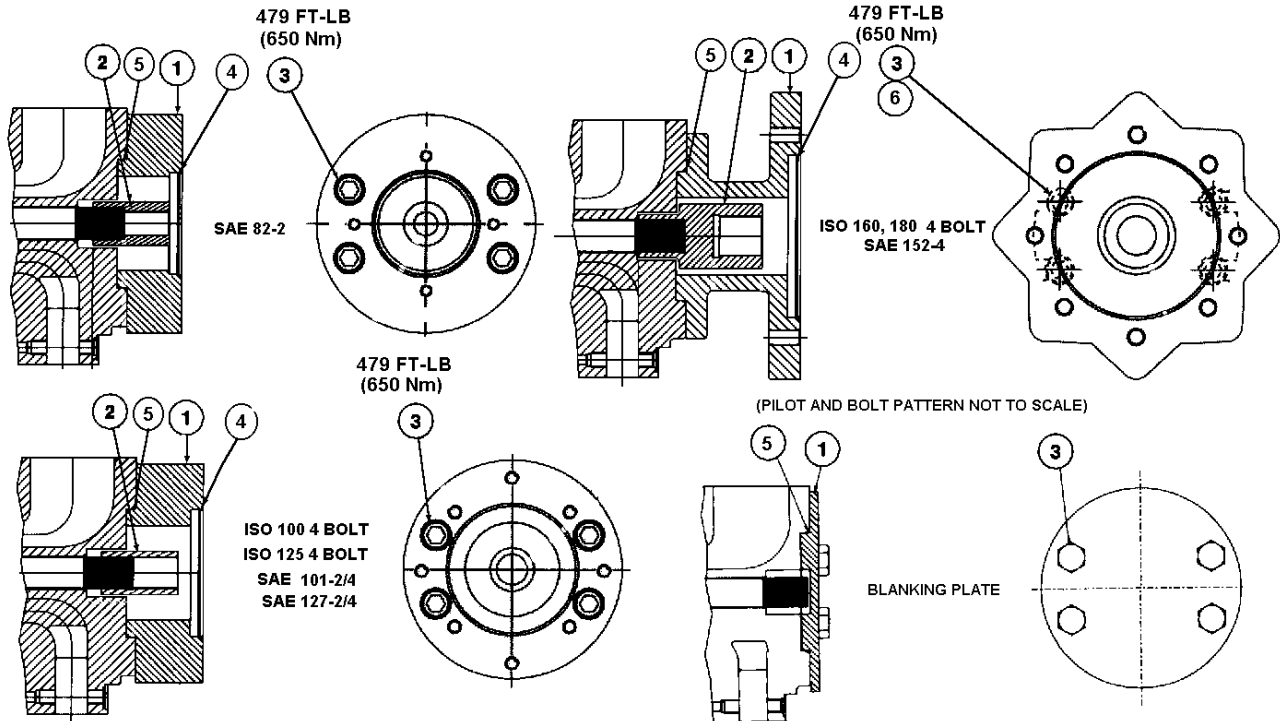
**Ref. Figure 1**  
**Exploded view of pump**  
**with**  
**pressure compensator control**

# CONTROLS ASSEMBLY

Install control cap assemblies (50) and (31). The control caps must be positioned on the housing for either CW or CCW pump rotation. See figures 4 & 5 for correct orientation. The control piston (44) was assembled previously for the correct pump rotation. Install eight hex head cap screws (35) into caps and torque to housing with 75 lbs-ft., 102 Nm.



If the pump has a rear drive feature, assemble coupling and adapter. See illustration, figure 3.



Ref. Figure 3



## GENERAL

The instructions contained in this manual cover complete disassembly and reassembly of the controls. Before proceeding with the disassembly or reassembly of any unit, this manual should be studied in order to become familiar with proper order and parts nomenclature.

## DESCRIPTION OF OPERATION

A pilot operated valve spool and sleeve combination is the core of the control function. For the compensator, torque limiter and load sensing controls, system pressure is applied to the input port of a three-way valve, and to one end of the valve spool. A small orifice feeds this pressure to the other end of the spool, and limits pilot flow to approximately 115 in<sup>3</sup>/minute, 1,9 lpm. A spring on this end biases the spool to normally port the control piston to pump case. This control piston links to the pump cam. On the opposite end of the control piston a small buck-up piston connects to system pressure. This force, pump timing forces, and a spring combine to put the pump on stroke.

## PRESSURE COMPENSATOR

A spring-loaded cone and seat connected to the spring end of the three-way spool establishes an adjustable pressure limit on this end of the spool. When system pressure reaches this value, flow through the spool creates a pressure difference across the spool. At approximately 250 psi, 17,2 bar difference, the spool shifts toward the spring, re-directing the control piston port to system pressure. This pressure applied to the control piston overcomes the forces putting the pump on stroke, causing the pump to reduce displacement. When the pump pressure drops, the spool meters to maintain the pump pressure at approximately 250 psi, 17,2 bar above the controlled pressure on the spring side. The spring end of this three-way spool may also be connected to a remote pressure control, through the vent port, "V".

## LOAD SENSING CONTROL

In the load sensing control, the system load pressure is applied to a modulating valve which establishes the compensator vent pressure at 200 psi, 13,8 bar above load pressure. Adding the differential pressure across the compensator spool to this pressure, the pump outlet pressure is approximately 350 psi to 450 psi, 24,1 to 31 bar above load pressure. There is essentially no flow in the sensing line, and the pump supplies the flow required to develop 350 psi to 435 psi, 24,1 to 30 bar across the metering valve to the load.

## TORQUE LIMITER

The input torque is limited to a set value with the torque limiter control. To limit input torque, pump displacement is reduced when pressure increases, and vice versa. This is accomplished by controlling the compensator pilot pressure with a linkage to the pump stroking piston.

The compensator vent connects to one end of a pin which is spring loaded on the other end. The pin slides through a spool which is positioned by a linkage to the control piston. Vent flow passes through the pin to a cross drilled hole, which is opened or blocked by the motion of the spool. As system pressure increases, the pin moves against the springs till the cross drilled passage opens, venting the compensator and causing the pump to reduce displacement. As displacement reduces, the sleeve follows, closing the cross drilled passage and establishing control at a higher pressure. For any pressure, there is a corresponding pump displacement. The position of the spool is controlled by the pressure acting against two springs, one which is always in contact with the pin, and the other which comes in contact as pressure increases, providing an increase in spring rate as pressure increases.

## TORQUE LIMITER WITH LOAD SENSING

A modulating valve is mounted to a torque limiter body to provide a load sensing control with torque limiting and pressure compensator override.

## ROTARY SERVO CONTROL

The rotary servo control is mounted on the off-stroke side of the control piston. Servo pressure is connected to the input port of a four-way valve, and to the end of this valve spool. A drilling and orifice connects to the opposite end of the spool. One cylinder port connects to the "off stroke" end of the control piston, while the other cylinder port connects to the "on stroke" end of the control piston, through the control on the opposite side.

A rotatable shaft converts to a linear motion on a pin. A sleeve over the pin is driven by a linkage to the control piston. The sleeve/pin combination meters pilot flow from the four-way valve controlling the shifting of the four-way valve, in such a manner that the four-way valve shifts to hold the cylinder position to the corresponding position for the input rotation.

### HYDRAULIC STROKER

In the hydraulic stroker, a spring loaded piston is attached to the pin. A control pressure of 50 psi, 3,45 bar causes the piston to commence to move against the spring, to position the pin in proportion to the control pressure, and thus cause the pump to stroke in proportion to control pressure. Full displacement is achieved at 225 psi, 15,5 bar.

### ELECTRIC STROKER

By mounting an electrically modulated pressure control valve on the hydraulic stroker to establish the control pressure, pump displacement is controlled by an electrical signal. For a 24 volt coil, the pump commences to stroke at approximately 175 mA electrical signal, and will be at full displacement at approximately 275 mA.

### PRESSURE COMPENSATOR AND TORQUE LIMITER OVERRIDE

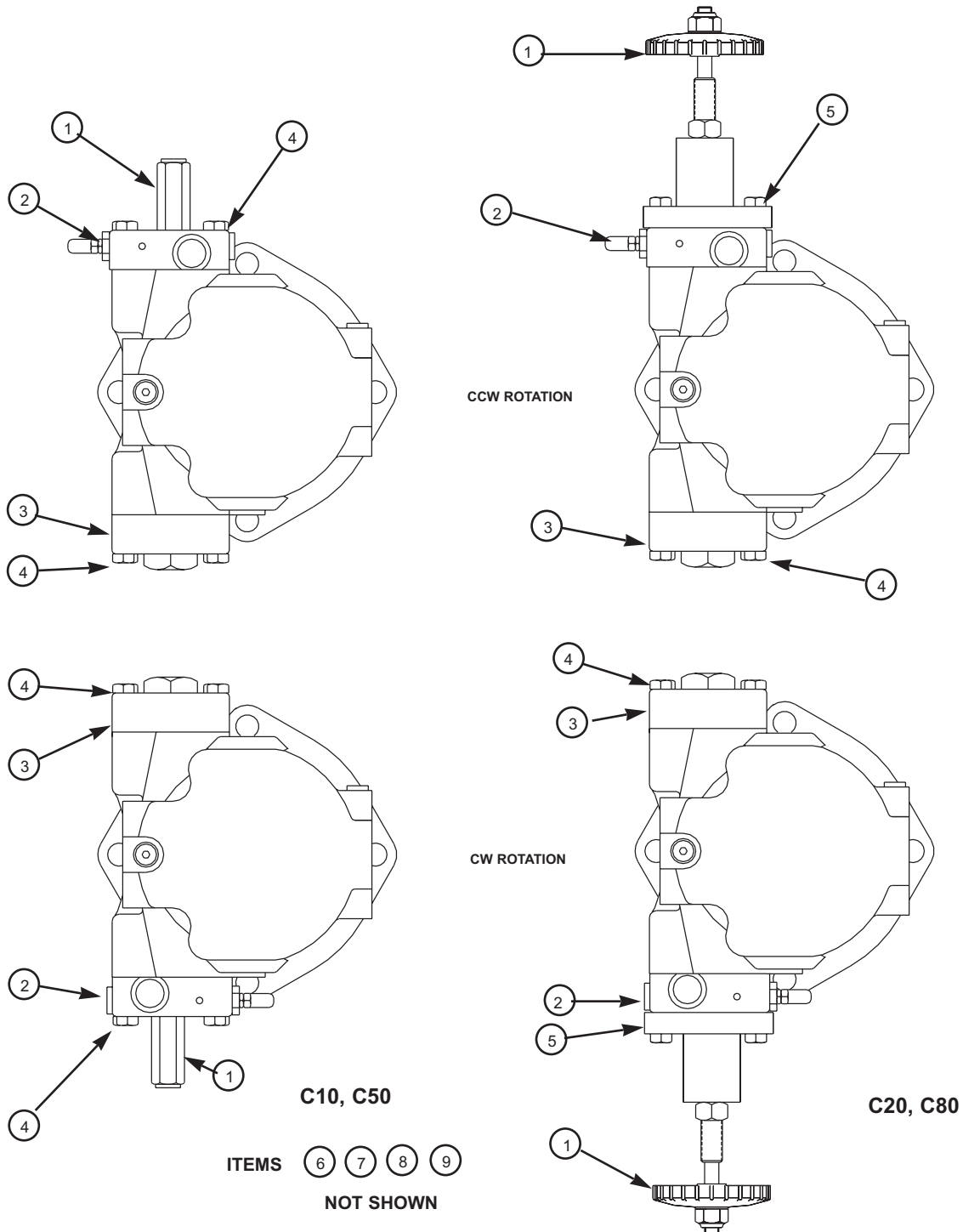
An override pressure compensator or a torque limiter control mounts on the smaller diameter of the control piston, opposite the servo, hydraulic or electric stroker. In the normal position, the spool in the override control connects this piston to the control valve on the opposite side, allowing control by the stroker. When system pressure or torque exceed the override setting, this spool connects system pressure to the smaller diameter control piston, to override the rotary servo, hydraulic or electric stroker command and reduce displacement according to the compensator or torque limiter setting. Override pressure must be sufficient to overcome servo pressure acting on the larger diameter piston.

#### TIGHTENING TORQUE FOR HYDRAULIC PLUGS

PORT SIZE	ft-lbs	Nm
SAE-4	11	15
SAE-6	18	24
SAE-8	46	62
SAE-10	75	102
SAE-14	130	175
SAE-16	135	183
1/4 BSPP	18	24
3/8 BSPP	18	24
1/2 BSPP	93	126
1" BSPP	146	198

### PORT SIZES

.....DESCRIPTION .....	P07 C MOD	....P110 C MOD
PORT C1 .....OFF-STROKE CYLINDER GAGE.....	SAE-4	....1/4 BSPP
PORT C2 .....ON-STROKE CYLINDER GAGE.....	SAE-4	....1/4 BSPP
PORT D .....CASE DRAIN .....	SAE-20	....1-1/4 BSPP
PORT D1 .....CASE DRAIN .....	SAE-20	....1-1/4 BSPP
PORT DG .....DRAIN GAGE, AIR BLEED PORT .....	SAE-4	....3/8 BSPP
PORT AG .....INLET GAGE .....	SAE-4	....1/4 BSPP
PORT BG .....SYSTEM GAGE.....	SAE-4	....1/4 BSPP
PORT BG1....ALTERNATE SYSTEM GAGE.....	SAE-6	....1/4 BSPP
PORT E .....ELECTROHYDRAULIC STROKER SERVO SUPPLY .....	SAE-4	....1/4 BSPP
PORT H .....HYDRAULIC STROKER SIGNAL.....	SAE-4	....1/4 BSPP
PORT LS ....LOAD SENSING LINE.....	SAE-4	....1/4 BSPP
PORT V .....COMPENSATOR, TORQUE LIMITER, LOAD SENSING VENT .....	SAE-8	....3/8 BSPP
PORT V1 .....SERVO VENT .....	SAE-4	....1/4 BSPP
PORT X .....SERVO SUPPLY .....	SAE-6	....3/8 BSPP
PORT XG .....SERVO GAGE .....	SAE-10	....1/2 BSPP



**PRESSURE COMPENSATOR**  
*parts list*

ITEM	DESCRIPTION	P07 PART NO.	P110 PART NO.	QTY. C10/50 C20/80	
1	Maximum Stop (Fig. 7)	S22-15467	S22-15467	1	—
	Maximum Handwheel (Fig. 8)	S22-15448	S22-15448	—	1
2	*Compensator Control (Fig. 6)	S22-15394	S22-15623	1	
	*Compensator Control (Fig. 6)	S22-15626	S22-15633		1
3	Buck Up Cap (Fig. 9)	S22-15447	S22-15447	1	1
4	Screw-H.H.C., M12 x 55 mm	363-12205	363-12205	8	6
5	Screw-H.H.C., M12 x 75 mm	363-12220	363-12220	—	2
6	Control Piston	032-91836	032-91836	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2
8	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2
9	Piston Ring	032-91816	032-91816	2	2

\*Include items 1, 4, 5, 7 and 8

### COMPENSATOR DISASSEMBLY

1. **See Figure 6.** Back off maximum volume screw or handwheel to full displacement. Remove maximum volume screw or handwheel assembly.
2. Remove bolts holding cap to pump.
3. Remove plug (15) and attached parts. Remove spring (11) and spool (18).
4. Remove adjusting plug (2) and attached parts. Remove seal piston (5). Note: a 10-24 screw may be used to assist in pulling the piston. Remove spring (7) and cone (8).
5. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
6. Examine seat (10) for wear. Do not remove unless damaged.

### ASSEMBLY

#### **See page 26 for tightening torque on plugs**

1. Install Avseal plugs (9) and .047", 1,19 mm. orifice (19) in body.
2. Press seat (10) into bore squarely against shoulder in bore.
3. Install spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal piston (16). Lubricate and install into plug (15). Install plug (15) into cap. Install screw (3), nut (4) and plastic cap (17).
4. Install O-ring (6) on seal piston (5).
5. Lubricate O-ring and install cone (8), spring (7) and seal piston into bore in cap (1), being careful that cone enters seat (10). Install remaining parts. Torque plugs (12) and (21).
6. Note proper location for cap on pump (pg. 24). Install O-rings on interface between cap and pump control pad.
7. Install cap on pump control pad, guiding the control piston into the bore. Install maximum volume stop assembly.
8. Torque mounting bolts to 75 lbs.·ft., 102 Nm.

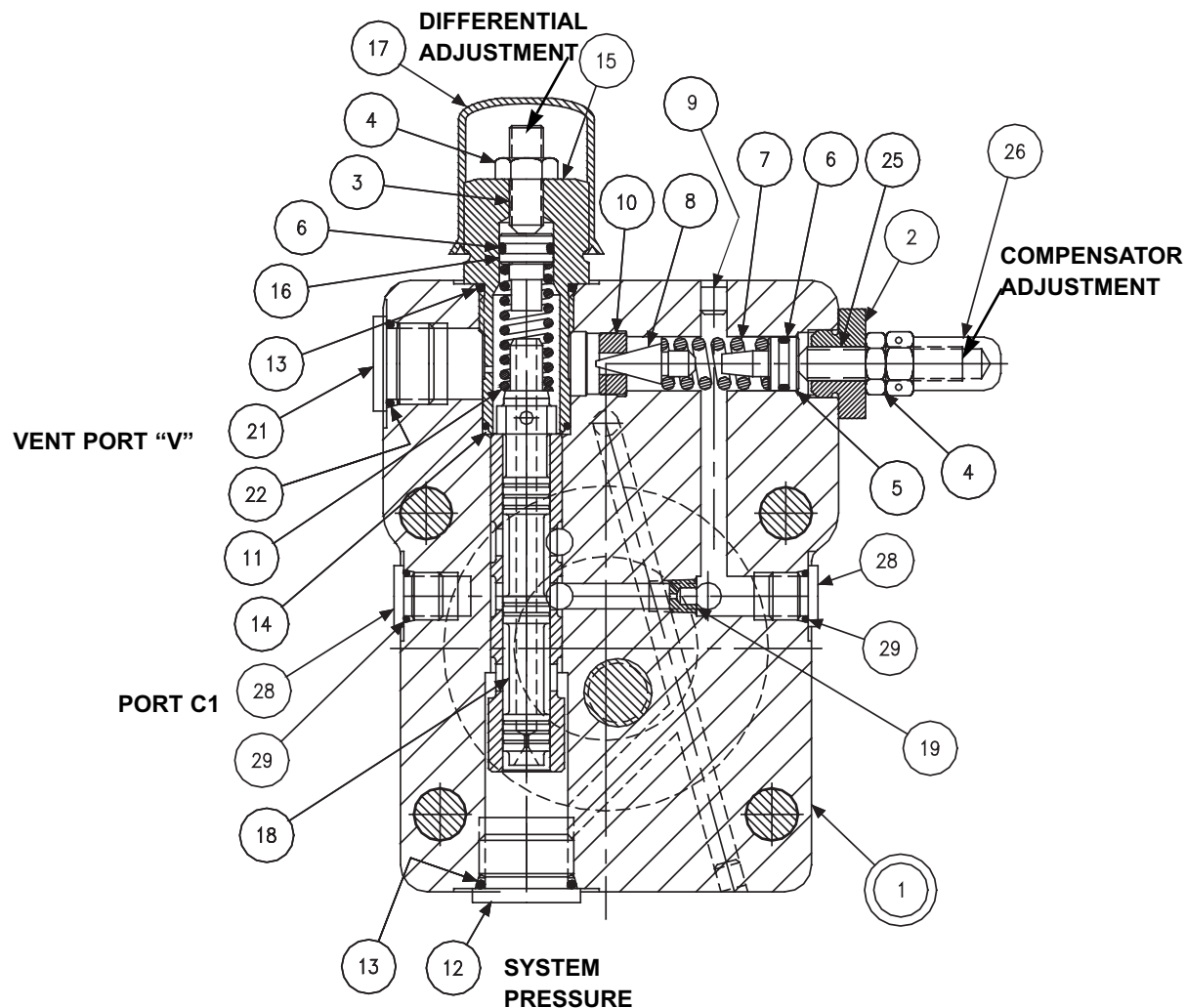


FIGURE 6

**PARTS LIST FOR FIGURE 6**

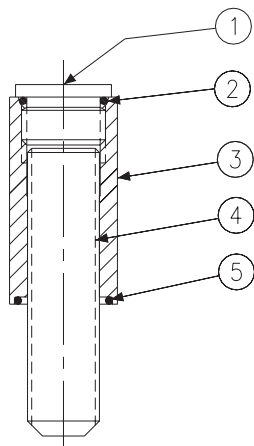
P07 C10 compensator S22-15394

P110 C10 compensator S22-15623

P07 C20 compensator S22-15626

P110 C20 compensator S22-15633

ITEM	DESCRIPTION	P07		P110	
		PART NO.	QTY.	PART NO.	QTY.
1	Cap-Sleeve Assembly	S22-15321	1	S22-15604	1
2	Adjusting Plug	032-91814	1	032-91814	1
3	Socket Setscrew 5/16-24 x 1	312-13160	1	312-13160	1
4	Nut, 5/16-24	335-13100	2	335-13100	2
5	Seal Piston	031-59367	1	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2	691-00012	2
7	Spring	032-91798	1	032-91798	1
8	Cone	036-12288	1	036-12288	1
9	Avseal Plug	447-00026	2	447-00026	2
10	Seat	036-11692	1	036-11692	1
11	Spring	033-71086	1	033-71086	1
12	Plug	488-35055	1	447-01008	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
14	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
15	Plug	031-57368	1	031-57368	1
16	Seal Piston	032-91305	1	032-91305	1
17	Cap	449-00612	1	449-00612	1
18	Spool	032-59482	1	032-59482	1
19	Orifice Plug, .047", 1,19 mm.	033-25528	1	033-25528	1
21	Plug	488-35018	1	447-00032	1
22	O-Ring, 90 S-1 ARP 908	691-00908	1	-	-
25	Setscrew 5/16-24 x 1-1/4	312-13180	1	312-13180	1
26	Acorn Nut	036-33474	1	036-33474	1
28	Plug	488-35061	2	447-01004	2
29	O-ring, 90 S-1 ARP 904	691-00904	2	-	-

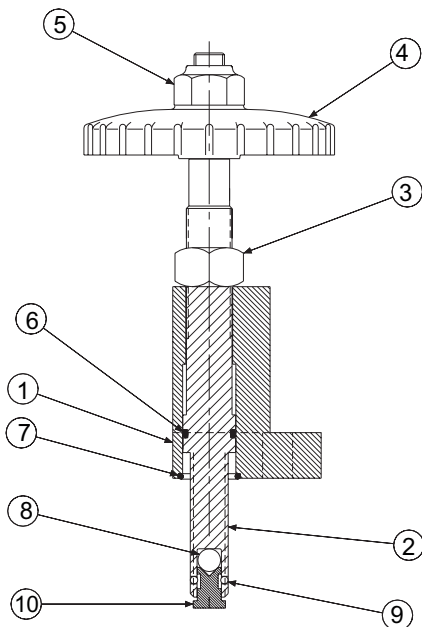


**Figure 7**  
maximum volume stop

**PARTS LIST FOR FIGURE 7**

*maximum volume stop S22-15467*

ITEM	DESCRIPTION	PART NO.	QTY.
1	Plug 8HP5N-S	488-35018	1
2	O-Ring, 90 S-1 ARP 908	691-00908	1
3	Nut, M16 Hex	032-91822	1
4	Screw, Soc. Set	311-50001	1
5	O-Ring, 70 S-1 ARP 115	671-00115	1



**Figure 8**  
Handwheel maximum volume stop

**PARTS LIST FOR FIGURE 8**

*handwheel S22-15448*

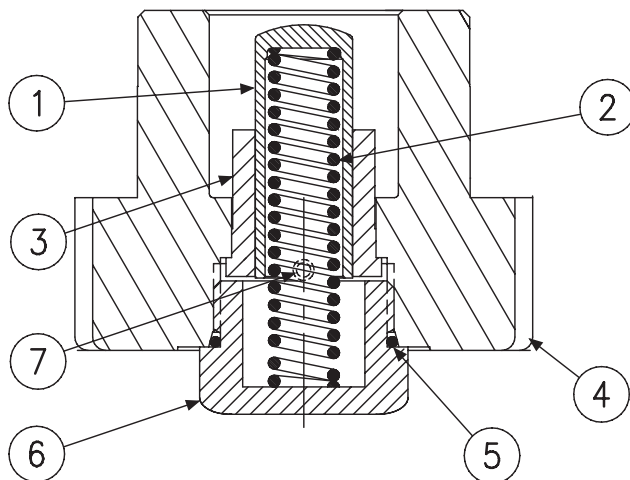
ITEM	DESCRIPTION	PART NO.	QTY.
1	Bracket	032-92056	1
2	Screw	032-92057	1
3	Nut, Hex	333-25000	1
4	Handwheel	031-59911	1
5	Nut, Elastic Stop 1/2-13	331-20100	1
6	O-Ring, 90 S-1 ARP 115	691-00115	1
7	O-Ring, 90 S-1 ARP-118	691-00118	1
8	Ball	201-12001	1
9	Ball	201-04001	2
10	Seat	032-92058	1

**MAXIMUM VOLUME HANDWHEEL DISASSEMBLY**

1. See Fig. 8. Remove the two screws holding the bracket (1) to the control cap.
2. Turn the handwheel counter-clockwise to remove the stop screw from the control cap.
3. Remove nut (5) and handwheel (4) from the stop screw (2).
4. Remove nut (3). Screw (2) may now be slipped through the bracket (1) to examine parts and to replace O-ring (6).
5. Seat (10) pivots and rotates on ball (8) and is retained by pressing two balls (9) into screw (2). Replace assembly if damaged.

**ASSEMBLY**

1. Install ball (8) and seat (10) in screw (2).
2. Press balls (9) into screw (2) to retain seat
3. Install O-ring (6) on screw (2). Lubricate O-ring and slide screw into bracket (1). Install remaining parts.
4. Turn handwheel clockwise into cap till the screw contacts the control piston.
5. Install and torque the assembly screws to 75 ft-lb, 102 Nm.



**FIGURE 9**  
**Buck-up cap assembly**

**PARTS LIST FOR FIGURE 9**

*buck-up cap S22-15447*

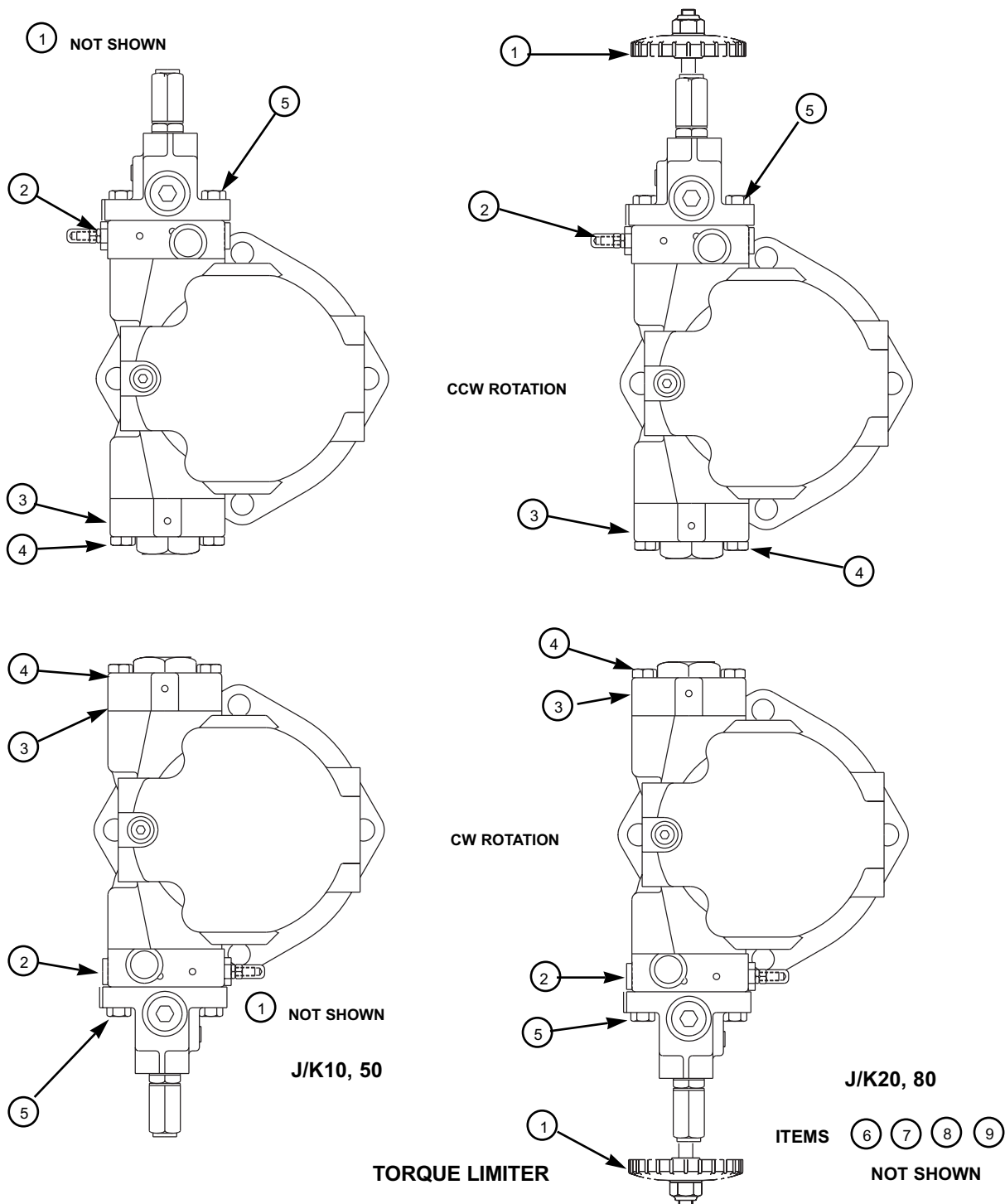
ITEM	DESCRIPTION	PART NO.	QTY.
1	Piston	032-92202	1
2	Spring	032-92205	1
3	Sleeve	032-92203	1
4	Control Cap	032-91832	1
5	O-Ring	691-00920	1
6	Plug	032-92204	1
7	Avseal Plug	447-00026	1

**BUCK-UP CAP DISASSEMBLY**

1. **See Figure 9.** Set maximum volume stop to full displacement. Remove 4 screws holding cap to pump. Caution! Spring load could cause injury!
2. Remove cap assembly from pump.
3. Remove and examine spring (2) and piston (1). If sleeve (3) is worn, press it out and replace.

**ASSEMBLY**

1. Install Avseal plug (7) into cap. Press sleeve (3) into cap to shoulder. Install piston (1), O-ring (5) and plug (6) into cap.
2. Install O-rings on interface between cap and pump control pad. Install spring (2) ) into control piston.  
Install cap assembly on pump housing as indicated on page 17 Fig. 5, guiding the control piston into the bore.
3. Torque the assembly bolts to 75 ft-lb, 102 Nm. Torque plug (7) to 225 lb-ft, 305 Nm.



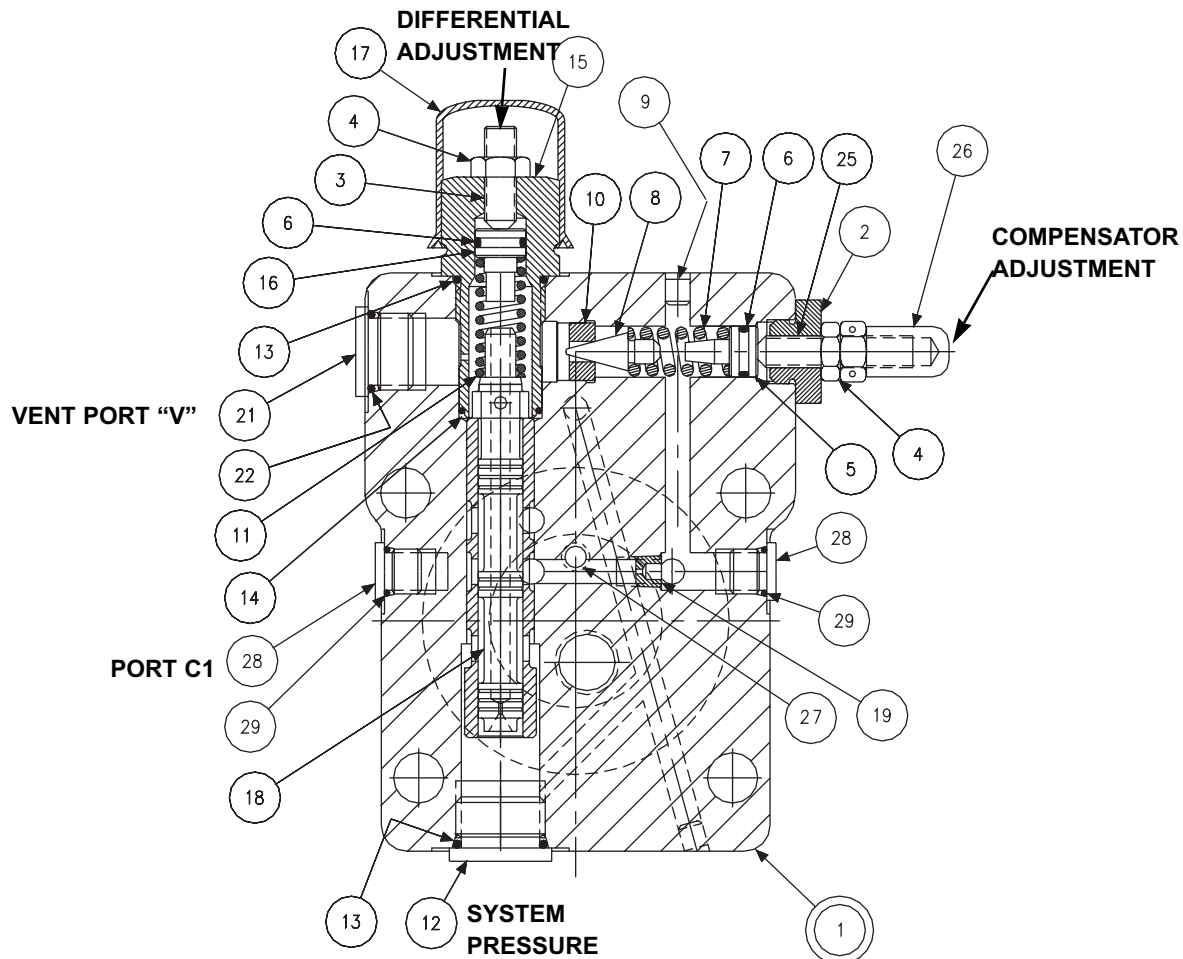
**PARTS LIST**  
torque limiter

ITEM	DESCRIPTION	P07 PART NO	P110 PART NO.	QUANTITY			
				J10	K10	J20	K20
1	Maximum Stop (Fig. 7)	S22-15467	S22-15467	1	1	—	—
	Maximum. Handwheel (Fig. 8)	S22-15448	S22-15448	—	—	1	1
2	*Low Torque Limiter (J10)(Fig. 11)	S22-15401	S22-15624	1	—	—	—
	*Low Torque Limiter (J20)(Fig. 11)	S22-15627	S22-15634	—	—	1	—
	*High Torque Limiter(K10)(Fig. 11)	S22-15629	S22-15631	—	1	—	—
	*High Torque Limiter (K20)(Fig. 11)	S22-15635	S22-15636	—	—	—	1
3	Buck Up Cap (Fig. 9)	S22-15447	S22-15447	1	1	1	1
4	Screw-H.H.C., M12 x 55 mm	363-12205	363-12205	6	6	4	4
5	Screw-H.H.C., M12 x 80 mm	363-12220	363-12220	2	2	4	4
6	Control Piston	032-91836	032-91836	1	1	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
8	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2	2	2
9	Piston ring	032-91816	032-91816	2	2	2	2

\*Include items 1, 4, 5, 7 and 8



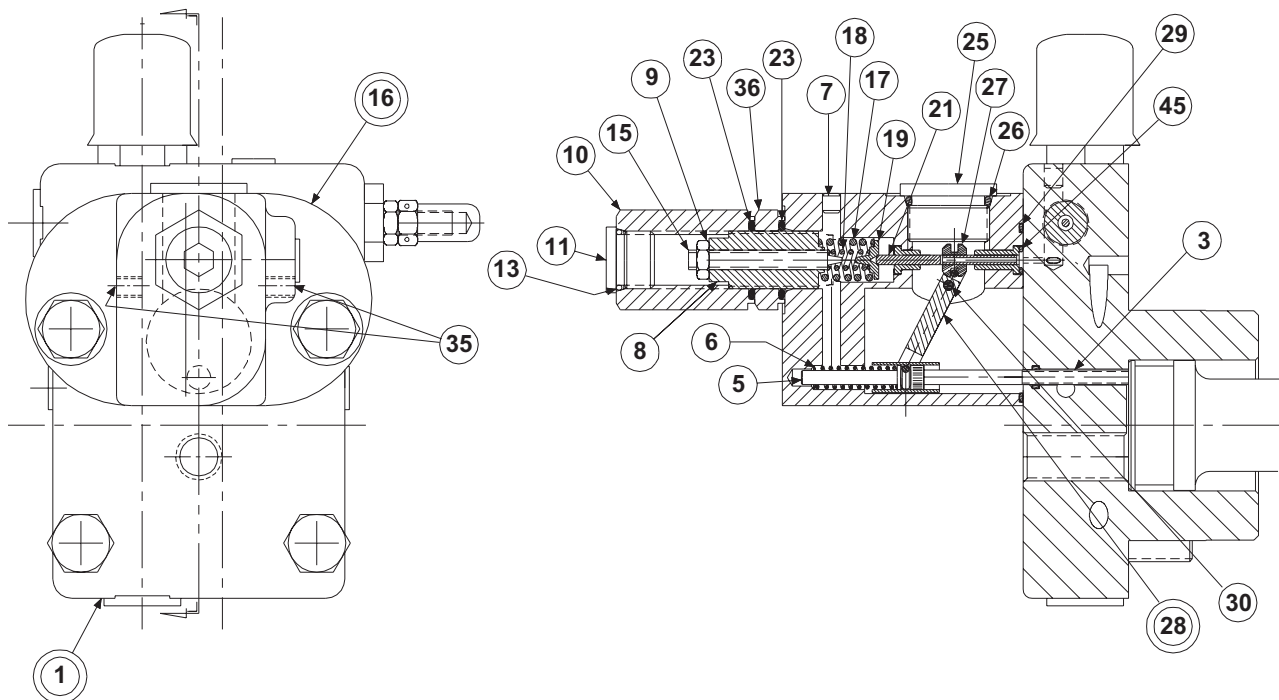
# TORQUE LIMITER CONTROL



**FIGURE 10  
TORQUE LIMITER CAP**

**PARTS LIST FOR FIGURE 10**  
*P07 torque limiter cap S22-15407*  
*P110 torque limiter cap S22-15607*

ITEM	DESCRIPTION	P07		P110	
		PART NO.	QTY	PART NO.	QTY
1	Cap-Sleeve Assembly	S22-15408	1	S22-15608	1
2	Adjusting Plug	032-91814	1	032-91814	1
3	Socket Setscrew 5/16-24 x 1	312-13160	1	312-13160	1
4	Nut, 5/16-24	335-13100	2	335-13100	2
5	Seal Piston	031-59367	1	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2	691-00012	2
7	Spring	032-91798	1	032-91798	1
8	Cone	036-12288	1	036-12288	1
9	Avseal Plug	447-00026	2	447-00026	2
10	Seat	036-11692	1	036-11692	1
11	Spring	033-71086	1	033-71086	1
12	Plug	488-35055	1	447-01008	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
14	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
15	Plug	031-57368	1	031-57368	1
16	Seal Piston	032-91305	1	032-91305	1
17	Cap	449-00612	1	449-00612	1
18	Spool	032-59482	1	032-59482	1
19	Orifice, .047", 1,19 mm.	033-25528	1	033-25528	1
21	Plug	488-35018	1	447-00032	1
22	O-ring, 70 S-1 ARP 908	691-00908	1	-	-
25	Setscrew 5/16-24 x 1-1/4	312-13180	1	312-13180	1
26	Nut, Acorn 5/16-24	036-33474	1	036-33474	1
27	O-Ring, 70 S-1 ARP 008	671-00008	1	671-00008	1
28	Plug	488-35061	2	447-01004	2
29	O-ring 90 S-1 ARP 904	691-00904	2	-	-



**FIGURE 11**  
Torque Limiter

**PARTS LIST FOR FIGURE 11**

P07 code J10,J50 S22-15401  
P07 code J20,J80 S22-15627  
P07 code K10K50, S22-15629  
P07 code K20K80, S22-15635  
P110 code J10,J50, S22-15624  
P110 code J20,J80 S22-15634  
P110 code K10K50, S22-15631  
P110 code K20,K80 S22-15636

ITEM	DESCRIPTION	P07	P110	QTY.	
		PART NO.	PART NO.	J	K
1	Cap (Figure 10)	S22-15407	S22-15607	1	1
3	Screw	032-91461	032-91461	1	1
5	Clevis pin	321-40000	321-40000	1	1
6	Spring, Compression	032-92100	032-92100	1	1
7	Plug, Avseal	447-00026	447-00026	1	1
8	Screw	032-91445	032-91445	1	1
9	Nut, Hex Jam 1/4-20 UNC	340-00038	340-00038	1	1
10	Hex Nut, 3/4-16 UNF	032-91449	032-91449	1	1
11	Plug, 8HP N-S	488-35018	488-35018	1	1
14	O-Ring, 90 S-1 ARP 908	691-00908	691-00908	1	1
15	Screw, Primary Adjusting	032-91446	032-91446	1	1
16	Body assembly	S22-15396	S22-15396	1	1
17	Outer Spring – J Version	032-91440	032-91440	1	—
	Outer Spring – K Version	032-91440	032-91440	—	1
18	Inner Spring – J Version	032-92240	032-92240	1	—
	Inner Spring – K Version	032-91441	032-91441	—	1
19	Spring Retainer	032-91819	032-91819	1	1
21	Spool	032-91438	032-91438	1	1
23	O-ring, 70 S-1 ARP 118	671-00118	671-00118	2	2
25	Plug, 12 HP5N-S	488-35014	488-35014	1	1
26	O-Ring, 90 S-1 ARP 912	691-00912	691-00912	1	1
27	Sleeve	032-91437	032-91437	1	1
28	Arm assembly	S22-15520	S22-15520	1	1
29	O-Ring, 70 S-1 ARP 035	671-00035	671-00035	1	1
30	Dowel Pin, 1/8 Dia. x 1.50 Lg.	324-20824	324-20824	1	1
35	Screw, SHC 10-32 x 1/4	312-09041	312-09041	2	2
36	Nut	032-91645	032-91645	1	1
45	O-Ring, 70 S-1 ARP 010	671-00010	671-00010	1	1

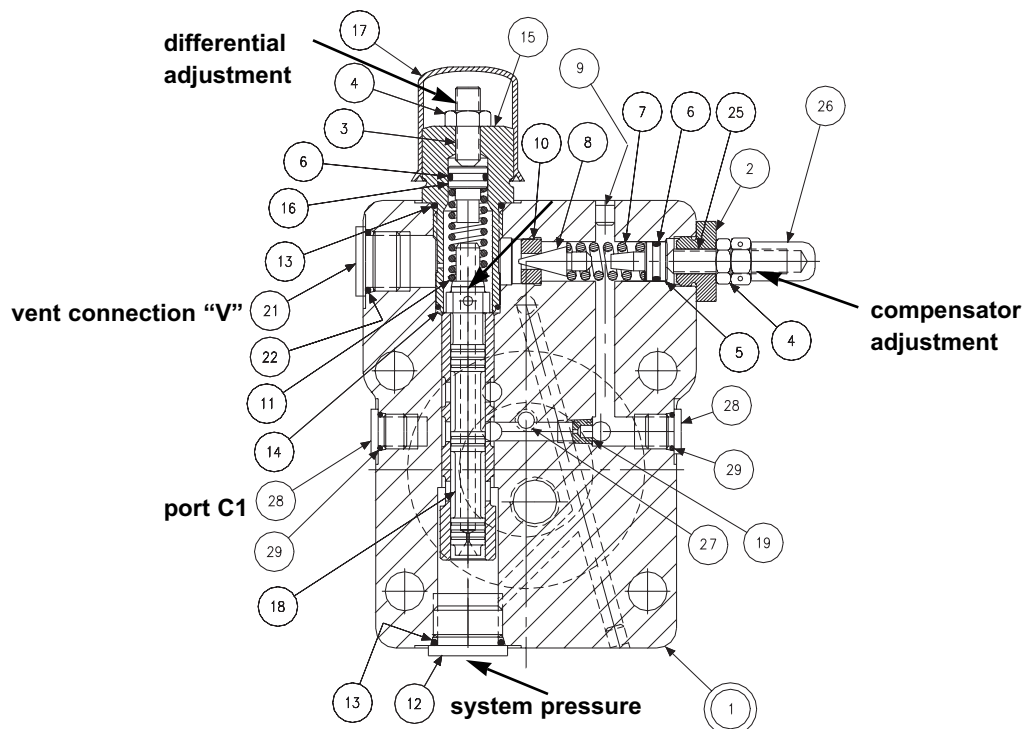
### DISASSEMBLY

1. **See Figure 11.** Remove 2 screws holding torque limiter body (16) to cap assembly (1).
2. Remove all parts from torque limiter body (16) except pin (30) and arm assembly (28). It is not necessary to remove these parts unless broken or worn. Examine parts for wear or damage.
3. Remove screw (3). Examine head for excessive wear, and body for smooth sealing surface with O-ring.
4. Remove maximum stop handwheel assembly or maximum stop screw assembly.
5. Remove cap assembly (1).
6. **See Figure 10.** Remove plug (15) and attached parts. Remove spring (11) and spool (18).
7. Remove adjusting plug (2) and attached parts. Remove spring (7) and cone (8).
8. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
9. Examine seat (10) for wear. Do not remove unless damaged.

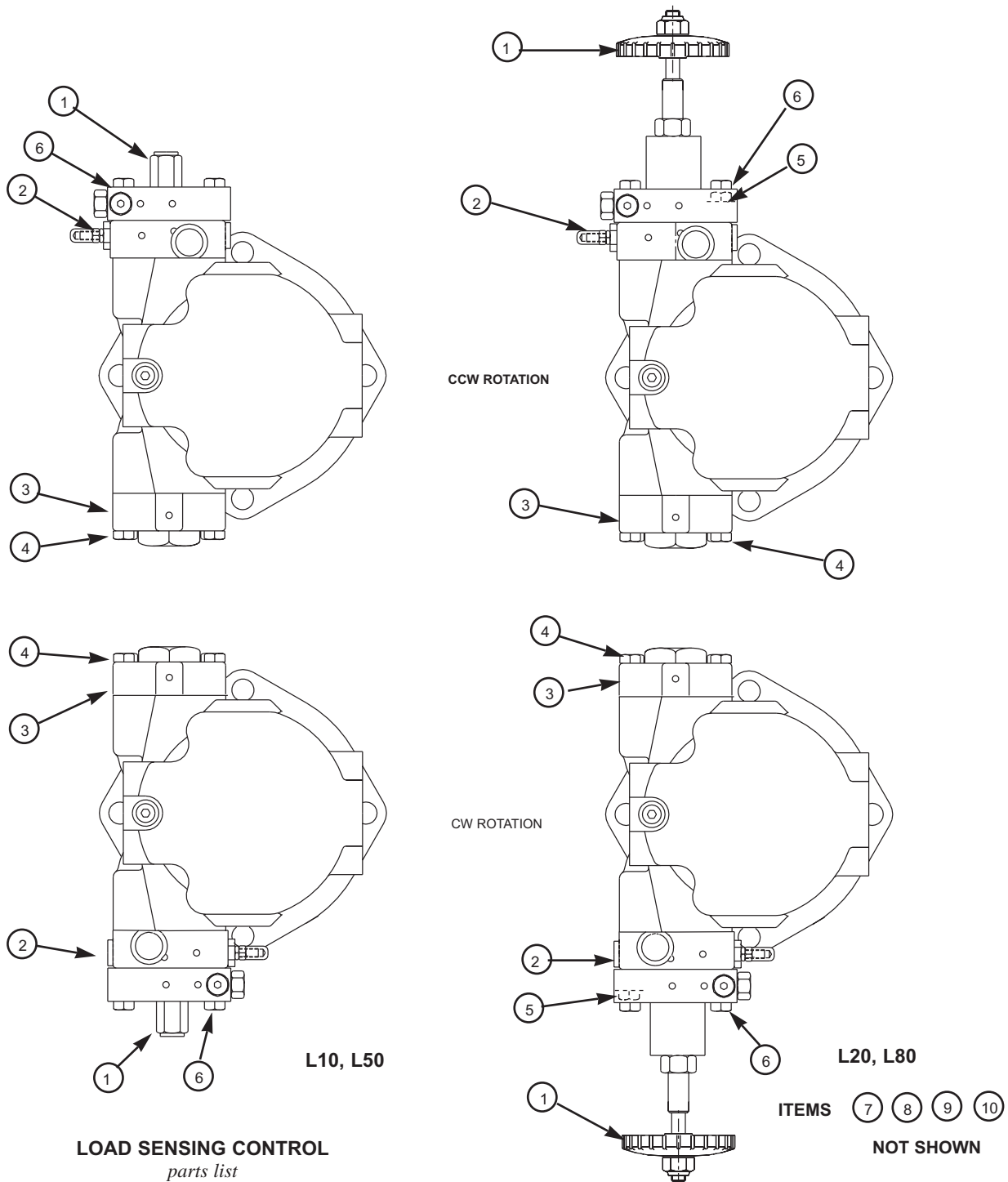
### ASSEMBLY

**See page 26 for tightening torque on plugs**

1. **See Figure 10.** Install Avseal plugs (9) and .047", 1,19 mm. orifice (19) in body.
2. Press seat (10) into bore squarely against shoulder in bore.
3. Install spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal piston (16). Lubricate and install into plug (15). Install plug (15) into cap. Install screw (3), nut (4) and acorn nut (17). Install plug (12), (21) and (28). Torque plugs.
4. Install O-ring (6) on seal piston (5). Lubricate O-ring and install cone (8), spring (7) and seal piston (5) into bore in cap (1), being careful that cone enters seat (10). Install adjusting plug (2), screw (25), nut (4) and acorn nut (26).
5. Carefully install O-ring (27) in the cap.
6. Note proper location for control cap (pg. 24). Install O-rings on interface between cap and pump control pad. Install cap, guiding control piston into bore. Torque mounting screws to 75 lb.\*ft., 102 Nm.
7. Install maximum volume handwheel or screw assembly. Set stop to clear control piston.
8. **See Figure 11.** Apply thread locking compound on threads of screw (3), lubricate the shank, thread through the cap into the control piston, and torque to 5 lb.\*ft., 6,8 Nm
9. Measure height from control cap to top of screw. With control piston at full displacement, dimension must be 1.50 +/- .03 in., 38,1 +/- 0,76 mm.
10. Press dowel (30) into body (16), through the link assembly (28), to 1/4", 6,35 mm below surface. Apply hydraulic sealant to threads of screws (35) and install over dowel (30).
11. While sleeve (27) is engaged into dowel on link (28), slide spool (21) into bore of body (16), and through sleeve (27). Spool (21) must move freely and easily at all positions of the link (28).
12. Assemble remaining parts per drawing. While spring retainer is engaging clevis pin (5) under dowel of link (28), slide the other opening of spring retainer over the top of the screw (3). Attach body assembly (16) to cap (1) and torque screws to 75 lb.\*ft., 102 Nm.



**Ref. Figure 10**  
**Torque limiter cap**

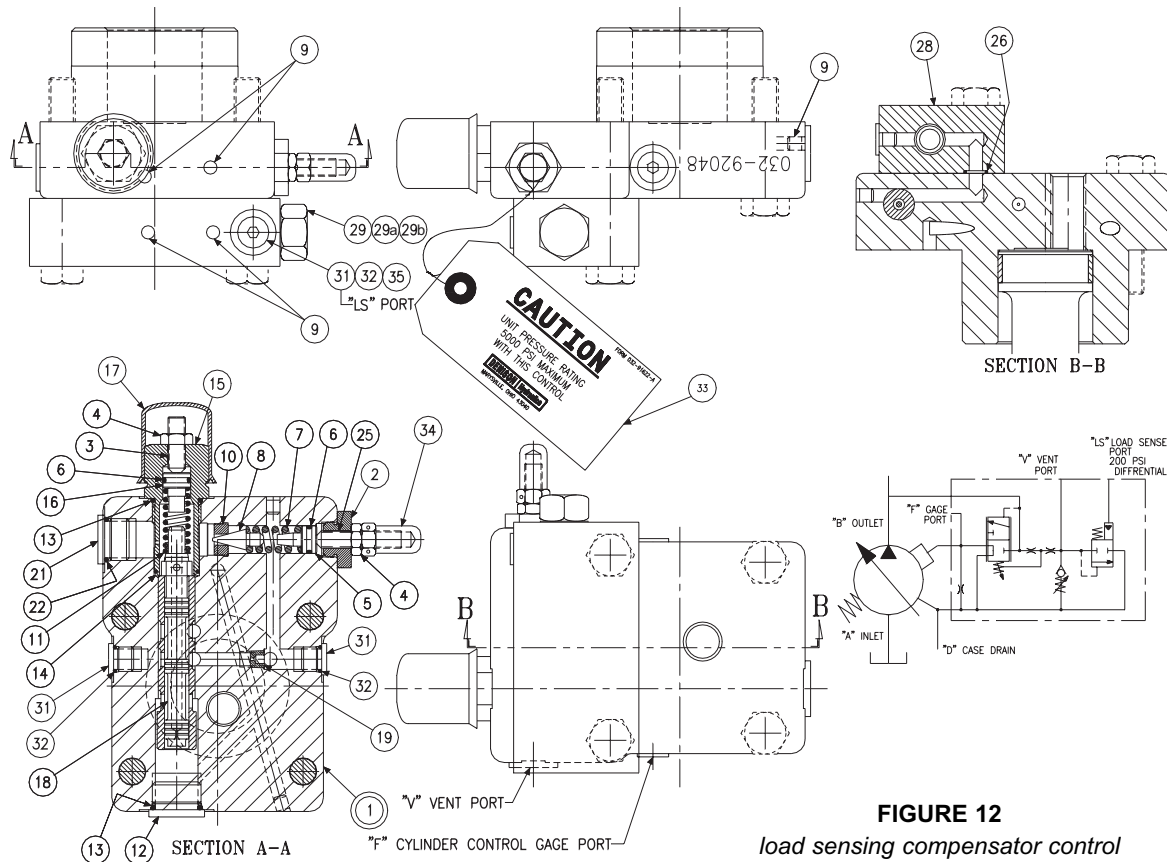


**LOAD SENSING CONTROL**  
parts list

ITEM	DESCRIPTION	P07	P110	QTY.	
		PART NO.	PART NO.	L10, L50	L20, L80
1	Maximum Volume Stop (Fig. 7)	S22-15467	S22-15467	1	—
	Maximum Volume Handwheel (Fig. 8)	S22-15448	S22-15448	—	1
2	*Load Sensing Control (L1*)(Fig. 12)	S22-15402	S22-15625	1	—
2	*Load Sensing Control (L2*)(Fig. 12)	S22-15628	S22-15637	—	1
3	Buck Up Cap (Fig. 9)	S22-15447	S22-15447	1	1
4	Screw-H.H.C., M12 x 55 mm	363-12205	363-12205	6	4
5	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	—	2
6	Screw-H.H.C. M12 x 90 mm	363-12240	363-12240	2	2
7	Control Piston	032-91836	032-91836	1	1
8	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2
9	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2
10	Piston Ring	032-91816	032-91816	2	2

\*Include items 1 (Maximum Volume Stop), 4, 6, 8 and 9

# LOAD SENSING PRESSURE COMPENSATOR CONTROL



**FIGURE 12**  
load sensing compensator control

## PARTS LIST FOR FIGURE 12 LOAD SENSING COMPENSATOR

P07 L1\* S22-15402

P07 L2\* S22-15628

P110 L1\* S22-15625

P110 L2\* S22-15637

ITEM	DESCRIPTION	P07		P110	
		PART NO.	QTY	PART NO.	QTY
1	Cap-Sleeve Assembly	S22-15143	1	S22-15176	1
2	Adjusting Plug	032-91814	1	032-91814	1
3	Socket Setscrew	312-13160	1	312-13160	1
4	Nut, 5/16-24	335-13100	2	335-13100	2
5	Seal Piston	031-59367	1	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2	691-00012	2
7	Spring	032-91798	1	032-91798	1
8	Cone	036-12288	1	036-12288	1
9	Avseal Plug	447-00026	5	447-00026	5
10	Seat	036-11692	1	036-11692	1
11	Spring	033-71086	1	033-71086	1
12	Plug, SAE-8, 1/2 BSPP	488-35055	1	447-01008	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
14	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
15	Plug	031-57368	1	031-57368	1
16	Seal Piston	032-91305	1	032-91305	1
17	Cap	449-00612	1	449-00612	1
18	Spool	032-59482	1	032-59482	1
19	Orifice, .047", 1,19 mm.	033-25528	1	033-25528	1
21	Plug, SAE-10, 1/2 BSPP	488-35018	1	447-00032	1
22	O-Ring, 90 S-1 ARP 908	691-00908	1	-	-
25	Setscrew 5/16-24 x 1-1/4	312-13180	1	312-13180	1
26	O-Ring, 70 S-1 ARP 011	671-00011	2	671-00011	2
28	Body-Valve	032-91620	1	032-91620	1
29	Isolation Valve Cartridge	517-00063-5	1	517-00063-5	1
29-A	O-Ring 90 S-1 ARP 017	691-00017	2	691-00017	2
29-B	O-Ring 90 S-1 ARP 015	691-00015	1	691-00015	1
31	Plug, SAE-4, 1/4 BSPP	488-35061	2	447-01004	2
32	O-Ring, 90 S-1 ARP 904	691-00904	2	691-00904	1
33	Tag, Caution	032-91622	1	032-91622	1
34	Nut, Acorn	036-33474	1	036-33474	1
35	Adapter	-	-	032-91507	1

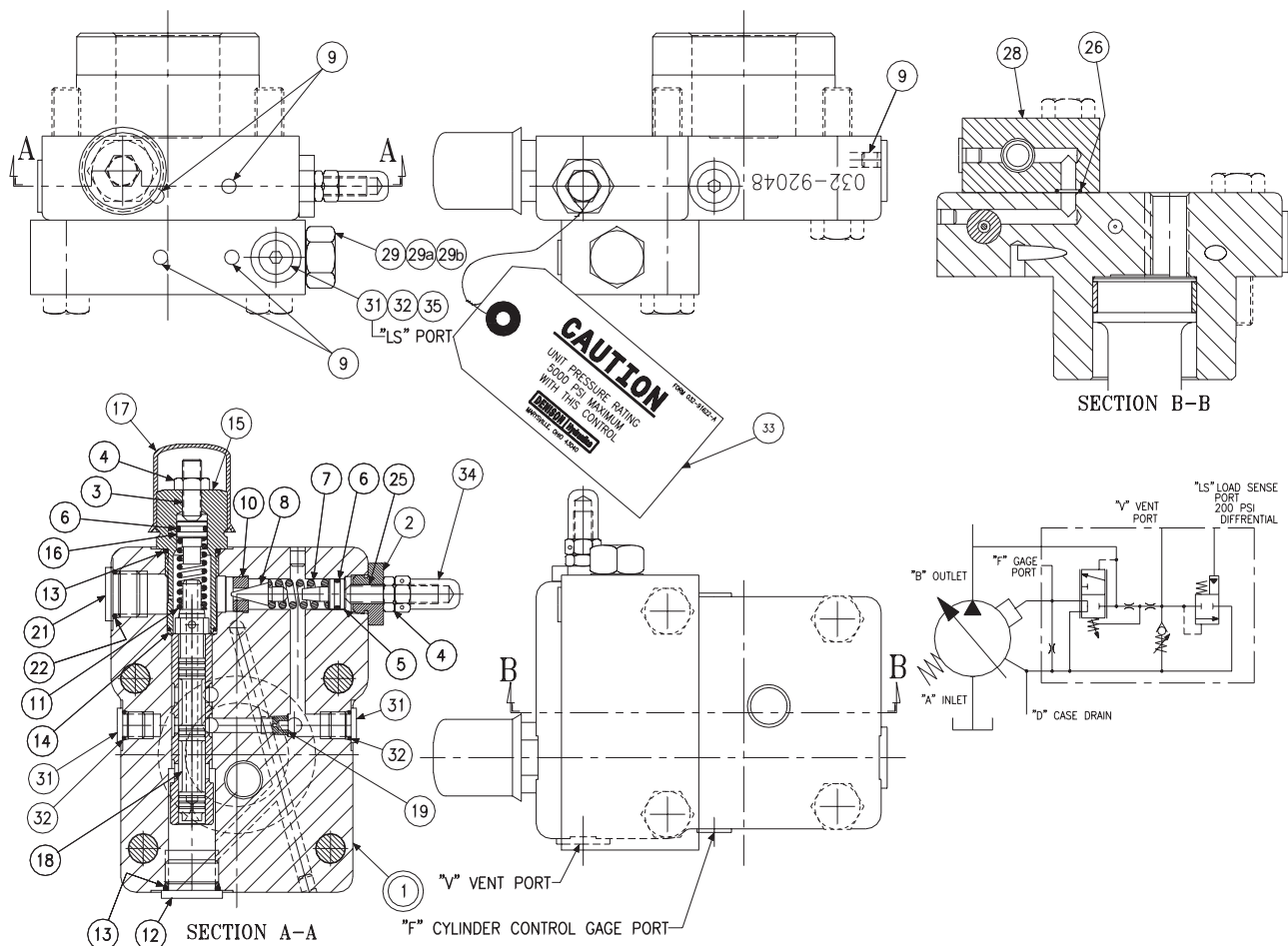
## DISASSEMBLY

1. See Figure 12 Back off maximum volume screw or handwheel to full displacement. Remove maximum volume assembly.
2. Remove bolts holding cap to pump.
3. Remove isolation valve (29) from block (28). Remove plug (15) and attached parts. Remove spring (11) and spool (18).
4. Remove adjusting plug (2) and attached parts. Remove seal piston (5). Note: a 10-24 screw may be used to assist in pulling the piston. Remove spring (7) and cone (8).
5. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
6. Examine seat (10) for wear. Do not remove unless damaged.

## ASSEMBLY

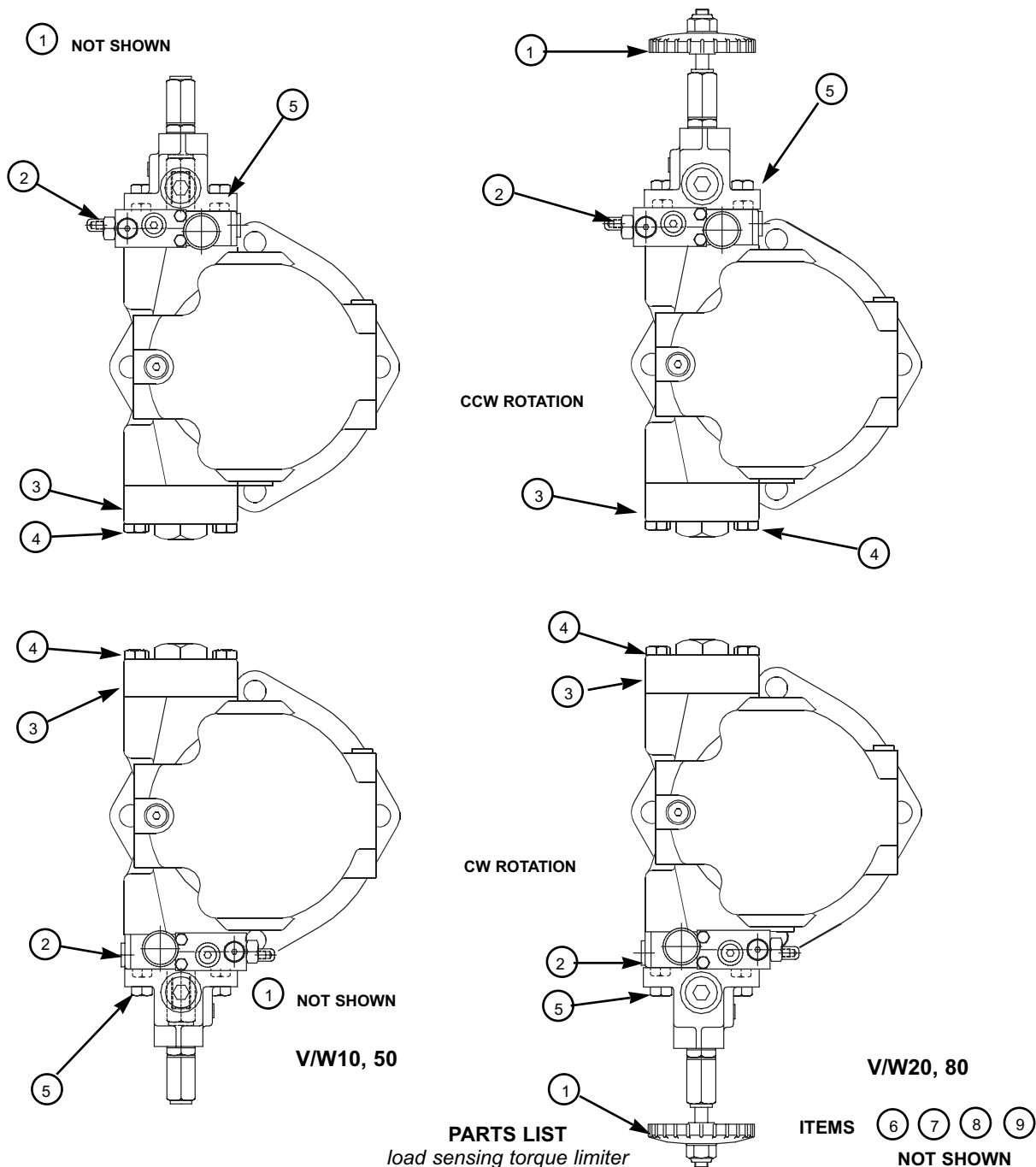
See page 26 for tightening torque on plugs

1. Install Avseal plugs (9) and .047", 1,19 mm. orifice (19) in body.
2. Press seat (10) into bore squarely against shoulder in bore.
3. Install plug (12) and spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal piston (16). Lubricate and install into plug (15). Install plug (15) into cap. Install screw (3), nut (4) and cover (17).
4. Install O-ring (6) on seal piston (5).
5. Lubricate O-ring and install cone (8), spring (7) and seal piston into bore in cap (1), being careful that cone enters seat (10). Install remaining parts in body (1).
6. Install O-rings (29-a) and (29-b) on valve (29). See Figure 13, page 40. Observe that backup ring on inside groove is toward the outside, the one on the middle groove is toward the inside, and the one on the outside groove is toward the outside. Lubricate and install valve (29) in block (28), being careful to avoid damaging the O-rings. Torque to 50 lb.\*ft., 67,8 Nm.
7. For the P110 only, install O-ring (32) on adapter (35). Install adapter in block (28). Install plug (31) in adapter (35). For the P07 only, install O-ring (32) on plug (31). Install plug (31) in block (28).
8. Note proper location for cap on pump (page 24). Install O-rings on interface between cap and pump control pad. Install O-rings (26) in block (28).
9. Install on pump control pad, guiding the control piston into the bore. Install maximum volume stop parts.
10. Torque mounting bolts to 75 lb.\*ft., 102 Nm.



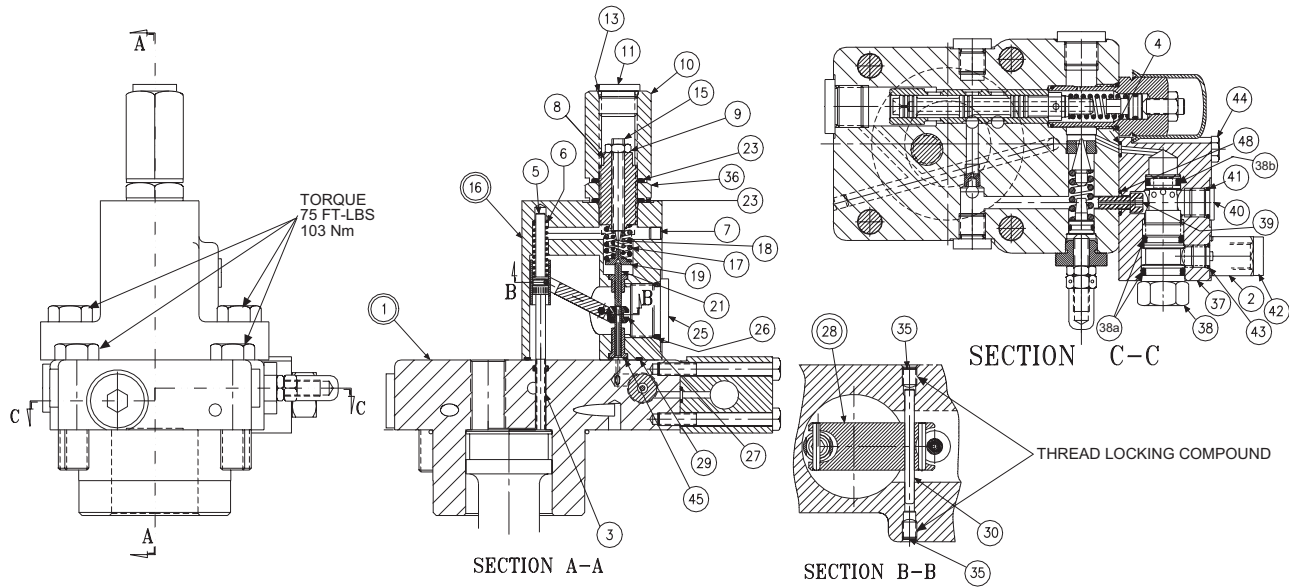
Ref. Figure 12  
load sensing compensator control





ITEM	DESCRIPTION	P07	P110	QUANTITY			
		PART NO	PART NO.	V10*	W10*	V20**	W20**
1	Maximum Volume Stop (Fig. 7)	S22-15467	S22-15467	1	1	—	—
	Maximum Volume Handwheel (Fig. 8)	S22-15448	S22-15448	—	—	1	1
2	***Low Torque Limiter Load Sensing (V10)(Fig. 13)	S22-16186	S22-16188	1	—	—	—
2	***Low Torque Limiter Load Sensing (V20)(Fig. 13)	S22-16195	S22-16196	—	—	1	—
	***High Torque Limiter Load Sensing (W10)(Fig. 13)	S22-16187	S22-16189	—	1	—	—
	***High Torque Limiter Load Sensing (W20)(Fig. 13)	S22-16197	S22-16198	—	—	—	1
3	Buck Up Cap (Fig. 9)	S22-15447	S22-15447	1	1	1	1
4	Screw-H.H.C., M12 x 55 mm	363-12205	363-12205	6	6	4	4
5	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	2	2	4	4
6	Control Piston	032-91836	032-91836	1	1	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
8	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2	2	2
9	Piston ring	032-91816	032-91816	2	2	2	2

\* Also V50, W50 \*\*Also V80, W80 \*\*\*Includes items 1, 4, 5, 7 and 8



**FIGURE 13**

**Load Sensing Torque Limiter**

**PARTS LIST FOR FIGURE 13**

P07 code V10, V50, S22-16186

P07 code W10, W50, S22-16187

P110 code V10, V50, S22-16188

P110 code W10, W50, S22-16189

ITEM	DESCRIPTION	P07	P110	QTY.	
		PART NO.	PART NO.	V	W
1	Cap (Figure 14)	S22-16177	S22-16179	1	1
2	Adapter	-	032-91507	1	1
3	Screw	032-91461	032-91461	1	1
5	Clevis pin	321-40000	321-40000	1	1
6	Spring, Compression	032-92100	032-92100	1	1
7	Plug, Avseal	447-00026	447-00026	1	1
8	Screw	032-91445	032-91445	1	1
9	Nut, Hex Jam 1/4-20 UNC	340-00038	340-00038	1	1
10	Hex Nut, 3/4-16 UNF	032-91449	032-91449	1	1
11	Plug, SAE-8	488-35018	488-35018	1	1
13	O-Ring, 90 S-1 ARP 908	691-00908	691-00908	1	1
15	Screw, Primary Adjusting	032-91446	032-91446	1	1
16	Body assembly	S22-15396	S22-15396	1	1
17	Outer Spring – V Version	032-91440	032-91440	1	—
	Outer Spring – W Version	032-91440	032-91440	—	1
18	Inner Spring – V Version	032-92240	032-92240	1	—
	Inner Spring – W Version	032-91441	032-91441	—	1
19	Spring Retainer	032-91819	032-91819	1	1
21	Spool	032-91438	032-91438	1	1
23	O-ring, 70 S-1 ARP 118	671-00118	671-00118	2	2
25	Plug, 12 SAE-12	488-35014	488-35014	1	1
26	O-Ring, 90 S-1 ARP 912	691-00912	691-00912	1	1
27	Sleeve	032-91437	032-91437	1	1
28	Arm assembly	S22-15520	S22-15520	1	1
29	O-Ring, 70 S-1 ARP 035	671-00035	671-00035	1	1
30	Dowel Pin, 1/8 Dia. x 1.50 Lg	324-20824	324-20824	1	1
35	Screw, SHC 10-32 x 1/4	312-09041	312-09041	2	2
36	Nut	032-91645	032-91645	1	1
37	Body, load sense	032-92359	032-92359	1	1
38	Valve, modulating	517-00063-5	517-00063-5	1	1
38a	O-ring, 90 S-1 ARP 017	691-00017	691-00017	2	2
38b	O-ring, 90 S-1 ARP 015	691-00015	691-00015	1	1
39	Screw, special	033-70908	033-70908	1	1
40	Plug, SAE-6	488-35003	488-35003	1	1
41	O-ring, 90 S-1 ARP 906	691-00906	691-00906	1	1
42	Plug, SAE-4, 1/4 BSPP	488-35013	447-01004	1	1
43	O-ring, 90 S-1 ARP 904	691-00904	691-00904	1	1
44	Screw, HHC, 1/4-20x2-1/4	306-40187	306-40187	2	2
45	O-Ring, 70 S-1 ARP 010	671-00010	671-00010	1	1
48	O-Ring, 70 S-1 ARP 012	671-00012	671-00012	1	1



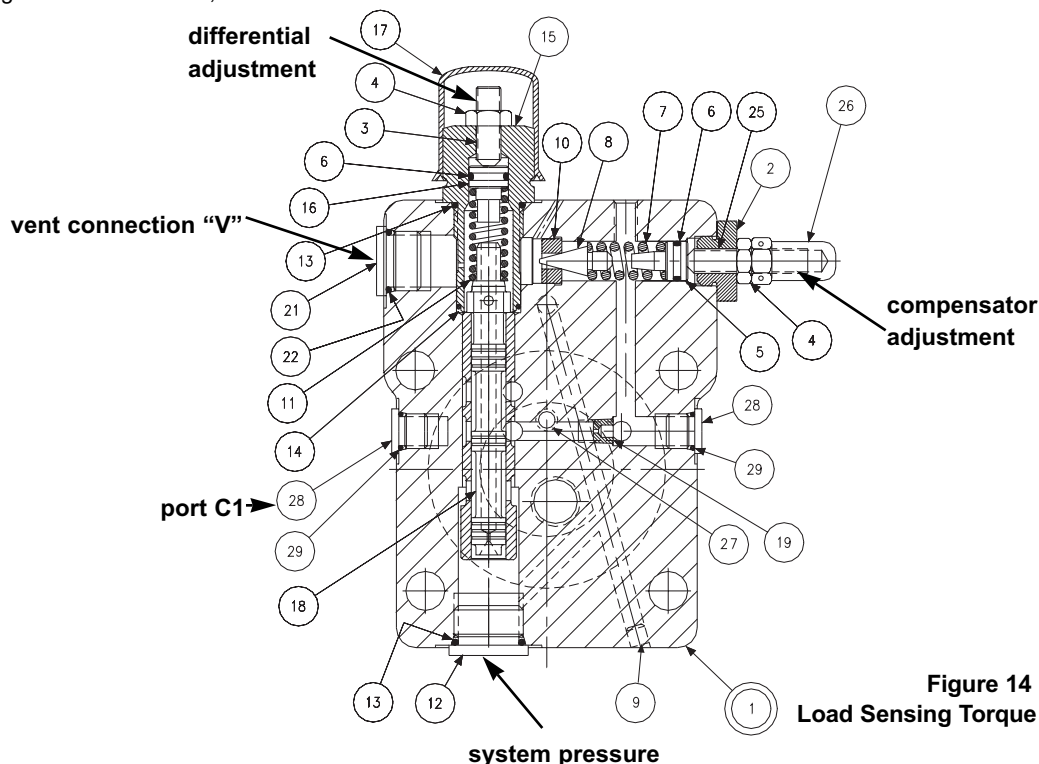
**DISASSEMBLY**

1. **See Figure 13.** Remove 2 screws holding torque limiter body (16) to cap assembly (1).
2. Remove all parts from torque limiter body (16) except pin (30) and arm assembly (28). It is not necessary to remove these parts unless broken or worn. Examine parts for wear or damage.
3. Remove screw (3). Examine head for excessive wear, and body for smooth sealing surface with O-ring.
4. Remove maximum stop handwheel assembly or maximum stop screw assembly.
5. Remove modulating valve (38) from body (37). Remove body (37) from cap assembly (1). Note plug (40) must be removed to remove special screw (39). Remove cap assembly (1).
1. **See Figure 14.** Remove plug (15) and attached parts. Remove spring (11) and spool (18).
2. Remove adjusting. plug (2) and attached parts. Remove seal piston (5). Note: a 10-24 screw may be used to assist in pulling the piston. Remove spring (7) and cone (8).
3. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
4. Examine seat (10) for wear. Do not remove unless damaged.

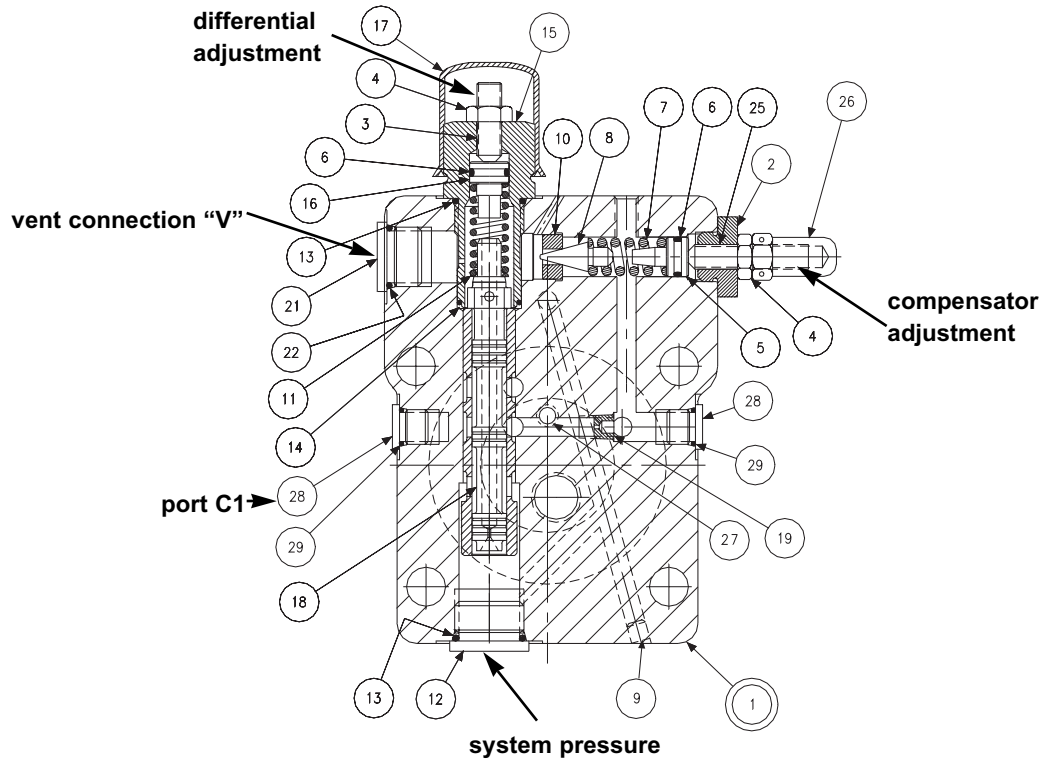
**ASSEMBLY**

**See page 26 for tightening torque on plugs**

1. **See Figure 14.** Install Avseal plug (9) and .047", 1,19 mm. orifice (19) in body.
2. Press seat (10) into bore squarely against shoulder in bore.
3. Install plug (12) and spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal piston (16). Lubricate and install into plug (15). Install plug (15) into cap. Install screw (3), nut (4) and cover (17).
4. Install O-ring (6) on seal piston (5).
5. Lubricate O-ring and install cone (8), spring (7) and seal piston into bore in cap (1), being careful that cone enters seat (10). Install remaining parts in body (1)
6. Note proper location for cap on pump (pg.24). Install O-rings on interface between cap and pump control pad
7. Install on pump control pad, guiding the control piston into the bore. Install maximum volume stop or handwheel parts.
8. **See Figure 13.** Install block (37) on cap (1) with O-rings (4) and (48). Use special screw (39) through the block.
7. Install O-rings (38a) and (38b) on valve (38). Observe that backup ring on inside groove is toward the outside, the one on the middle groove is toward the inside, and the one on the outside groove is toward the outside. Lubricate and install valve (38) in block (37), being careful to avoid damaging the O-rings. Torque to 50 lb.\*ft., 67,8 Nm.
7. For the P110 only, install O-ring (43) on adapter (2). Install adapter in block (37). Install plug (31) in adapter (35). For the P07 only, install O-ring (43) on plug (42). Install plug (42) in block (37).
- 8.. Apply thread locking compound on threads of screw (3), lubricate the shank, thread through the cap into the control piston, and torque to 5 lb.\*ft., 6,8 Nm
9. Measure height from control cap to top of screw. With control piston at full displacement, dimension must be 1.50 +/- .03 in., 38,1 +/- 0,76 mm.
10. Press dowel (30) into body (16), through the link assembly (28), to 1/4", 6,35 mm below surface. Apply hydraulic sealant to threads of screws (35) and install over dowel (30).
11. While sleeve (27) is engaged into dowel on link (28), slide spool (21) into bore of body (16), and through sleeve (27). Spool (21) must move freely and easily at all positions of the link (28).
12. Assemble remaining parts per drawing. While spring retainer is engaging clevis pin (5) under dowel of link (28), slide the other opening of spring retainer over the top of the screw (3). Attach body assembly (16) to cap (1) and torque mounting screws to 75 lb.\*ft., 102 Nm.



**Figure 14**  
**Load Sensing Torque limiter cap**

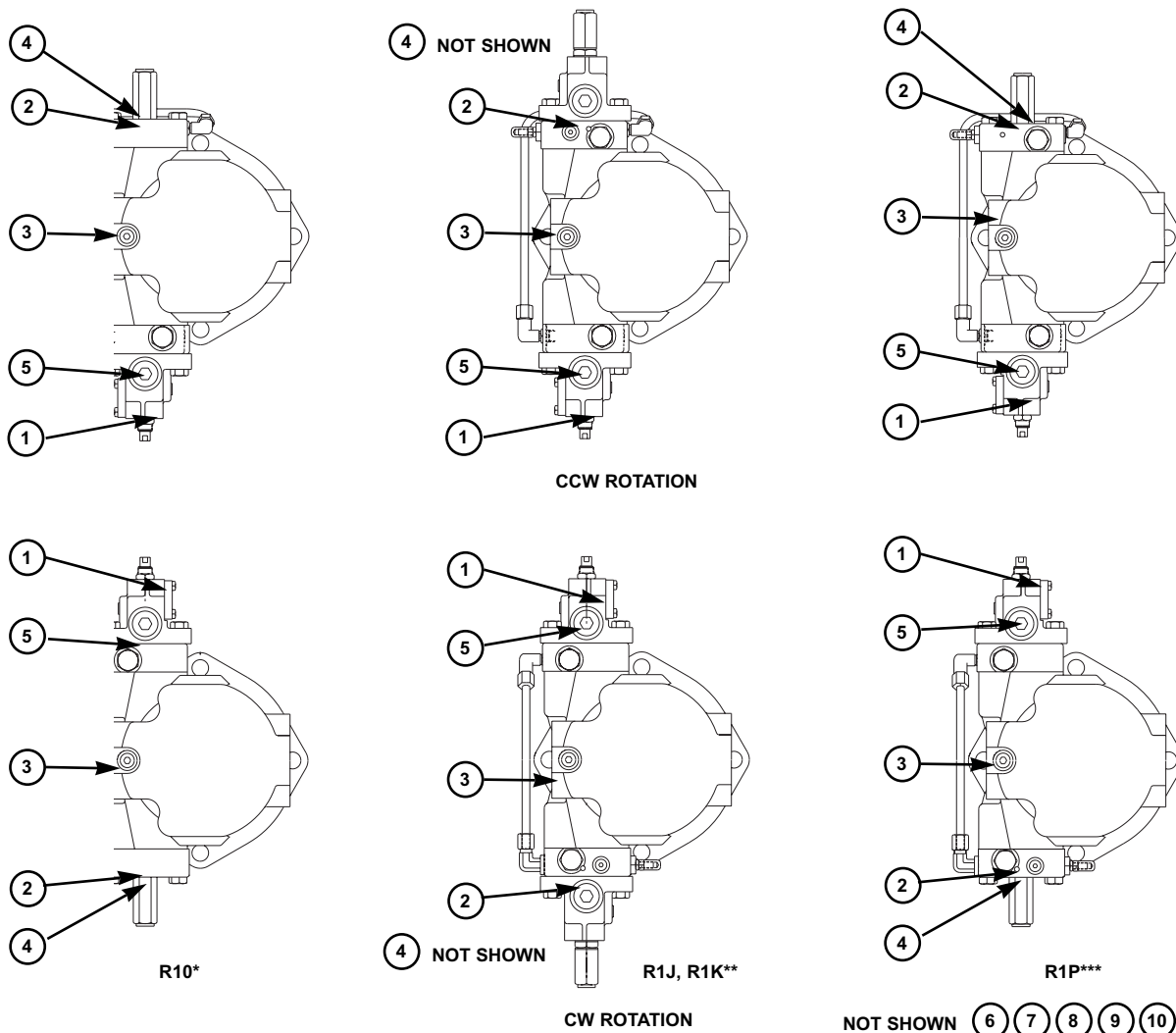


Ref. Figure 14  
Load Sensing Torque limiter cap

#### PARTS LIST FOR FIGURE 14

P07 load sensing torque limiter cap  
S22-16177  
P110 load sensing torque limiter cap  
S22-16179

ITEM	DESCRIPTION	P07		P110	
		PART NO.	QTY	PART NO.	QTY
1	Cap-Sleeve Assembly	S22-16178	1	S22-16180	1
2	Adjusting Plug	032-91814	1	032-91814	1
3	Socket Setscrew 5/16-24 x 1	312-13160	1	312-13160	1
4	Nut, 5/16-24	335-13100	2	335-13100	2
5	Seal Piston	031-59367	1	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2	691-00012	2
7	Spring	032-91798	1	032-91798	1
8	Cone	036-12288	1	036-12288	1
9	Avseal Plug	447-00026	1	447-00026	1
10	Seat	036-11692	1	036-11692	1
11	Spring	033-71086	1	033-71086	1
12	Plug	488-35055	1	447-01008	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
14	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
15	Plug	031-57368	1	031-57368	1
16	Seal Piston	032-91305	1	032-91305	1
17	Cap	449-00612	1	449-00612	1
18	Spool	032-59482	1	032-59482	1
19	Orifice, .047", 1,19 mm.	033-25528	1	033-25528	1
21	Plug	488-35018	1	447-00032	1
22	O-ring, 70 S-1 ARP 908	691-00908	1	-	-
25	Setscrew, 5/16-24 x 1-1/4	312-13180	1	312-13180	1
26	Nut, Acorn 5/16-24	036-33474	1	036-33474	1
27	O-Ring, 70 S-1 ARP 008	671-00008	1	671-00008	1
28	Plug	488-35061	2	447-01004	2
29	O-ring 90 S-1 ARP 904	691-00904	2	-	-



## PARTS LIST

rotary servo

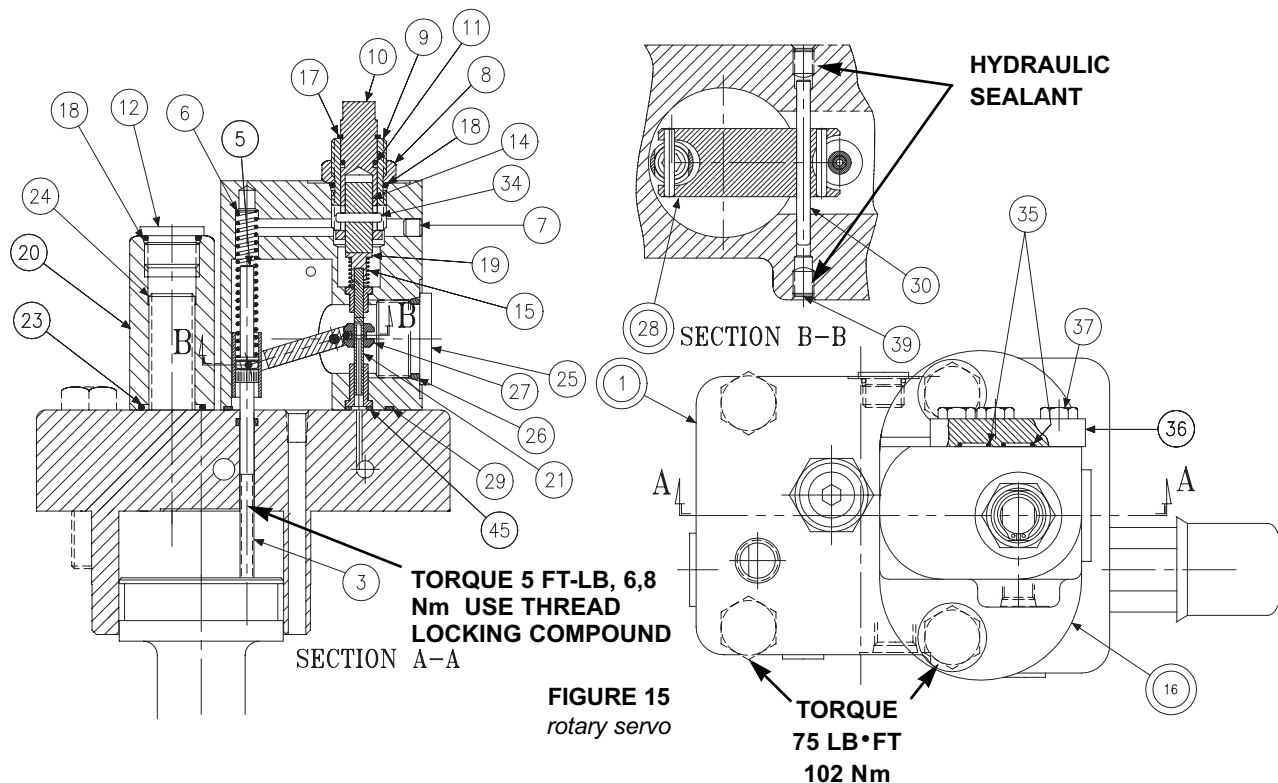
ITEM	DESCRIPTION	P07	P110	QUANTITY			
		PART NO.	PART NO.	R10*	R1J**	R1K**	R1P***
1	#Rotary Servo (Fig. 15)	S22-16200	S22-16199	1	1	1	1
2	#Control Cap (Fig.26)	S22-15325	S22-15613	1	—	—	—
	#Low Torque Override (Fig. 29)	S22-16207	S22-16208	—	1	—	—
	#High Torque Override (Fig. 29)	S22-16209	S22-16210	—	—	1	—
	#Compensator Override (Fig. 27)	S22-16205	S22-16206	—	—	—	1
3	Tube Assembly, CW rotation (Fig. 24)	S22-16035	S22-16037	1	1	1	1
	Tube Assembly, CCW rotation (Fig. 25)	S22-16036	S22-16038				
4	Screw-H.H.C., M12 x 55 mm	363-12205	363-12205	6	4	4	6
5	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	2	4	4	2
6	Control Piston	032-91848	032-91848	1	1	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
8	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2	2	2
9	Piston Ring	032-91816	032-91816	1	1	1	1
10	Piston Ring	032-91811	032-91811	1	1	1	1

\*Also R50

\*\*Also R5J, R5K

\*\*\*Also R5P

#Includes items 4, 5, 7 and 8



**PARTS LIST FOR FIGURE 15**

**ROTARY SERVO**

P07 S22-16200

P110 S22-16199

ITEM	DESCRIPTION	P07		P110	
		PART NO.	QTY.	PART NO.	QTY.
1	Cap (Figure 16)	S22-16063	1	S22-16064	1
3	Screw	032-91461	1	032-91461	1
5	Pin, Clevis	321-40000	1	321-40000	1
6	Spring, Compression	032-92100	1	032-92100	1
7	Plug, Avseal	447-00026	1	447-00026	1
8	Locknut	492-15116	1	492-15116	1
9	Cam	032-91515	1	032-91515	1
10	Shaft	032-91514	1	032-91514	1
11	O-Ring, 90 S-1 ARP 012	691-00012	1	691-00012	1
12	Plug, 10HP5N-S	488-35055	1	488-35055	1
13	O-Ring, 90 S-1 ARP 910	691-00910	1	691-00910	1
14	Slide Pin	032-91513	1	032-91513	1
15	Spring	225-92105	1	225-92105	1
16	Body	S22-15393	1	S22-15393	1
17	Retaining Ring	356-31050	1	356-31050	1
18	O-Ring, 90 S-1 ARP 908	691-00908	1	691-00908	1
19	Spring Retainer	032-91516	1	032-91516	1
20	Nut, M16	032-91822	1	031-91049	1
21	Spool	032-91438	1	032-91438	1
23	O-Ring, 70 S-1 ARP 118	671-00115	1	671-00115	1
24	Setscrew, M16(2P)x80mm	311-50001	1	311-50001	1
25	Plug, 12 HP5N-S	488-35014	1	488-35014	1
26	O-Ring, 90 S-1 ARP 912	691-00912	1	691-00912	1
27	Sleeve	032-91437	1	032-91437	1
28	Arm assembly	S22-15520	1	S22-15520	1
29	O-Ring, 70 S-1 ARP 035	671-00035	1	671-00035	1
30	Dowel Pin, 1/8 Dia x 1.50 Lg.	324-20824	1	324-20824	1
33	O-Ring, 70 S-1 ARP 904	671-00904	1	671-00904	1
34	Dowel Pin, 1/8 x 5/8	324-20810	1	324-20810	1
35	O-Ring, 70 S-1 ARP 011	671-00011	2	671-00011	2
36	Plate	032-91510	1	032-91510	1
37	Screw, HHC, 1/4-20 x 3/4	306-40142	3	306-40142	3
38	Plug, SAE-4	488-35061	1	488-35061	1
39	Screw, SHC 10-32 x 1/4	312-09041	2	312-09041	2
45	O-Ring, 70 S-1 ARP 010	671-00010	1	671-00010	1

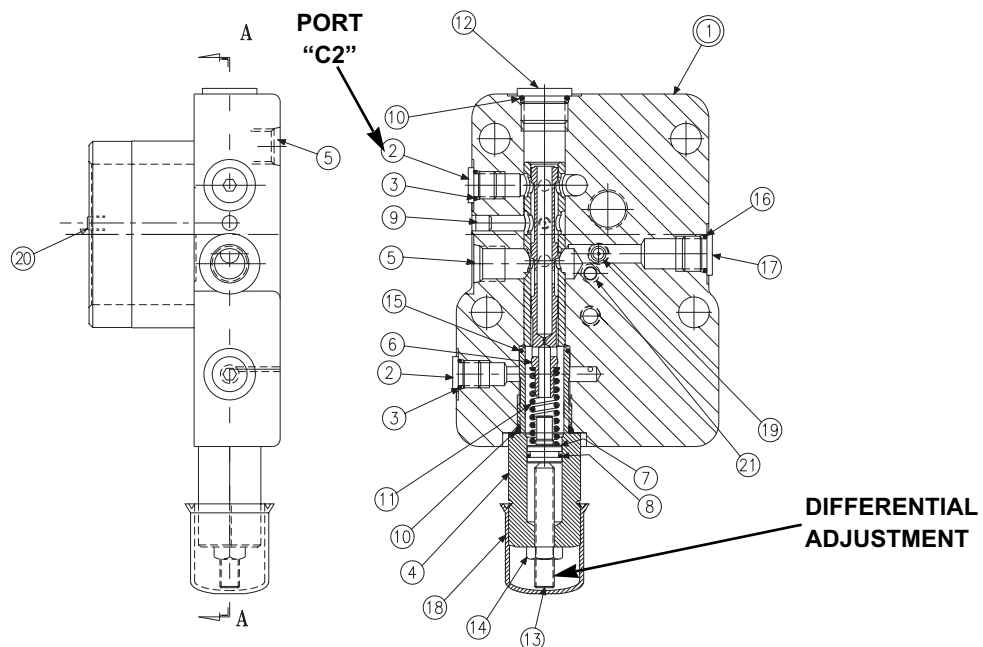
### DISASSEMBLY

1. **See Figure 15.** Remove 2 screws holding body (16) to cap assembly (1).
2. Remove all parts from body (16) except pin (30) and arm assembly (28). It is not necessary to remove these parts unless broken or worn. Examine parts for wear or damage.
3. Remove screw (3). Examine head for excessive wear, and body for smooth sealing surface with O-ring.
4. **See Figure 16.** Remove tube lines to cap assembly.
5. Remove screws holding cap assembly to pump body.
6. Remove cap assembly (1). Remove plug (4) with attached parts. Remove spring (11) and spool (6).
7. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
8. Remove screw (13) and nut (14). Push a rod through the cap to remove the retainer (7).

### ASSEMBLY

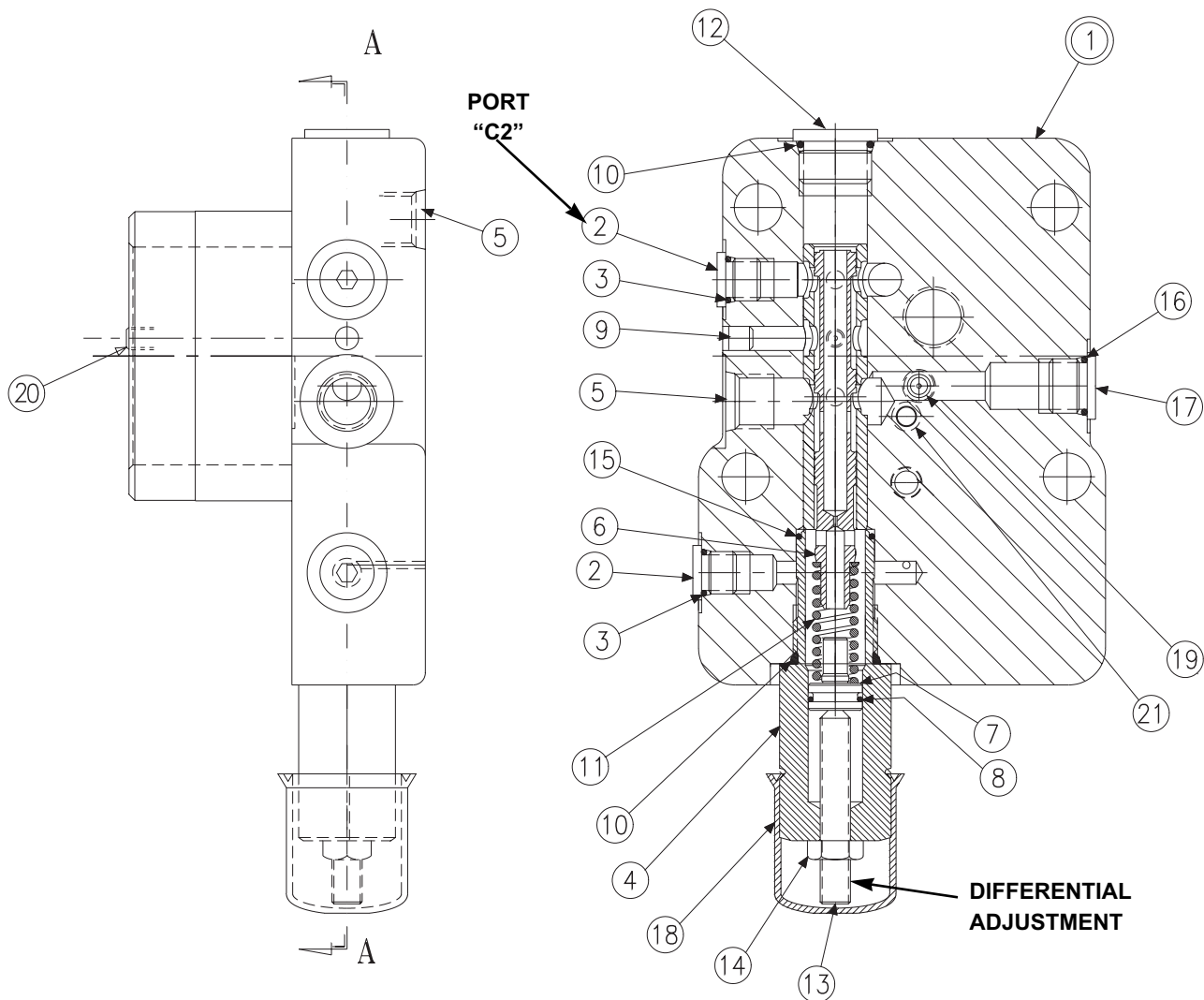
**See page 26 for tightening torque on plugs**

1. **See Figure 16.** Install Avseal plug (9) in cap.
2. Install spool (6) into bore as shown. Install spring (11) over end of spool.
3. Install O-ring (8) on spring retainer (7). Install retainer (7), screw (13) and nut (14) in plug (4).
4. Install O-rings (10) and (15) on plug (4). Install plugs (4) and (12) in body (1). Install .047", 1,19 mm orifice (19), and .071", 1,98 mm orifice (20), and plugs (2) and (17). Torque plugs. Install O-ring (21) in cap.
5. Turn screw (13) in until spring retainer (17) contacts spring (11). Turn an additional 1-1/2 turns and lock in position.
6. Note proper location for control on pump (pg. 24). Install O-rings on interface between cap and pump control pad. Install cap on pump control pad, guiding the control piston into the bore.
7. Torque two assembly bolts to 75 lb. • ft., 102 N m.
8. **See Figure 15.** Apply thread sealing compound on threads of screw (3), lubricate the shank, thread through the cap into the control piston, and torque to 5 lb. • ft., 6,78 N m.
9. Install minimum stop screw (24) and turn clockwise to by two springs, one which is always in contact with the pin, and the other comes in contact as pressure increases, to provide an increase in spring rate as pressure increases. Stroke pump to full displacement. Measure height from control cap to top of screw (3). With control piston at full displacement, dimension must be .74 +/- .03 in., 18,8 +/- 0,76 mm.  
Back out minimum stop screw (24) till there is no contact with control piston.
10. Press dowel (30) into body (16), through the link (28), to 1/4 in., 6,35 mm below surface. Apply hydraulic sealant to threads of screws (39) and install over dowel (30).
11. Press spool (21) into retainer (19). Caution: do not use excessive force.
12. While sleeve (27) is engaged into dowel on link (28), slide above spool assembly with spring (15) into bore of body (16), and through sleeve (27). Spool (21) must move freely and easily at all positions of the link (28).
13. Press dowel (34) through slide pin (14), while inside shaft (10). Dowel (34) must evenly extend from both sides of slide pin (14).
14. Assemble all other components into body (16) per Figure 15. Torque plug (12)
15. While spring retainer is engaging clevis pin (5) under dowel of link (28), slide the other opening of spring retainer over the top of the screw (3). Attach body assembly (16) to cap (1) with two screws and torque to 75 lb. • ft., 103 N m.



**Figure 16**  
**Servo cap**

SECTION A-A



Ref. Figure 16  
Servo cap

## SECTION A-A

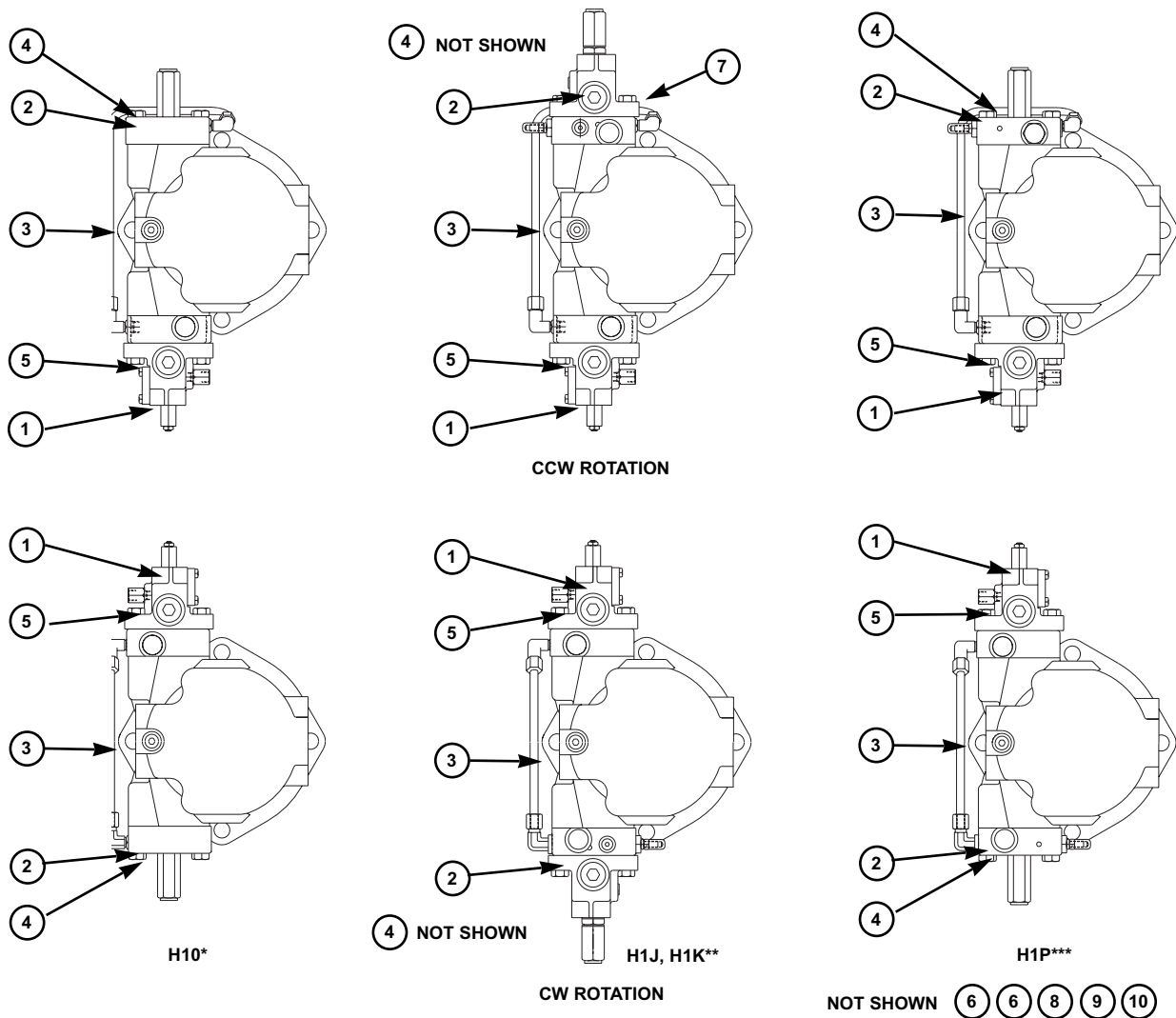
### PARTS LIST FOR FIGURE 16

P07 servo cap S22-16063

P110 servo cap S22-16064

ITEM	DESCRIPTION	P07		P110	
		PART NO.	QTY.	PART NO.	QTY.
1	Cap/Sleeve	S22-16065	1	S22-16066	1
2	Plug, SAE-4, 1/4 BSPP	488-35061	2	447-01004	1
3	O-ring, 90 S-1 ARP 904	691-00904	2	--	-
4	Plug	032-91861	1	032-91861	1
5	Plug	449-00015	1	449-00599	1
6	Spool	032-92409	1	032-92409	1
7	Spring retainer	032-92550	1	032-92550	1
8	O-Ring, 90 S-1 ARP 013	691-00013	1	691-00013	1
9	Avseal Plug	447-00026	1	447-00026	1
10	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
11	Spring	032-92098	1	032-92098	1
12	Plug, SAE-10, 1/2 BSPP	488-35018	1	447-01008	1
13	Screw, 5/16 -24 x 2	312-35062	1	312-35062	1
14	Nut, 5/16-24	335-13100	1	335-13100	1
15	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
16	O-Ring, 90 S-1 ARP 906	691-00906	1	--	
17	Plug, SAE-6, 3/8 BSPP	488-35041	1	447-00032	1
18	Cap	449-00612	1	449-00612	1
19	Orifice, .047", 1.19 mm	033-25528	1	033-25528	1
20	Orifice, .078", 1.98 mm	032-92399	1	032-92399	1
21	O-Ring, 70 S-1 ARP 008	671-00008	1	671-00008	1





### PARTS LIST

hydraulic stroker

ITEM	DESCRIPTION	P07	P110	QUANTITY			
		PART NO.	PART NO.	H10*	H1J**	H1K**	H1P***
1	#Hydraulic Stroker (Fig. 17)	S22-16202	S22-16201	1	1	1	1
2	#Control Cap (Fig.26)	S22-15325	S22-15613	1	—	—	—
	#Low Torque Override (Fig. 29)	S22-16207	S22-16208	—	1	—	—
	#High Torque Override (Fig. 29)	S22-16209	S22-16210	—	—	1	—
	#Compensator Override (Fig. 27)	S22-16205	S22-16206	—	—	—	1
3	Tube Assembly, CW rotation (Fig. 24)	S22-16035	S22-16037	1	1	1	1
	Tube Assembly, CCW rotation (Fig. 25)	S22-16036	S22-16038				
4	Screw-H.H.C., M12 x 55 mm	363-12205	363-12205	6	4	4	6
5	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	2	4	4	2
6	Control Piston	032-91848	032-91848	1	1	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
8	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2	2	2
9	Piston Ring	032-91816	032-91816	1	1	1	1
10	Piston Ring	032-91811	032-91811	1	1	1	1

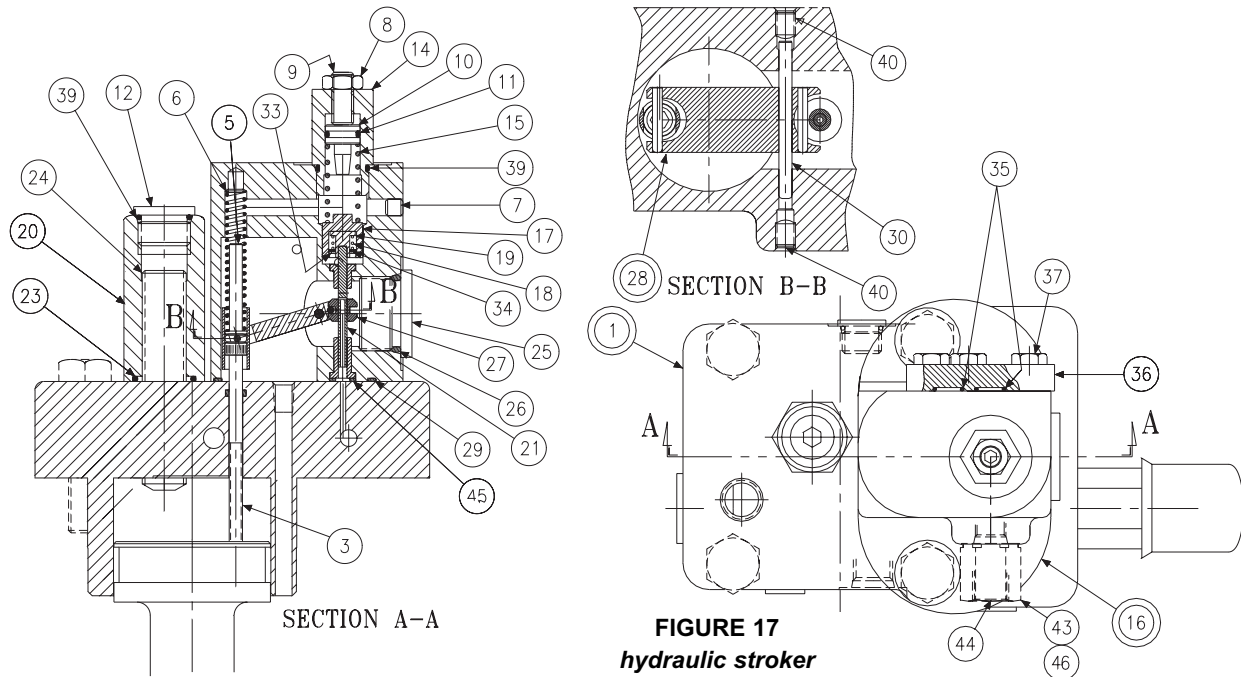
\*Also H50

\*\*Also H5J, H5K

\*\*\*Also H5P

#Includes items 4, 5, 7 and 8

# HYDRAULIC STROKER CONTROL



## PARTS LIST FOR FIG. 17

P07 hydraulic stroker S22-16202

P110 hydraulic stroker S22-16201

ITEM	DESCRIPTION	P07		P110	
		PART NO.	QTY.	PART NO.	QTY.
1	Cap (Figure 16)	S22-16063	1	S22-16064	1
3	Screw	032-91461	1	032-91461	1
5	Clevis pin	321-40000	1	321-40000	1
6	Spring, Compression	032-92100	1	032-92100	1
7	Plug, Avseal	447-00026	1	447-00026	1
8	Nut, 5/16-24	335-13100	1	335-13100	1
9	Setscrew, 5/16-24 x 1-1/4	312-13180	1	312-13180	1
10	Seal Piston	032-91918	1	032-91918	1
11	O-Ring, 90 S-1 ARP 012	691-00012	1	691-00012	1
12	Plug, 10HP5N-S	488-35055	1	488-35055	1
14	Spring Cap	032-91511	1	032-91511	1
15	Spring	225-92101	1	225-92101	1
16	Body	S22-15393	1	S22-15393	1
17	Spool	032-91512	1	032-91512	1
18	Spring	225-92109	1	225-92109	1
19	Spring Retainer	032-91516	1	032-91516	1
20	Nut, 3/4-10	031-91049	1	031-91049	1
21	Spool	032-91438	1	032-91438	1
23	O-Ring, 70 S-1 ARP 118	671-00118	1	671-00118	1
24	Socket Setscrew, 3/4-10 x 3	311-26320	1	311-26320	1
25	Plug, SAE-12	488-35014	1	488-35014	1
26	O-Ring, 90 S-1 ARP 912	691-00912	1	691-00912	1
27	Sleeve	032-91437	1	032-91437	1
28	Arm assembly	S22-15520	1	S22-15520	1
29	O-Ring, 70 S-1 ARP 035	671-00035	1	671-00035	1
30	Dowel Pin, 1/8 Dia x 1.50 Lg.	324-20824	1	324-20824	1
33	Retaining. Ring	356-30037	1	356-30037	1
34	Washer	032-91517	1	032-91517	1
35	O-Ring, 70 S-1 ARP 011	671-00011	2	671-00011	2
36	Plate	032-91510	1	032-91510	1
37	Screw, HHC, 1/4-20 x 3/4	306-40142	3	306-40142	3
39	O-Ring, 90 S-1 ARP 908	691-00908	1	691-00908	1
40	Screw, SHC 10-32 x 1/4	312-09041	2	312-09041	2
43	Fitting	-	-	032-91507	1
44	Seal	-	-	449-00603	1
45	O-Ring, 70 S-1 ARP 010	671-00010	1	671-00010	1
46	O-ring, 90 S-1 ARP 904	-	-	691-00904	1



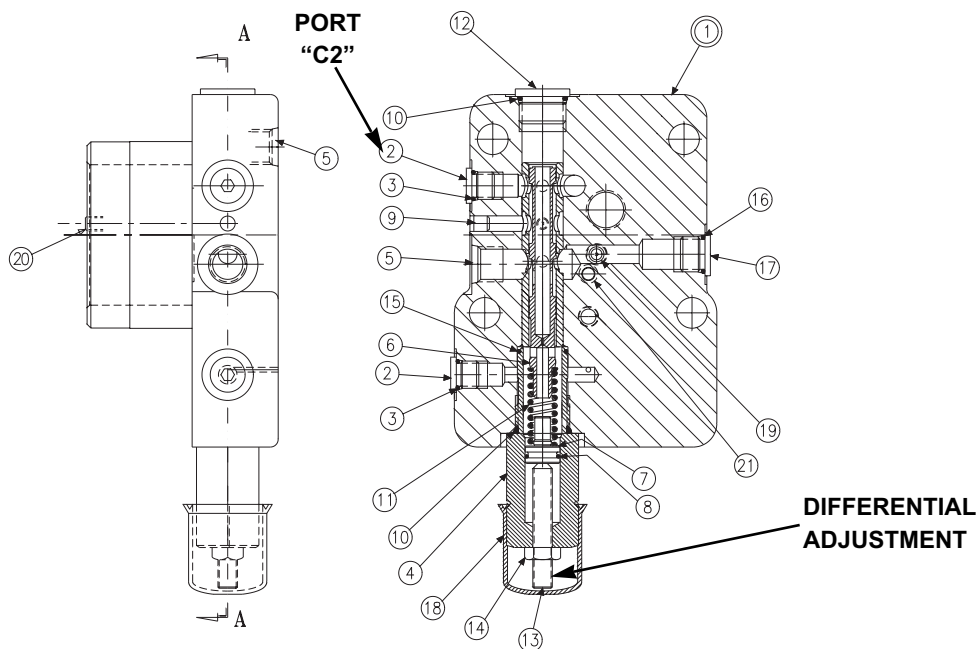
## DISASSEMBLY

1. See figure 17. Remove 2 screws holding body (16) to cap assembly (1).
2. Remove all parts from body (16) except pin (30) and arm assembly (28). It is not necessary to remove these parts unless broken or worn. Examine parts for wear or damage.
3. Remove screw (3). Examine head for excessive wear, and body for smooth sealing surface with O-ring.
4. See figure 16. Remove tube lines to cap assembly.
5. Remove screws holding cap assembly to pump body.
6. Remove cap assembly (1). Remove plug (4) with attached parts. Remove spring (11) and spool (6).
7. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
8. Remove screw (13) and nut (14). Push a rod through the cap to remove the retainer (77).

## ASSEMBLY

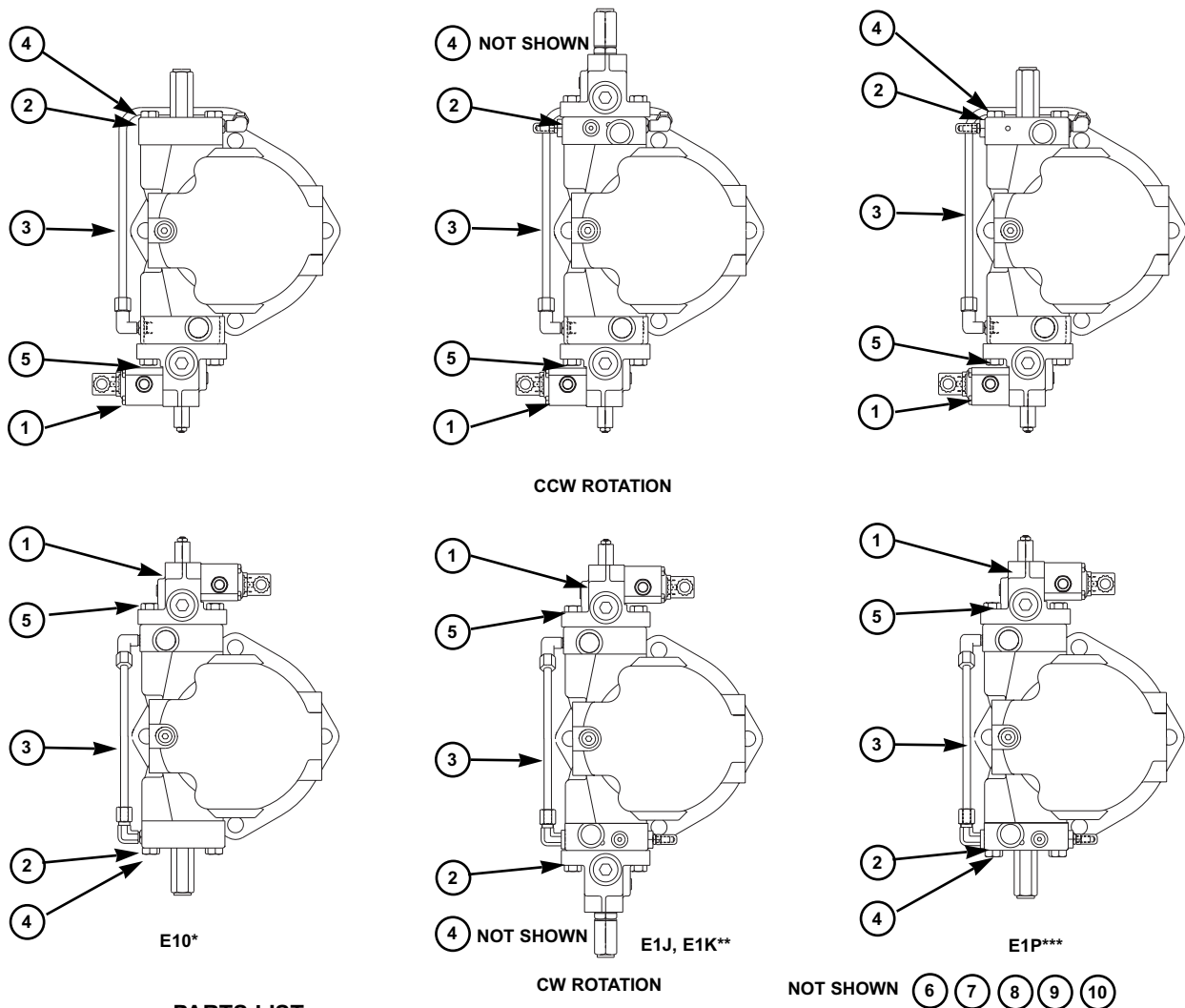
See page 26 for tightening torque on plugs

1. See figure 16. Install Avseal plug (9) in cap.
2. Install spool (6) into bore as shown. Install spring (11) over end of spool.
3. Install O-ring (8) on spring retainer (7). Install retainer (7), screw (13), and nut (14) in plug (4).
4. Install O-rings (10) and (15) on plug (4). Install plugs (4) and (12) in body (1). Install .047", 1,19 mm orifice (19), and .071", 1,98 mm orifice (20) and plugs (2) and (17). Torque plugs. Install O-ring (21) in cap.
5. Turn screw (13) in until spring retainer (7) contacts spring (11). Turn an additional 1-1/2 turns and lock in position.
6. Note proper location for control on pump (pg. 24). Install O-rings on interface between cap and pump control pad. Install cap on pump control pad, guiding the control piston into the bore.
7. Torque two assembly bolts to 75 lb.·ft., 102 Nm.
8. See figure 17. Apply thread locking compound on threads of screw (3), lubricate the shank, thread through the cap into the control piston, and torque to 5 lb.·ft., 6,78 Nm.
9. Install minimum stop screw (24) and turn clockwise to stroke pump to full volume. Measure height from control cap to top of screw (3). With control piston at full displacement, dimension must be .74 +/- .03 in., 18,8 +/- 0,76 mm. Back out minimum stop screw (24) till there is no contact with control piston.
10. Press dowel (30) into body (16), through the link (28), to 1/4", 6,35 mm below surface. Apply hydraulic sealant to threads of screws (40) and install over dowel (30).
11. Press spool (21) into retainer (19). Caution: do not use excessive force. Place spool/retainer assembly into spool (17) with spring (18) and washer (34). Secure with retaining ring (33).
12. While sleeve (27) is engaged into dowel on link (28), slide above spool assembly into bore of body (16), and through sleeve (27). Spool (21) must move freely and easily at all positions of the link (28).
13. Assemble all other components into body (16) per above drawing. Torque plug (12).
14. While spring retainer is engaging clevis pin (5) under dowel of link (28), slide the other opening of spring retainer over the top of the screw (3). Attach body assembly (16) to cap (1) with two screws and torque to 75 lb.·ft., 102 Nm.
15. Install tubing assembly (Figure 24, 25).



SECTION A-A

ref. Figure 16  
SERVO CAP



**PARTS LIST**  
*electrohydraulic stroker*

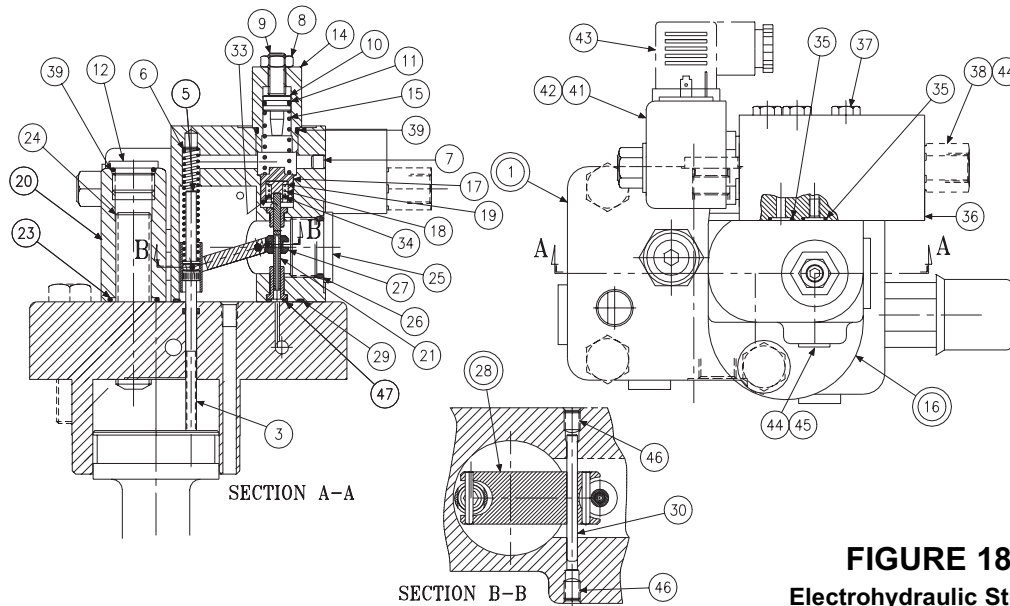
ITEM	DESCRIPTION	P07	P110	QUANTITY			
		PART NO.	PART NO.	E10*	E1J**	E1K**	E1P***
1	#Electrohydraulic Stroker (Fig. 18)	S22-16057	S22-16060	1	1	1	1
2	#Control Cap (Fig.26)	S22-15325	S22-15613	1	—	—	—
	#Low Torque Override (Fig. 29)	S22-16207	S22-16208	—	1	—	—
	#High Torque Override (Fig. 29)	S22-16209	S22-16210	—	—	1	—
	#Compensator Override (Fig. 27)	S22-16205	S22-16206	—	—	—	1
3	Tube Assembly, CW rotation (Fig. 24)	S22-16035	S22-16037	1	1	1	1
	Tube Assembly, CCW rotation (Fig. 25)	S22-16036	S22-16038				
4	Screw-H.H.C., M12 x 55 mm	363-12205	363-12205	6	4	4	6
5	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	2	4	4	2
6	Control Piston	032-91848	032-91848	1	1	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
8	O-Ring, 70 S-1 ARP 151	671-00151	671-00151	2	2	2	2
9	Piston Ring	032-91816	032-91816	1	1	1	1
10	Piston Ring	032-91811	032-91811	1	1	1	1

\*Also E50

\*\*Also E5J, E5K

\*\*\*Also E5P

#Includes items 4, 5, 7 and 8



**FIGURE 18**  
Electrohydraulic Stroker

**PARTS LIST FOR FIGURE 18**

*P07 electrohydraulic stroker*

*S22-16204*

*P110 electrohydraulic stroker*

*S22-16203*

ITEM	DESCRIPTION	P07		P110	
		PART NO.	QTY.	PART NO.	QTY.
1	Cap (Figure 16)	S22-16063	1	S22-16064	1
3	Screw	032-91461	1	032-91461	1
5	Clevis pin	321-40000	1	321-40000	1
6	Spring, Compression	032-92100	1	032-92100	1
7	Plug, Avseal	447-00026	1	447-00026	1
8	Nut, 5/16-24	335-13100	1	335-13100	1
9	Setscrew, 5/16-24 x 1-1/4	312-13180	1	312-13180	1
10	Seal Piston	032-91918	1	032-91918	1
11	O-Ring, 90 S-1 ARP 012	691-00012	1	691-00012	1
12	Plug, SAE-8	488-35018	1	488-35018	1
14	Spring Cap	032-91511	1	032-91511	1
15	Spring	225-92101	1	225-92101	1
16	Body	S22-15393	1	S22-15393	1
17	Spool	032-91512	1	032-91512	1
18	Spring	225-92109	1	225-92109	1
19	Spring Retainer	032-91516	1	032-91516	1
20	Nut, M16	031-91822	1	031-91822	1
21	Spool	032-91438	1	032-91438	1
23	O-Ring, 70 S-1 ARP 115	671-00115	1	671-00115	1
24	Socket Setscrew, M16	311-50001	1	311-50001	1
25	Plug, SAE-12	488-35014	1	488-35014	1
26	O-Ring, 90 S-1 ARP 912	691-00912	1	691-00912	1
27	Sleeve	032-91437	1	032-91437	1
28	Arm assembly	S22-15520	1	S22-15520	1
29	O-Ring, 70 S-1 ARP 035	671-00035	1	671-00035	1
30	Dowel Pin, 1/8 Dia x 1.50 Lg.	324-20824	1	324-20824	1
33	Retaining Ring	356-30037	1	356-30037	1
34	Washer	032-91517	1	032-91517	1
35	O-Ring, 70 S-1 ARP 011	671-00011	2	671-00011	2
36	Block	032-91509	1	032-91509	1
37	Screw, 1/4-20 x 2-1/4	306-40187	3	306-40187	3
38	Adapter	-	-	032-91507	1
39	O-Ring, 90 S-1 ARP 908	691-00908	1	691-00908	1
41	Proportional Pressure Valve	517-00095	1	517-00095	1
42	Coil, 24VDC	517-00096	1	517-00096	1
	Coil, 12VDC	517-00097		517-00097	
43	Connector	167-01008-8		167-01008-8	1
44	O-Ring, 90 S-1 ARP 904	691-00904	1	691-00904	2
45	Plug, SAE-4	488-35061	1	488-35061	1
46	Screw, SHC 10-32 x 1/4	312-09041	2	312-09041	2
47	O-Ring, 70 S-1 ARP 010	671-00010	1	671-00010	1

**DISASSEMBLY**

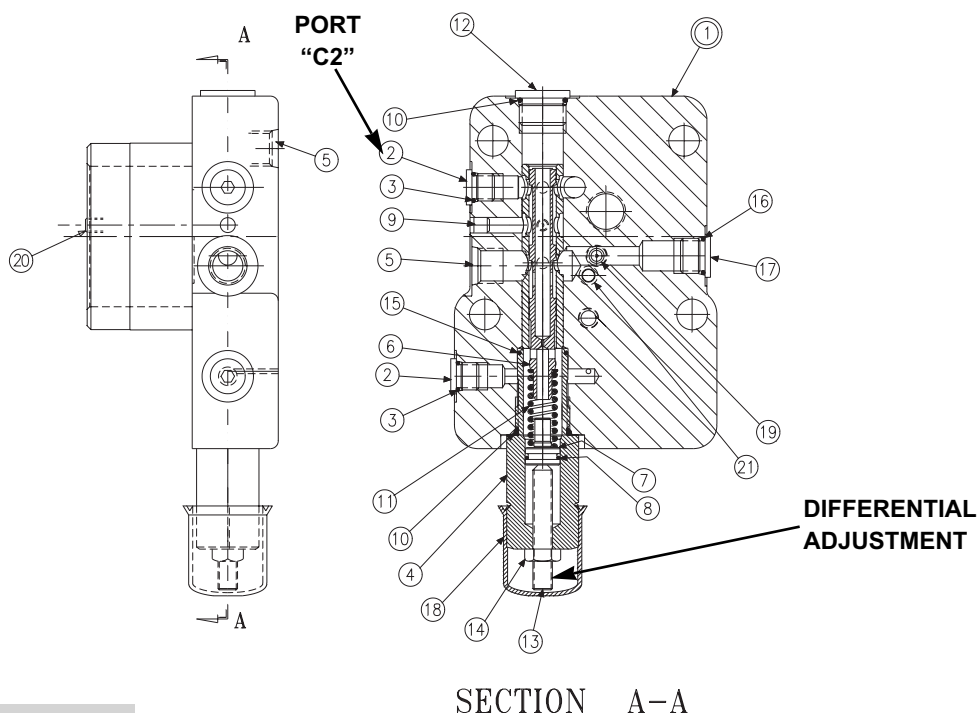
1. See Figure 18. Remove 3 screws (37) holding block (36) to body (16).
2. Remove 2 screws holding body (16) to cap assembly (1).
3. Remove all parts from body (16) except pin (30) and arm assembly (28). It is not necessary to remove these parts unless broken or worn. Examine parts for wear or damage.
4. Remove screw (3). Examine head for excessive wear, and body for smooth sealing surface with O-ring.
5. See Figure 16. Remove tube lines to cap assembly.
6. Remove screws holding cap assembly to pump body.
7. Remove cap assembly (1). Remove plug (4) with attached parts. Remove spring (11) and spool (6).
8. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve or cap is worn, replace the cap-sleeve assembly (1).
9. Remove screw (13) and nut (14). Push a rod through the cap to remove the retainer (7).

**ASSEMBLY**

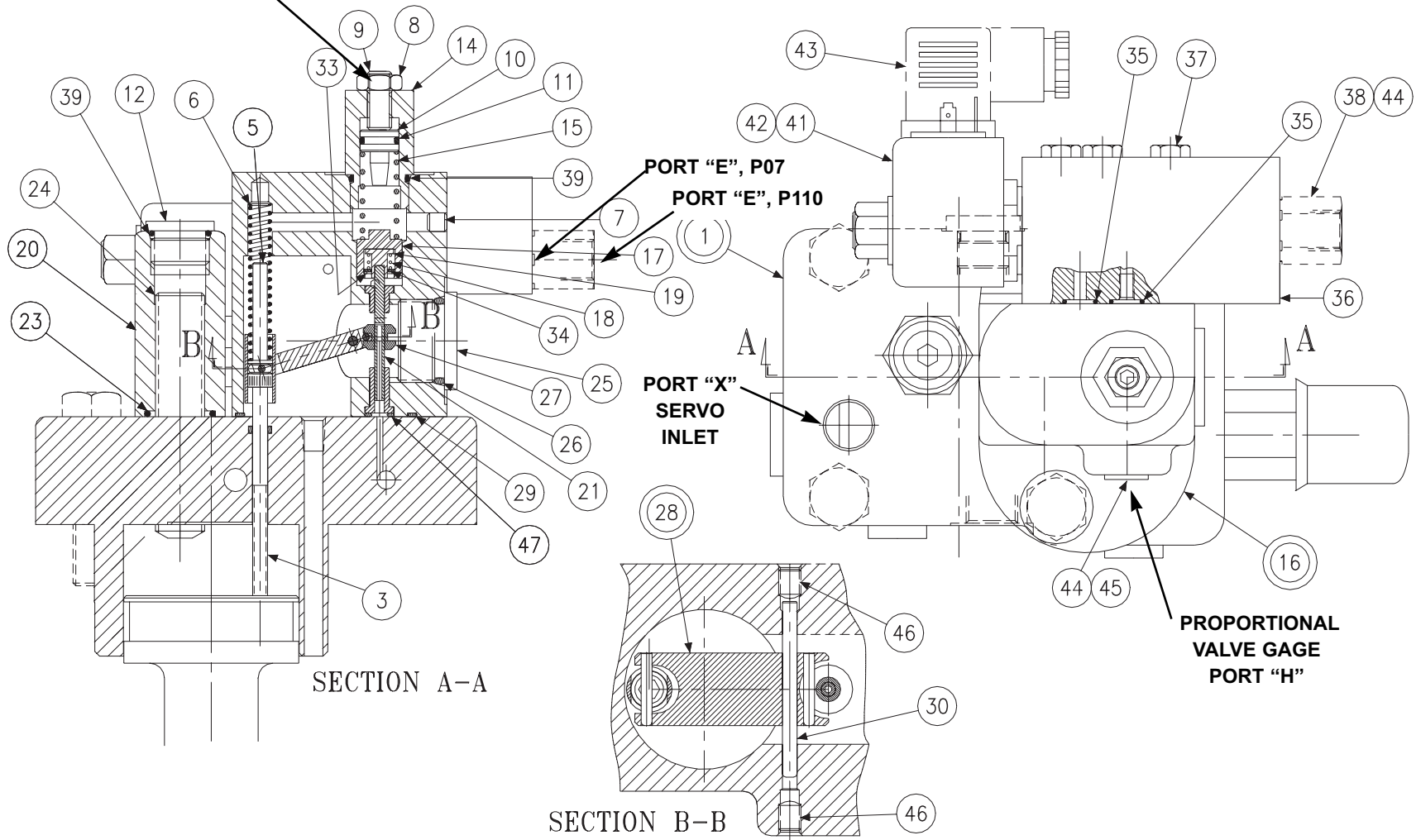
See page 26 for tightening torque on plugs

1. See Figure 16. Install Avseal plug (9) in cap.
2. Install spool (6) into bore as shown. Install spring (11) over end of spool.
3. Install O-ring (8) on spring retainer (7). Install retainer (7), screw (13), and nut (14) in plug (4).
4. Install O-rings (10) and (15) on plug (4). Install plugs (4) and (12) in body (1). Install .047", 1,19 mm orifice (19), and .071", 1,98 mm orifice, (20) and plugs (2) and (17). Torque plugs. Install O-ring (21) in cap.
5. Turn screw (13) in until spring retainer (7) contacts spring (11). Turn an additional 1-1/2 turns and lock in position.
6. Note proper location for control on pump (pg 24). Install O-rings on interface between cap and pump control pad. Install cap on pump control pad, guiding the control piston into the bore.
7. Torque two assembly bolts to 75 lb.\*ft., 102 N m.
8. See Figure 18. Apply thread locking compound on threads of screw (3), lubricate the shank, thread through the cap into the control piston, and torque to 5 lb.\*ft., 6.78 N\*m.
9. Install minimum stop screw (24) and turn clockwise to stroke pump to full volume. Measure height from control cap to top of screw (3). With control piston at full displacement, dimension must be .74 +/- .03 in., 18,8 +/- 0,76 mm. Back out minimum stop screw (24) till there is no contact with control piston.
10. Press dowel (30) into body (16), through the link (28), to 1/4, 6,35 mm below surface, apply hydraulic sealant to threads of screws (46) and install over dowel (30).
11. Press spool (21) into retainer (19). Caution: do not use excessive force. Place spool/retainer assembly into spool (17) with spring (18) and washer (34). Secure with retaining ring (33).
12. While sleeve (27) is engaged into dowel on link (28), slide above spool assembly into bore of body (16), and through sleeve (27). Spool (21) must move freely and easily at all positions of the link (28).
13. Install proportional valve (41) in block. Torque to 20 ft.\*lbs., 27 N m.
14. Install coil on proportional valve. Torque to 20-25 in.\*lbs., 2,2-2,8 N m maximum
15. Assemble all other components into body (16) per above drawing. Torque the plug (12).
16. While spring retainer is engaging clevis pin (5) under dowel of link (28), slide the other opening of spring retainer over the top of the screw (3). Attach body assembly (16) to cap (1) with two screws and torque to 75 lb.\*ft., 102 N m.
17. Install tubing assembly (Figure 24, 25).

**Figure 16**  
**Servo cap**



ADJUST FOR ZERO FLOW AT  
175 MA ELECTRICAL COMMAND



Ref. Figure 18  
ELECTROHYDRAULIC STROKER

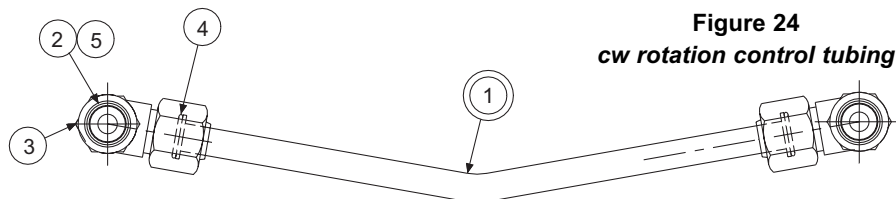
PQ CONTROL  
IN PROCESS OF DEVELOPMENT

PQ CONTROL  
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PQ CONTROL  
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PQ CONTROL  
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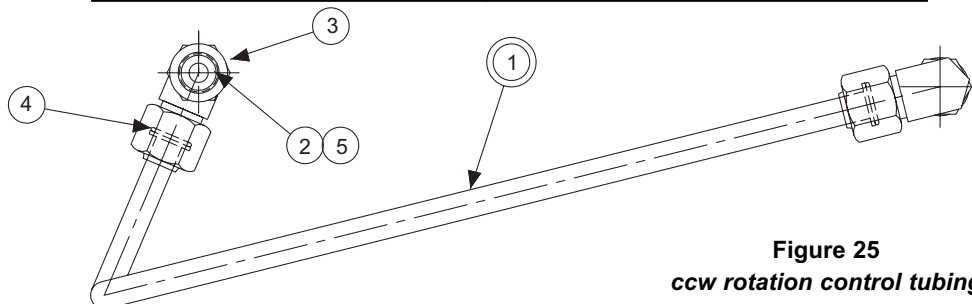


**Figure 24**  
*cw rotation control tubing*

**PARTS LIST FOR FIGURE 24**

*cw rotation control tubing S22-16035 (P07) S22-16037 (P110)*

ITEM	DESCRIPTION	P07 PART NO.	P110 PART NO.	QTY.
1	Servo tube w/nut & sleeve	S22-16032	S22-16077	1
2	O-ring, 90 S-1	691-00906	691-00113	2
3	Elbow fitting	492-15382	492-15426	2
4	O-ring, 90 S-1 ARP 012	691-00012	691-00012	2
5	Fitting retaining ring	-	492-15417	2



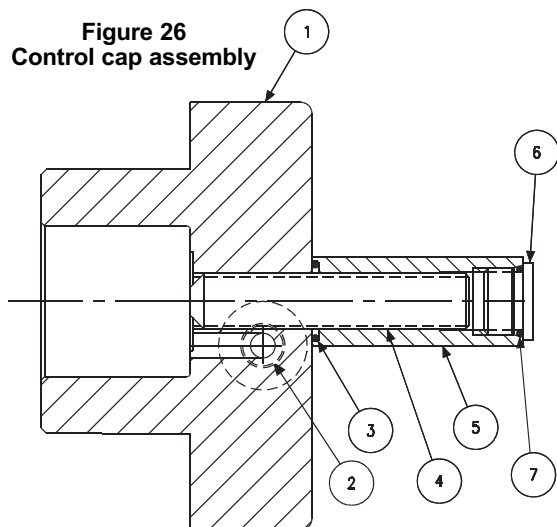
**Figure 25**  
*ccw rotation control tubing*

**PARTS LIST FOR FIGURE 25**

*ccw rotation control tubing S22-16036 (P07) S22-16038 (P110)*

ITEM	DESCRIPTION	P07 PART NO.	P110 PART NO.	QTY.
1	Servo tube w/nut & sleeve	S22-16076	S22-16078	1
2	O-ring, 90 S-1	691-00906	691-00113	2
3	Elbow fitting	492-15382	492-15426	2
4	O-ring, 90 S-1 ARP 012	691-00012	691-00012	2
5	Fitting retaining ring	-	492-15417	2

**Figure 26**  
*Control cap assembly*



**CONTROL CAP DISASSEMBLY**

1. See Figure 26. Remove nut (5) and maximum volume screw (4).
2. Remove 4 screws holding cap to pump.
3. Remove cap assembly from pump.

**ASSEMBLY**

See page 26 for tightening torque on plugs

1. Install O-rings on interface between cap and pump control pad. Install cap on pump housing as indicated on the applicable view (pg. 24), guiding the control piston into the bore.
2. Torque the assembly bolts to 75 lb.\*ft., 102 N.m.
3. Install screw (4) in cap. Install O-ring (3) on nut (5). Install nut (5) on screw.
4. Adjust screw till pump is slightly on stroke and lock nut (5).
5. Install O-ring (7) on plug (6). Install plug in nut (5). Torque plug (6).

**PARTS LIST FOR FIGURE 26**

*P07 control cap assembly S22-15325*

*P110 control cap assembly S22-15613*

ITEM	DESCRIPTION	P07		P110	
		PART NO.	QTY.	PART NO.	QTY.
1	Control Cap	032-91842	1	032-92229	1
2	Plug	449-00015	1	449-00599	1
3	O-ring, 70 S-1 ARP 115	671-00115	1	671-00115	1
4	Screw, M16	311-50001	1	311-50001	1
5	Nut, M16	031-91822	1	031-91822	1
6	Plug, SAE-8	488-35018	1	488-35018	1
7	O-ring 90 S-1 ARP 908	691-00908	1	691-00908	1

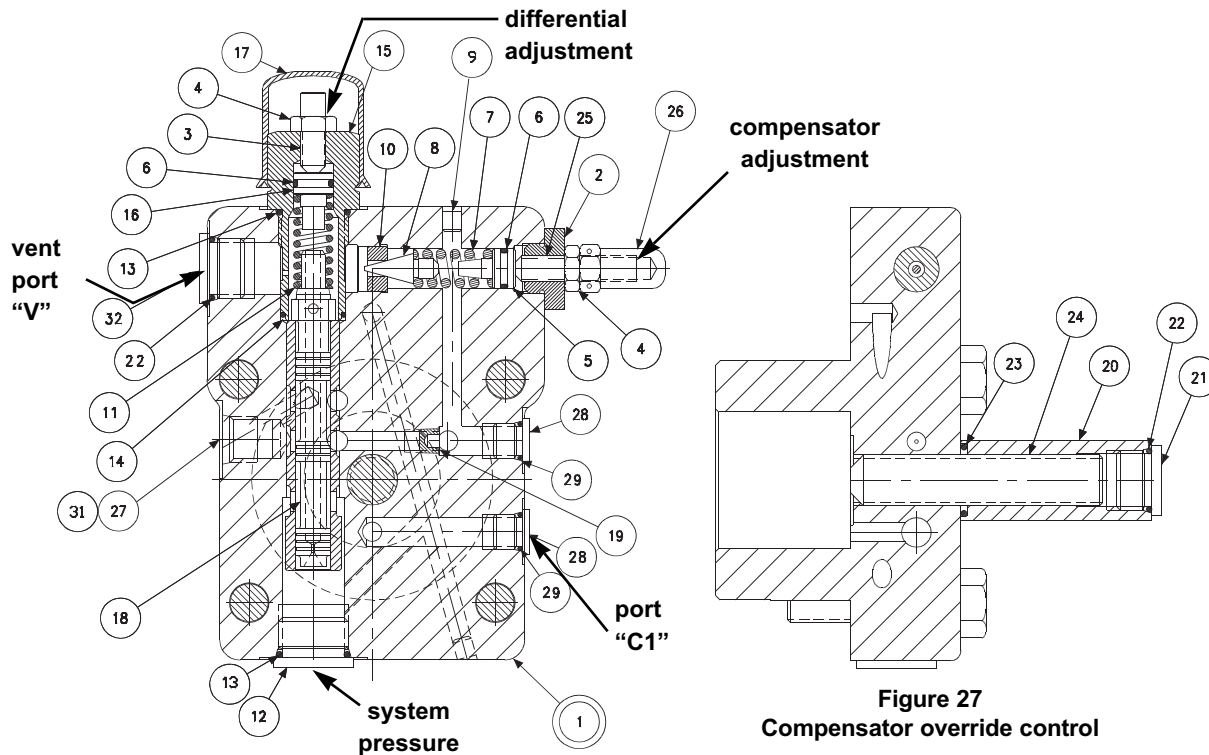


Figure 27  
Compensator override control

**PARTS LIST FOR FIGURE 27**

*compensator override control*

*P07 compensator override S22-16205*

*P110 comp. override S22-16206*

ITEM	DESCRIPTION	P07		P110	
		PART NO.	QTY.	PART NO.	QTY.
1	Cap-Sleeve Assembly	S22-16043	1	S22-16044	1
2	Adjustment Plug	032-91814	1	032-91814	1
3	Socket Setscrew 5/16-24 x 1	312-13160	1	312-13160	
4	Nut, 5/16-24	335-13100	2	335-13100	2
5	Seal Piston	031-59367	1	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2	691-00012	2
7	Spring	032-91798	1	032-91798	1
8	Cone	036-12288	1	036-12288	1
9	Avseal Plug	447-00026	2	447-00026	2
10	Seat	036-11692	1	036-11692	1
11	Spring	225-92101	1	225-92101	1
12	Plug, SAE-10, 1/2 BSPP	488-35055	1	447-01008	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
14	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
15	Plug	031-57368	1	031-57368	1
16	Seal piston	032-92480	1	032-92480	1
17	Cap	449-00612	1	449-00612	1
18	Spool	032-92549	1	032-92549	1
19	Plug, 1/16 NPTF	431-90104	1	431-90104	1
20	Nut, M16	032-91822	1	032-91822	1
21	Plug	488-35018	1	488-35018	1
22	O-ring, 90 S-1 ARP 908	691-00908	2	691-00908	1
23	O-ring, 70 S-1 ARP 115	671-00115	1	671-00115	1
24	Socket. Setscrew, M16	311-50001	1	311-50001	1
25	Socket Setscrew 5/16-24	312-13180	1	312-13180	
26	Acorn Nut	036-33474	1	036-33474	1
27	Plug	449-00015		449-00599	1
28	Plug, SAE-4, 1/4 BSPP	488-35061	2	447-01004	2
29	O-ring, 90 S-1 ARP 904	691-00904	2	447-00032	2
31	Orifice	035-40489	1	035-40489	1
32	Plug, SAE-8, 3/8 BSPP	488-35018	1	447-00032	1

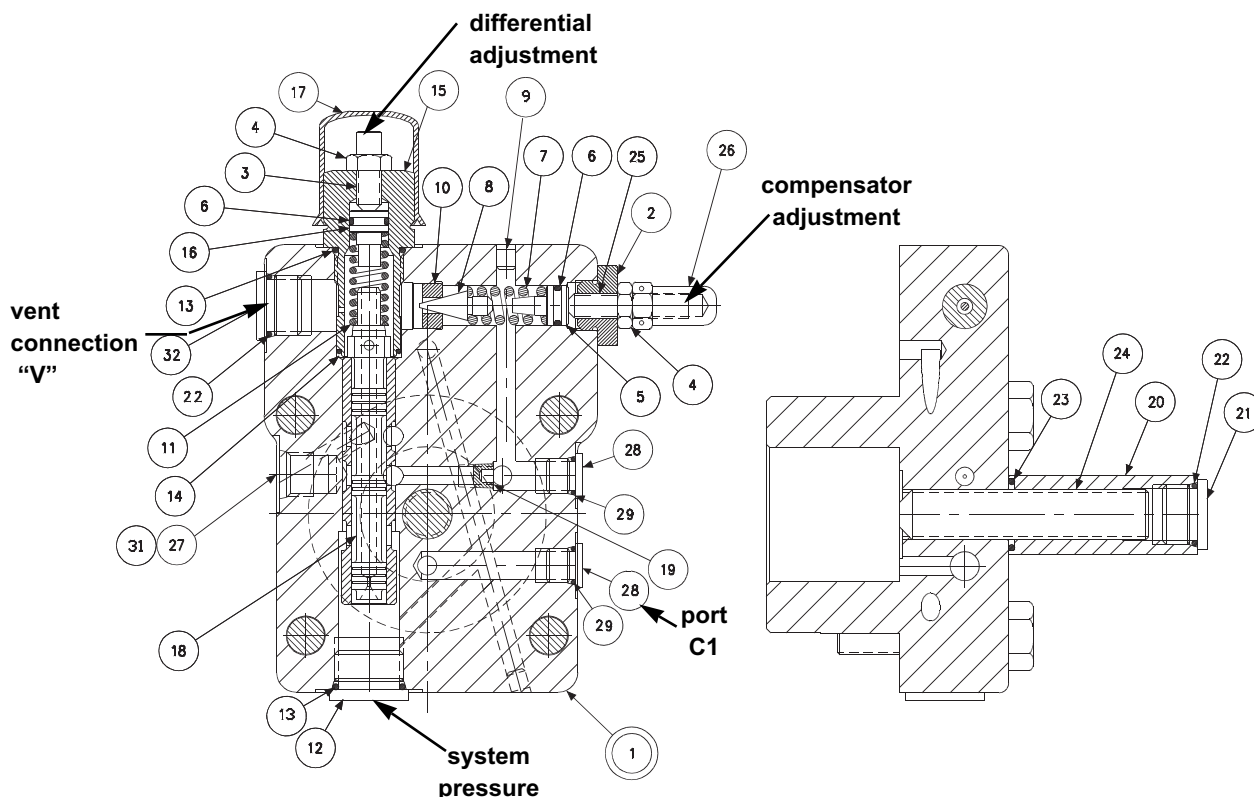
## DISASSEMBLY

1. See Figure 27. Remove tube line to cap.
2. Remove maximum volume stop assembly (items 20, 21, 22, 23, 24).
3. Remove cap assembly.
4. Remove plug (15) and attached parts. Remove spring (11) and spool (18).
5. Remove adjusting plug (2) and attached parts. Remove seal piston (5). Note: a 10-24 screw may be attached to assist in pulling the piston. Remove spring (7) and cone (8).
6. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve, snout or cap is worn, replace the cap-sleeve assembly (1).
7. Examine seat (10) for wear. Do not remove unless damaged.

## ASSEMBLY

See page 26 for tightening torque on plugs

1. Install Avseal plugs (9) in body. Install .032", 0,81 mm orifice (31) as indicated. Install plug (19) as shown.
2. Press seat (10) into bore to shoulder in bore.
3. Install spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal piston (16). Lubricate and install into plug (15). Install O-rings (13) and (14) on plug (15). Install plug (15) into cap. Install screw (3), nut (4) and cover (17).
4. Install O-ring (6) on seal piston (5).
5. Lubricate O-ring and install cone (8), spring (7) and seal piston into bore in cap (1), being careful that cone enters seat (10).
6. Install remaining parts. Torque plugs (12) (21) (28) and (32).
7. Note proper location for cap on pump (pg. 24). Install O-rings on interface between cap and pump control pad.
8. Install cap assembly on pump, guiding the control piston into the bore.
9. Torque mounting bolts to 75 lb.\*ft., 102 Nm.
10. Install tubing assembly (Figure 24, 25).



Ref. Figure 27  
COMPENSATOR OVERRIDE CONTROL

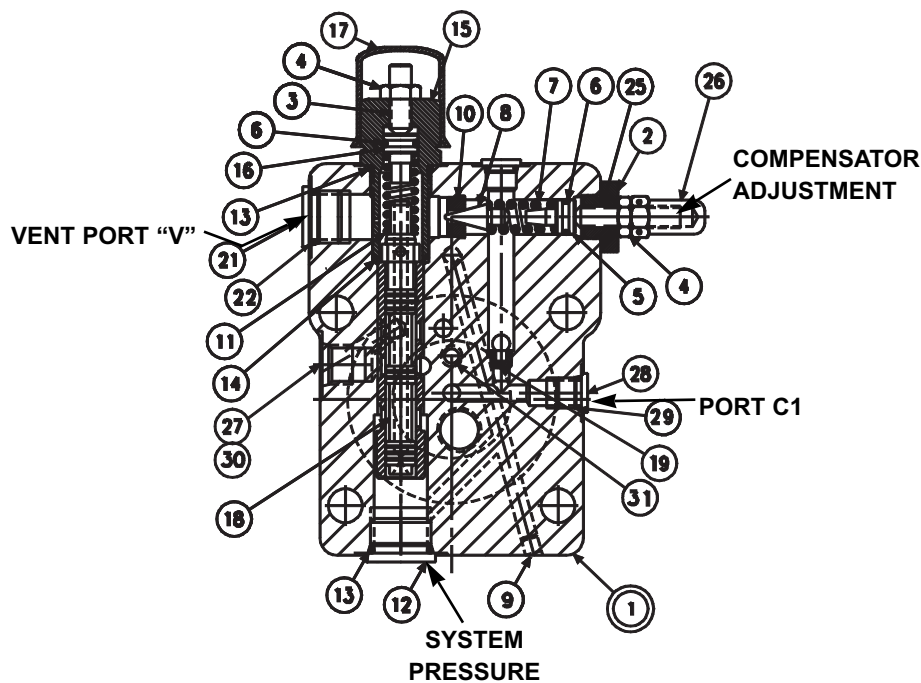


FIGURE 28

torque limiter override cap

**PARTS LIST FOR FIGURE 28**

torque limiter override cap

P07 cap S22-16049

P110 cap S22-16050

ITEM	DESCRIPTION	P07		P110	
		PART NO.	QTY.	PART NO.	QTY
1	Cap-Sleeve Assembly	S22-16045	1	S22-16046	1
2	Adjustment. Plug	032-91814	1	032-91814	1
3	Socket Setscrew 5/16-24 x 1	312-13160	1	312-13160	1
4	Nut, 5/16-24	335-13100	2	335-13100	2
5	Seal Piston	031-59367	1	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2	691-00012	2
7	Spring	032-91798	1	032-91798	1
8	Cone	036-12288	1	036-12288	1
9	Avseal Plug	447-00026	2	447-00026	2
10	Seat	036-11692	1	036-11692	1
11	Spring	225-92101	1	225-92101	1
12	Plug, SAE-10, 1/2 BSPP	488-35055	1	447-01008	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2	691-00910	1
14	O-Ring, 90 S-1 ARP 017	691-00017	1	691-00017	1
15	Plug	031-57368	1	031-57368	1
16	Seal Piston	032-92480	1	032-92480	1
17	Cap	449-00612	1	449-00612	1
18	Spool	032-92549	1	032-92549	1
19	Plug	431-90104	1	431-90104	1
21	Plug, SAE-8, 3/8 BSPP	488-35018	1	447-00032	1
22	O-ring 90 S-1 ARP 908	691-00908	1	-	
23	Socket Setscrew	312-13180	1	312-13180	1
25	Acorn Nut	036-33474	1	036-33474	1
26	Plug	449-00015	1	449-00599	1
28	Plug, SAE-4, 1/4 BSPP	488-35061	2	447-01004	2
29	O-ring, 90 S-1 ARP 904	691-00904	2	-	-
30	Orifice, .032", 0,81 mm	035-40489	1	035-40489	1
31	O-Ring, 70 S-1 ARP 008	671-00008	1	671-00008	1

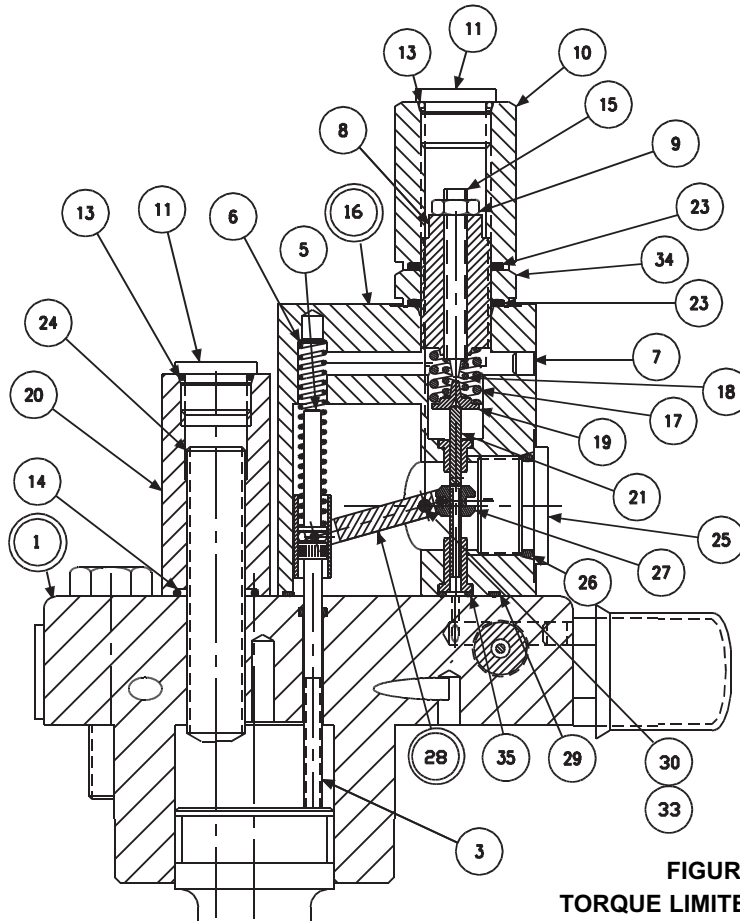


FIGURE 29  
TORQUE LIMITER OVERRIDE

**PARTS LIST FOR FIGURE 29**

*torque limiter override*

*P07 code J, S22-16207*

*P07 code K, S22-16209*

*P110 code J, S22-16208*

*P110 code K, S22-16210*

ITEM	DESCRIPTION	P07 PART NO.	P110 PART NO.	QTY.	
				**J	**K
1	Cap (Figure 28)	S22-16049	S22-16050	1	1
3	Screw	032-91461	032-91461	1	1
5	Clevis pin	321-40000	321-40000	1	1
6	Spring, Compression	032-92100	032-92100	1	1
7	Plug, Avseal	447-00026	447-00026	1	1
8	Screw	032-91445	032-91445	1	1
9	Nut, Hex Jam 1/4-20 UNC	340-00038	340-00038	1	1
10	Hex Nut, 3/4-16 UNF	032-91449	032-91449	1	1
11	Plug, SAE-8	488-35018	488-35018	2	2
13	O-Ring, 90 S-1 ARP 908	691-00908	691-00908	2	2
14	O-ring, 70 S-1 ARP115	671-00115	671-00115	1	1
15	Screw, Primary Adjustment	032-91446	032-91446	1	1
16	Body assembly	S22-15396	S22-15396	1	1
17	Outer Spring – J Version	032-91440	032-91440	1	—
	Outer Spring – K Version	032-91440	032-91440	—	1
18	Inner Spring – J Version	032-92240	032-92240	1	—
	Inner Spring – K Version	032-91441	032-91441	—	1
19	Spring Retainer	032-91819	032-91819	1	1
20	Nut, M16 hex	032-91822	032-91822	1	1
21	Spool	032-91438	032-91438	1	1
23	O-ring, 70 S-1 ARP 118	671-00118	671-00118	2	2
24	Socket Setscrew, M16	311-50001	311-50001	1	1
25	Plug, SAE-12	488-35014	488-35014	1	1
26	O-Ring, 90 S-1 ARP 912	691-00912	691-00912	1	1
27	Sleeve	032-91437	032-91437	1	1
28	Arm assembly	S22-15520	S22-15520	1	1
29	O-Ring, 70 S-1 ARP 035	671-00035	671-00035	1	1
30	Dowel Pin	324-20824	324-20824	1	1
33	Screw, SHC 10-32 x 1/4	312-09041	312-09041	2	2
34	Nut	032-91645	032-91645	1	1
35	O-Ring, 70 S-1 ARP 010	671-00010	671-00010	1	1

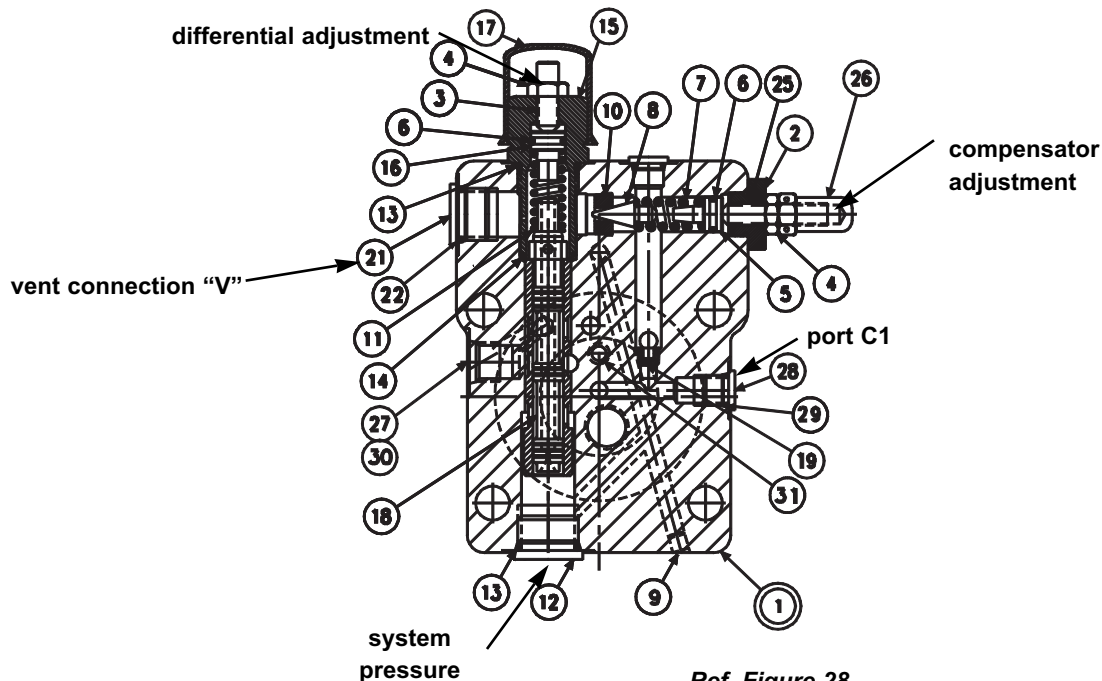
### Disassembly

1. See figure 29. Remove 2 screws holding torque limiter body (16) to cap assembly (1).
2. Remove all parts from torque limiter body (16) except pin (30) and arm assembly (28). It is not necessary to remove these parts unless broken or worn. Examine parts for wear or damage.
3. Remove screw (3). Examine head for excessive wear, and body for smooth sealing surface with O-ring.
4. See figure 28. Remove maximum volume stop assembly (items 11, 13, 14, 20, 24).
5. Remove cap assembly (1).
6. Remove plug (15) and attached parts. Remove spring (11) and spool (18).
7. Remove adjusting plug (2) and attached parts. Remove seal piston (5). Note: a 10-24 screw may be attached to assist in pulling the piston. Remove spring (7) and cone (8).
8. Do not remove sleeve in body (1). Sleeve is pressed into cap and finished to size. If sleeve, snout or cap is worn, replace the cap-sleeve assembly (1).
9. Examine seat (10) for wear. Do not remove unless damaged.

### Assembly

#### See page 26 for tightening torque on plugs

1. See figure 28. Install Avseal plugs (9), plug (19), .032", 0,81 mm orifice (30).
2. Press seat (10) into bore squarely against shoulder in bore.
3. Install spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal piston (16). Lubricate and install into plug (15). Install O-rings (13) and (14) on plug (15) Install plug (15) into cap. Install screw (3), nut (4) and cover (17).
4. Install O-ring (6) on seal piston (5).
5. Lubricate O-ring and install cone (8), spring (7) and seal piston into bore in cap (1), being careful that cone enters seat (10). Install adjustment plug (2), screw (25), nut (4), and acorn nut (26).
6. Install plugs (12), (21) and (28) and torque.
7. Carefully install O-ring (31) into the cap.
8. Note proper location for cap (pg. 24). Install O-rings on interface between cap and pump control pad. Install cap assembly on pump, guiding the control piston into the bore. Torque two mounting screws to 75 lb.\*ft., 102 Nm.
9. Install maximum stop screw (24), nut (20), O-ring (14) and plug (11) with O-ring (13).
10. See figure 29. Apply thread locking compound on threads of screw (3), lubricate the shank, thread through the cap into the control piston, and torque to 5 lb.\*ft., 6,78 Nm.
11. Measure height from control cap to top of screw. With control piston at zero displacement, dimension must be .74 +/- .03 in., 18,8 +/- 0,76 mm.
12. Press dowel (30) into body (16), through the link assembly (28), to 1/4", 6,35 mm below surface. Apply hydraulic sealant to threads of screws (33) and install over dowel (30).
13. While sleeve (27) is engaged into dowel on link (28), slide spool (21) into bore of body (16), and through sleeve (27). Spool (21) must move freely and easily at all positions of the link (28).
14. Assemble remaining parts per drawing. Torque plug (11).
15. While spring retainer is engaging clevis pin (5) under dowel of link (28), slide the other opening of spring retainer over the top of the screw (3). Attach body assembly (16) to cap (1) and torque assembly screws to 75 lb.\*ft., 102 Nm.
16. Install tubing assembly (Figure 24, 25).



Ref. Figure 28

Torque limiter override cap



Test Conditions: (If using service facility test stand)

Fluid: Mobil 4259 DE (ISO V6-32 or equivalent)

RPM: 1450 or 1750  $\pm$  50 RPM

Inlet Temperature: 120° F  $\pm$  10° F., 49° C  $\pm$  4° C

Inlet Condition: Atmospheric to + 5 psi, 0,345 bar

Case Pressure: 25 psi  $\pm$  5 psi, 1,72 bar  $\pm$  0,345 bar

Mount pump on test stand, or customer system. System line must have a relief valve. Connect system lines and case drain line. Fill pump case with clean oil. If pump is mounted vertically with the shaft up, vent the case by removing the plug from port "DG" to purge trapped air. To check for external leaks, install a check or relief valve in the case drain line to build 25 psi, 1,72 bar case pressure. Dry all oil from exterior of pump. If leaks are detected at any time, they shall be repaired before proceeding.

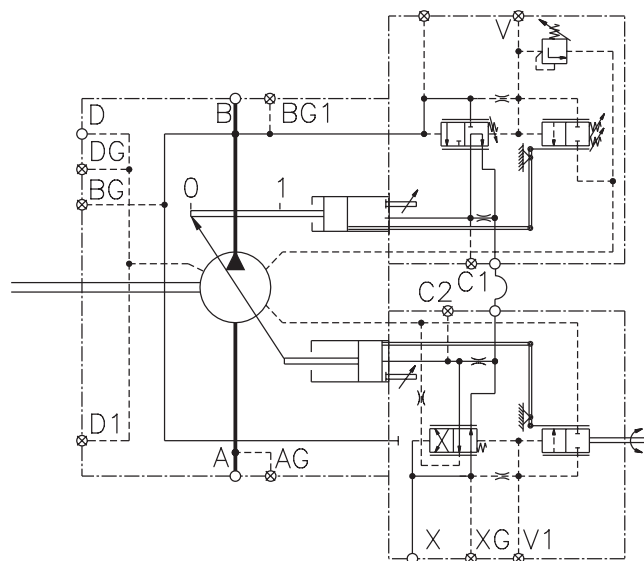
Adjust maximum volume stop to full displacement by backing off screw or handwheel CCW until there is no contact with control piston.

### ROTARY SERVO TEST

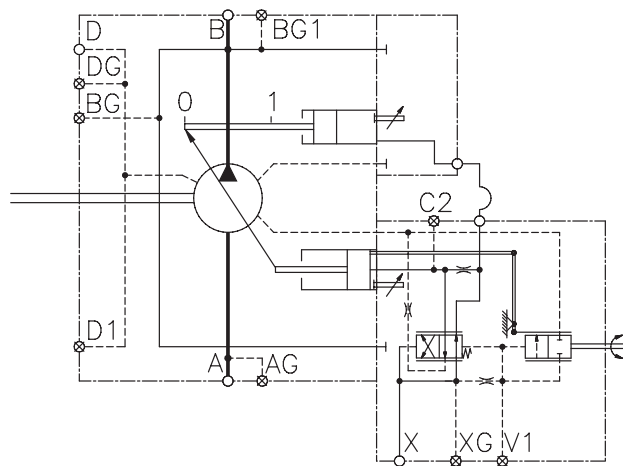
The rotary servo mounts on the minimum displacement side of the pump. It utilizes a rotating shaft containing a cam to position a pin, and a sleeve positioned by a feedback link to the control cylinder. The sleeve/pin combination meters pilot flow to position a 4-way valve. This valve is ported to both ends of the control cylinder. The 4-way spool directs oil to/from the control cylinder such that it moves in a direction to maintain the metered position between the sleeve and spool. The pump displacement is thus established by the position of the shaft.

A compensator or torque limiter override may be installed on the on-stroke side of the control piston. When the set pressure or torque is reached, system pressure is directed into the piston to reduce displacement, overriding the servo commanded position.

Before testing the rotary servo, disable the compensator or torque limiter override, if applicable, by turning the compensator differential adjustment fully in. **CAUTION:** System must contain a relief valve to limit system pressure. System relief valve should be set to minimum pressure.

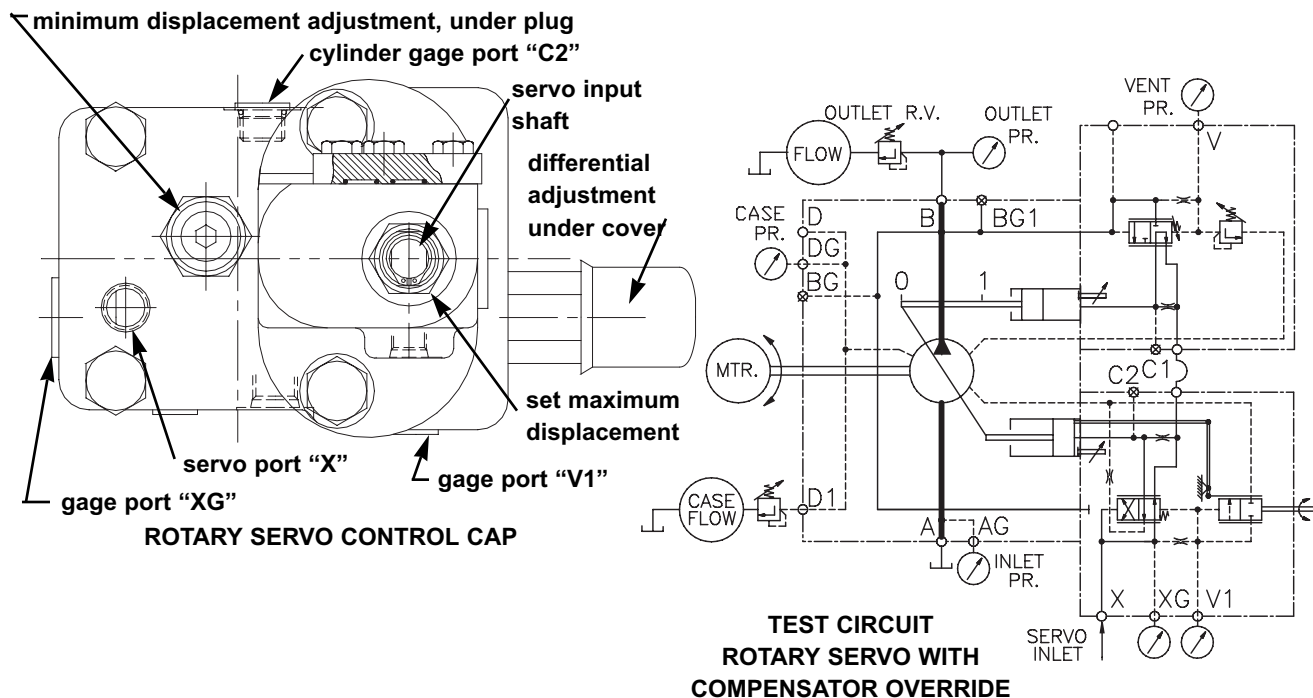


**HYDRAULIC CIRCUIT  
ROTARY SERVO TORQUE  
LIMITER OVERRIDE**



**HYDRAULIC CIRCUIT  
ROTARY SERVO**



**ROTARY SERVO TEST (continued)**

Plumb servo supply (5 gpm, 19 lpm minimum at 1500 psi, 103 bar maximum) to control port "X".

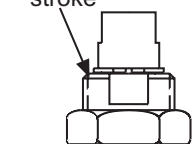
Thread minimum displacement adjustment so that pump is on stroke.

Install gages on servo pressure gage port XG and on gage port V1, capable of measuring pressure difference to 10 psi, 0,69 bar. Gages must be adequate for servo pressure.

Turn servo differential adjustment screw in till solid, then seven turns out.

Start pump. Adjust rotary servo shaft till pump is at some displacement between zero and full. Adjust differential pressure by adjusting the differential screw until the difference in pressure readings between port XG and V1 is 250 +/-10 psi, 17,2 +/- 0,7 bar. Install cover over differential adjustment. Remove gages and plug gage ports.

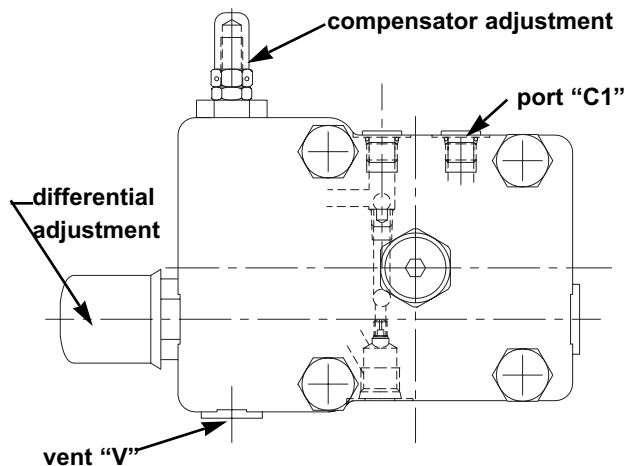
With rotary servo shaft rotated fully clockwise, adjust maximum volume adjustment on servo until output flow is at the full displacement position. Lock in place.



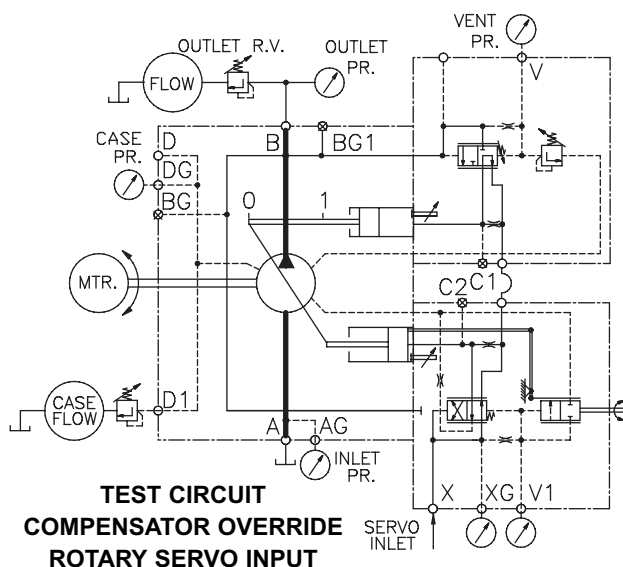
Fully rotate servo shaft counter-clockwise. Pump flow should go towards zero displacement. Back out minimum volume stop until pump is at zero displacement. Lock in place.

Rotate shaft clockwise and counterclockwise at various outlet pressures. Pump displacement should follow shaft rotation between full and zero displacement smoothly and proportionally. Full to zero or zero to full displacement should be achieved in no more than .3 second.

Proceed to **COMPENSATOR TEST** (pg. 66), **TORQUE LIMITER TEST** (pg. 70), or **FINAL PUMP TEST** (pg. 75), as applicable.



COMPENSATOR OVERRIDE CAP



TEST CIRCUIT  
COMPENSATOR OVERRIDE  
ROTARY SERVO INPUT

### COMPENSATOR TEST

Outlet relief valve should be set to minimum pressure.

If the pump contains a servo, hydraulic or electrohydraulic stroker control, test that control first, (pg. 64, 68 or 69) then set the control to give full displacement on the pump.

Install gages on outlet pressure and "V" capable of measuring pressure difference to 10 psi, 0,69 bar. Gages must be adequate for outlet pressure.

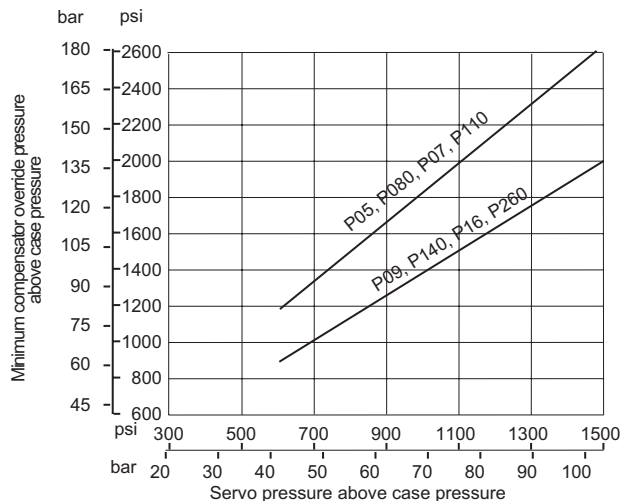
If testing pump with load sensing compensator or torque limiter control, the test stand must include a gage on the line from "LS" capable of measuring pressure difference to 10 psi, 0,69 bar and the other components shown in the load sensing test circuit. Open speed control valve fully, and close load valve to first test the compensator function.

Turn compensator adjustment screw CCW until there is no contact with spring, then adjust 1/2 turn CW after contact is made with spring.

Turn differential adjustment screw out till there is no contact with spring, then in 1-1/2 turns. (Approximately one nut width exposure of screw thread)

Start prime mover. Observe for correct rotation. Pump should be at full displacement at minimum pressure.

Adjust outlet relief valve until compensator destrokes pump to zero displacement. Adjust differential pressure across ports XG and V1 to 250+/- 10 psi, 17,2 +/- 0,7 bar. Compensator pressure should be approximately 1000 psi, 69 bar with the 1/2 turn pre-adjustment. Note: With servo type controls, minimum compensator pressure will be higher, depending on the servo supply pressure. See chart below.

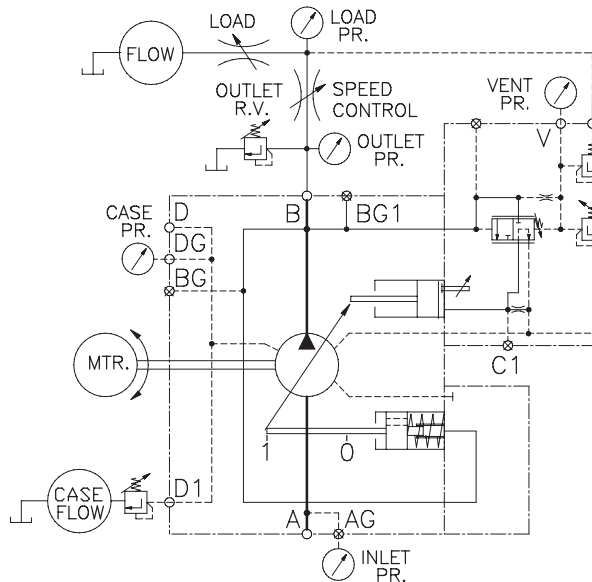


Raise compensator from minimum to maximum outlet pressure. At each condition, increase the outlet pressure until the pump fully de-strokes. At no time should the outlet pressure vary over 150 psi, 10,3 bar from the compensator setting. The control should be steady and stable at all conditions.

Calculate compensator leakage by subtracting leakage flow at full flow from leakage flow fully compensated.  
Compensator leakage: 5 gpm, 18.9 lpm. maximum

Reduce outlet pressure to 150 psi, 10,3 bar below the compensator setting. Pump should return to full displacement. Repeat two or more times. Compensator settings should be repeatable. Proceed to **FINAL PUMP TEST (pg. 75)**, or **LOAD SENSING TEST (below)** if applicable.

### LOAD SENSING TEST



**TEST CIRCUIT  
LOAD SENSING**

**Caution:** Load sensing control is limited to 5000 psi, 345 bar maximum pressure.

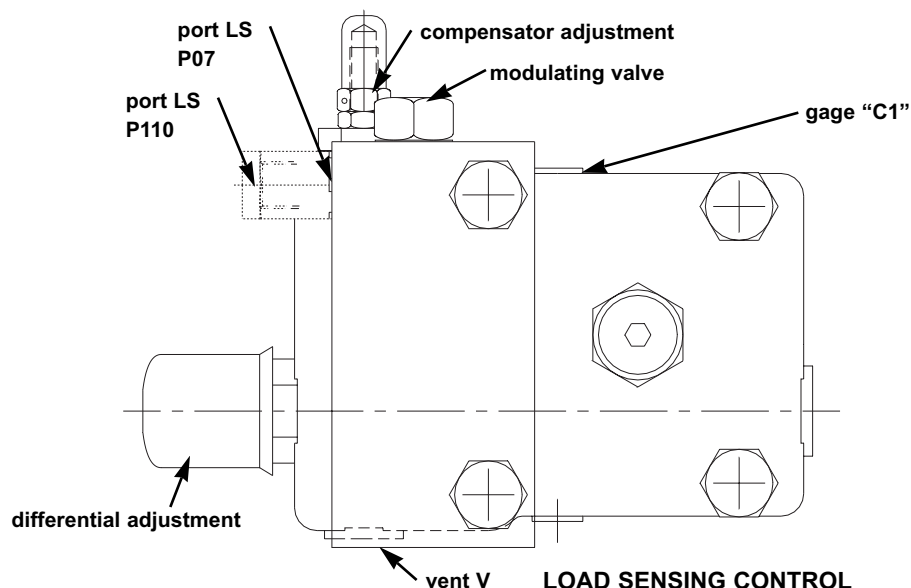
Pump should be connected to speed control valve, load sensing line and load valve as shown.

Close the speed control valve. Check the pressure difference from outlet pressure to load pressure. Using the differential adjustment, set this pressure difference to 450 psi  $\pm$  25 psi, 31,0  $\pm$  1,72 bar or shop order requirement. Caution: Too low or too high a setting will cause the control to malfunction. Install cap on differential adjustment.

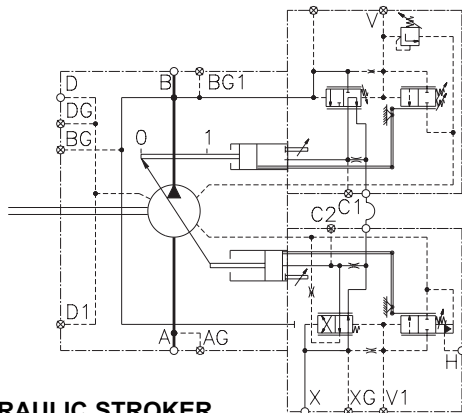
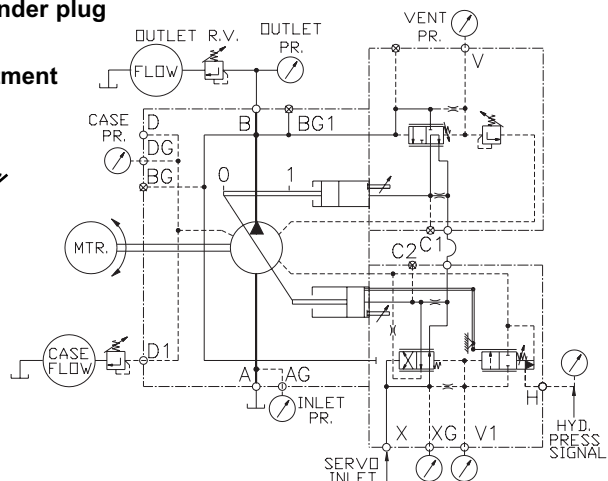
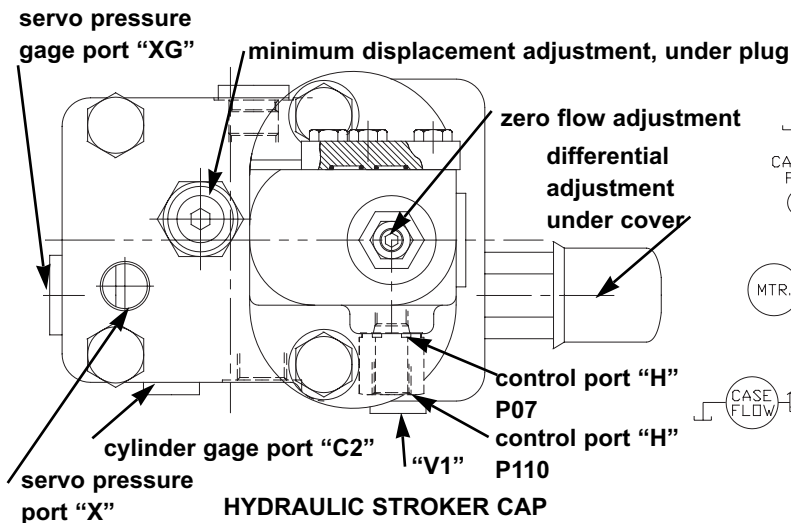
Fully open the speed control valve. Set the compensator to 3000 psi, 207 bar, and 5000 psi, 345 bar. (One turn of adjustment equals approximately 2000 psi, 138 bar.) At each condition, increase the outlet pressure by closing the load valve until the pump fully de-strokes. At no time should the outlet pressure vary more than 150 psi, 10,3 bar from the compensator setting. The control should be steady and stable at all conditions.

With pump at full flow and 5000 psi, 345 bar outlet pressure, close speed control valve till flow reduces slightly. Note flow. Open load valve slowly, to drop outlet pressure toward minimum. Flow shall remain constant within 2 gpm, 7,6 lpm at all pressures.

Adjust the speed control valve till flow is at a low value. Note flow. Raise and lower outlet pressure by closing and opening the load valve. Flow shall remain constant within 2 gpm, 7,6 lpm. Proceed to **FINAL PUMP TEST (pg. 75)**.

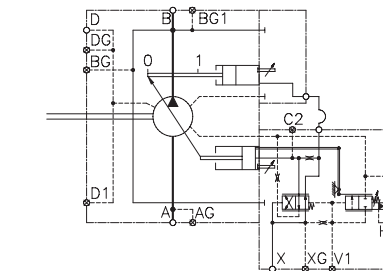


**LOAD SENSING CONTROL**



HYDRAULIC STROKER,  
TORQUE LIMITER OVERRIDE

TEST CIRCUIT  
HYDRAULIC STROKER  
COMPENSATOR OVERRIDE



HYDRAULIC STROKER

#### HYDRAULIC STROKER TEST

Before testing hydraulic stroker, disable the compensator or torque limiter override, if applicable, by turning the compensator differential adjustment fully in. (See compensator or torque limiter test). **CAUTION:** System must contain a relief valve to limit outlet pressure. Outlet relief valve should be set to minimum pressure.

Plumb servo supply (5 gpm, 19 lpm minimum at 1500 psi, 103 bar maximum) to control port "X". Plumb adjustable hydraulic pressure (50 to 350 psi, 3,45 to 24 bar) to control port "H".

Thread minimum displacement adjustment screw so that pump is on stroke.

Install gages on servo pressure gage port XG and on gage port V1, capable of measuring pressure difference to 10 psi, 0,69 bar. Gages must be adequate for servo pressure.

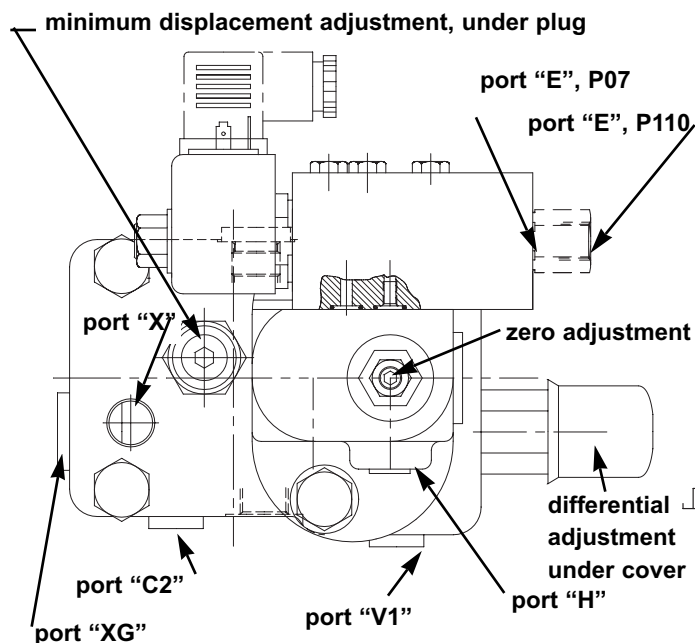
Turn hydraulic stroker differential adjustment screw in till solid, then out 7 turns.

Start pump. Apply hydraulic control signal to port "H" till pump is at some displacement between zero and full. Adjust differential pressure by adjusting the differential screw until the difference in pressure readings between port XG and V1 is 250 psi, 17,2 bar. Install cover over differential adjustment.

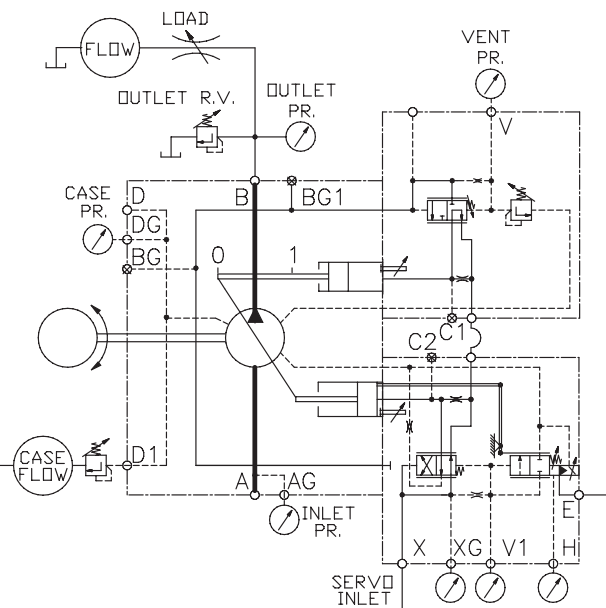
Set signal pressure to 50 psi, 3,45 bar. Back out zero volume stop and set zero flow adjustment until pump is at zero displacement. Lock both adjustments in place.

Slowly increase and decrease signal pressure between 0 and 275 psi, 19,0 bar several times at minimum and maximum operating outlet pressure. Pump displacement should follow control pressure smoothly and proportionally. Rapidly adjust signal pressure between 0 and 275 psi, 19,0 bar. Full to zero or zero to full displacement should be achieved in no more than 0,3 second.

Proceed to **COMPENSATOR TEST (pg. 66)**, **TORQUE LIMITER TEST (pg. 70)**, or **FINAL PUMP TEST (pg. 75)**, as applicable.



ELECTROHYDRAULIC STROKER CAP

TEST CIRCUIT  
ELECTROHYDRAULIC STROKER  
COMPENSATOR OVERRIDE**ELECTROHYDRAULIC STROKER TEST**

Before testing electrohydraulic stroker, disable the compensator or torque limiter override, if applicable, by turning the compensator differential adjustment fully in. (See compensator or torque limiter test) **CAUTION:** System must contain a relief valve to limit outlet pressure. Outlet relief valve should be set to minimum pressure.

Plumb servo supply (5 gpm, 19 lpm minimum at 1500 psi, 103 bar maximum) to control port "X", and to the electric stroker port, "E"

Install gages on servo pressure gage port XG and on gage port V1, capable of measuring pressure difference to 10 psi, 0,69 bar. Gages must be adequate for servo pressure.

Thread zero volume stop screw so that pump is on stroke.

Turn electrohydraulic stroker differential adjustment screw in till solid, then 7 turns out.

Start pump. Observe for correct rotation. Adjust current to proportional valve till pump is at some displacement between zero and full. Adjust differential pressure by adjusting the differential screw until the difference in pressure readings between port XG and V1 is 250 psi, 17,2 bar. Install cover over differential adjustment.

Adjust current to 170 mA. Back out zero volume stop and set zero flow adjustment until pump is at zero displacement. Lock both adjustments in place. If pump fails to respond, measure pressure at port "H", pressure to be 50 psi, 3,45 bar minimum, for 170 mA current with 24 V. coil. Remove gage after checking, to avoid unstable operation.

Increase current to 300 mA. Pump should go to full displacement. Set maximum volume screw on opposite control cap for full displacement.

Increase and decrease the amperage between 0 and 300 mA several times at minimum to maximum outlet pressure. Pump displacement should follow amperage smoothly and proportionally. Full to zero or zero to full displacement should be achieved in .3 second. Adjust amperage up to 225 mA from zero displacement, then adjust down from full displacement to 225 mA. The flows at the two 225 mA settings shall not vary more than 2 gpm, 7,6 lpm from each other.

Proceed to **COMPENSATOR TEST** (pg. 66), **TORQUE LIMITER TEST** (pg. 70), or **FINAL PUMP TEST** (pg. 75), as applicable.

# TORQUE LIMITER AND TORQUE LIMITER OVERRIDE TEST

The torque limiter design is a compensator with a means of varying pump displacement with pressure in this manner: The compensator vent port applies pressure to a pin. The pin moves against two independently adjustable springs. A sleeve, sliding over the pin, opens or closes the vent passage, to control the compensator pressure. The sleeve is connected through a linkage to the control piston. As pressure increases, the displacement must reduce, and vice versa, to provide approximate constant torque.

Install gages on outlet pressure and "V" capable of measuring pressure difference to 10 psi, 0,69 bar. Gages must be adequate for outlet pressure.

Turn compensator adjustment screw out to remove spring load, then 1/2 turn in.

Turn differential adjustment screw out till there is no contact with spring, then in 1-1/2 turns. (Approximately one nut width exposure of screw thread)

If the pump contains a servo, hydraulic or electrohydraulic stroker control, test that control first (pg. 64, 68 or 69) then set the control to give full displacement on the pump. **CAUTION:** System must contain a relief valve to limit outlet pressure. Outlet relief valve should be set at 500 psi, 34,5 bar.

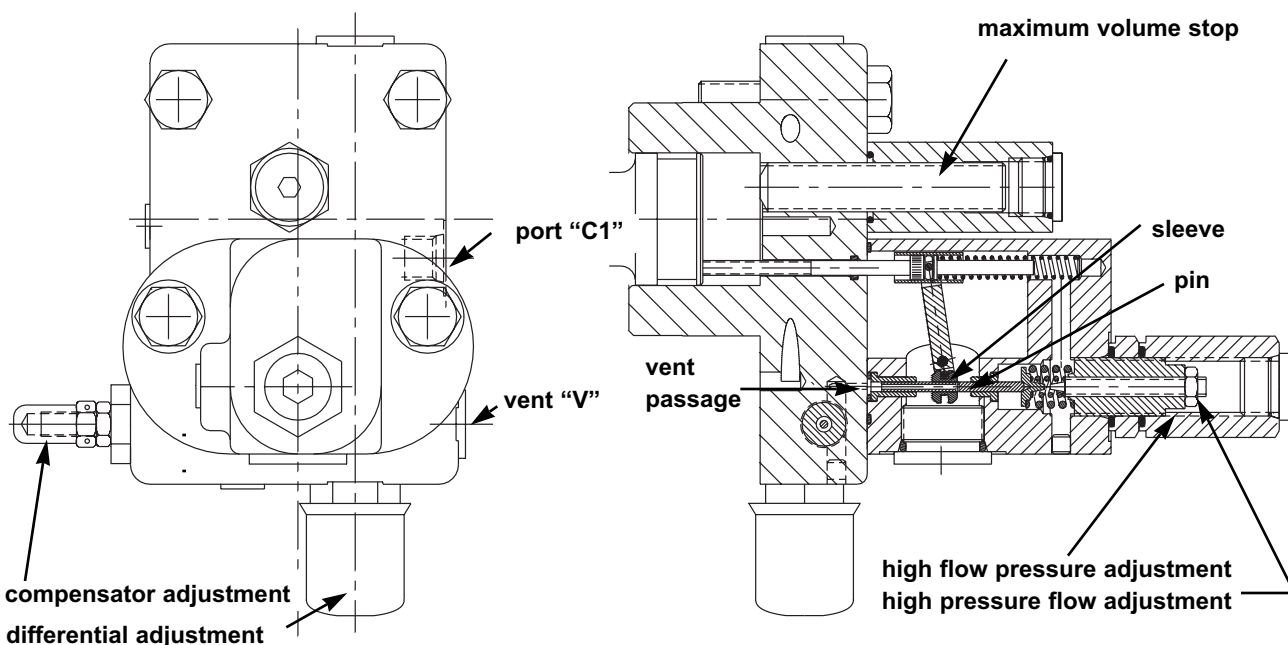
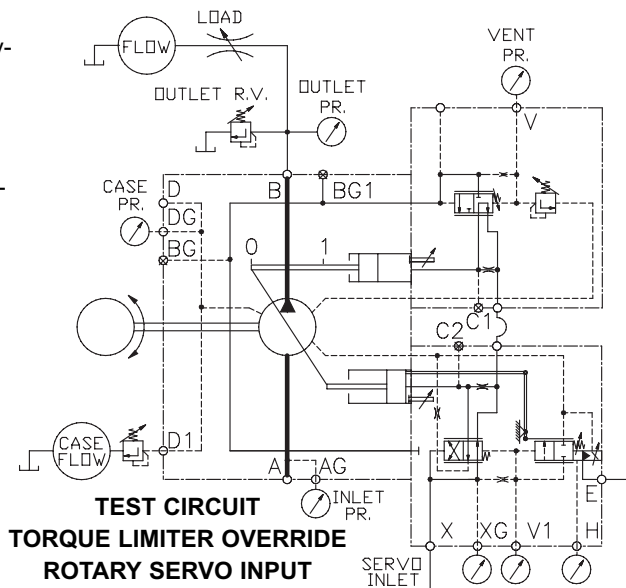
To test and set compensator function, disable torque limiter in this manner: Back out high pressure flow adjustment screw (inner) to remove all load. Turn in high flow pressure adjustment screw (outer) to go solid. Caution! do not apply over 10 in. •lb, 1,2 Nm torque to avoid damage to internal parts!

Start prime mover with outlet relief set at 500 psi, 34,5 bar. Apply a load to the pump.

Pump should be at full displacement at 500 psi, 34,5 bar.

Increase outlet pressure until compensator de-strokes pump to zero displacement. Note minimum compensated pressure versus servo pressure in chart on page 66. Set compensator to minimum compensated pressure.

Adjust compensator differential spool pressure to 250 psi, 17,2 bar. This is accomplished by adjusting the differential screw until the difference in pressure readings between the outlet pressure and compensator vent "V" gages installed in the compensator cap is 250 psi, 17,2 bar. Install cover over differential adjustment.



TORQUE LIMITER

Set the compensator to 3000 psi, 207 bar, 6000 psi, 414 bar, and 7250 psi, 500 bar. (One turn approximately equals 2000 psi, 138 bar)

At each condition, increase the outlet pressure until the pump fully de-strokes. At no time should the outlet pressure vary more than 150 psi, 10,3 bar from the compensator setting. The control should be steady and stable at all conditions.

Reduce outlet pressure below the compensator setting. Pump should return to full displacement. Repeat two or more times. Compensator setting should be repeatable.

Set compensator adjustment to at least 500 psi, 34,5 bar above the maximum outlet pressure.

#### TORQUE LIMITER TEST AND ADJUSTMENT

Set the torque limiter by using the formula:

$$HP = P \cdot Q / (\text{Eff} \cdot 1714), \text{ or } P = HP(\text{Eff} \cdot 1714) / Q, \text{ or } Q = HP(\text{Eff} \cdot 1714) / P$$

where P = Pressure in psi

Q = flow in GPM

Eff. = overall efficiency

$$\text{or } kW = P \cdot Q / (\text{Eff} \cdot 600), \text{ or } P = kW(\text{Eff} \cdot 600) / Q, \text{ or } Q = kW(\text{Eff} \cdot 600) / P$$

where P = pressure in Bar

Q = flow in lpm

Eff. = overall efficiency

calculate these two values:

- a. Outlet pressure at full pump flow.
- b. Pump flow at full outlet pressure.

1. Set outlet to pressure (a) calculated above. Back out high pressure flow adjusting screw (inner screw) to remove all load. Set the high flow pressure adjusting screw (outer) so that pump just commences to de-stroke.

2. Set the system to the required maximum outlet pressure. Set high pressure flow adjusting screw (inner) to obtain the calculated flow (b) at full outlet pressure.

Note: Electric motor current or engine load may be used instead of calculated flows to set power. In step 1, set the high flow adjustment to achieve the rated motor current or engine load. In step 2, set the high pressure adjustment to achieve the rated motor current or engine load.

Proceed to **FINAL PUMP TEST** (pg. 75)







Open load valve slowly, to drop outlet pressure toward minimum. Flow shall remain constant within 2 gpm, 7,6 lpm at all pressures.

Adjust the speed control valve till flow is at a low value. Note flow. Raise and lower outlet pressure by closing and opening the load valve. Flow shall remain constant within 2 gpm, 7,6 lpm.

Fully open the speed control valve.

Set the torque limiter by using the formula:

$$HP = P \cdot Q / (\text{Eff} \cdot 1714), \text{ or } P = HP(\text{Eff} \cdot 1714) / Q, \text{ or } Q = HP(\text{Eff} \cdot 1714) / P$$

where P = Pressure in psi

Q = flow in GPM

Eff. = overall efficiency

$$\text{or } kW = P \cdot Q / (\text{Eff} \cdot 600), \text{ or } P = kW(\text{Eff} \cdot 600) / Q, \text{ or } Q = kW(\text{Eff} \cdot 600) / P$$

where P = pressure in Bar

Q = flow in lpm

Eff. = overall efficiency

calculate these two values:

- a. Outlet pressure at full pump flow.
- b. Pump flow at full outlet pressure.

1. Set outlet to pressure (a) calculated above. Back out high pressure flow adjusting screw (inner screw) to remove all load. Set the high flow pressure adjusting screw (outer) so that pump just commences to de-stroke.

2. Set the system to the required maximum outlet pressure. Set high pressure flow adjusting screw (inner) to obtain the calculated flow (b) at full outlet pressure.

Note: Electric motor current or engine load may be used instead of calculated flows to set power. In step 1, set the high flow adjustment to achieve the rated motor current or engine load. In step 2, set the high pressure adjustment to achieve the rated motor current or engine load.

Proceed to **FINAL PUMP TEST** (pg. 75)

PQ CONTROL  
IN PROCESS OF DEVELOPMENT

**FINAL PUMP TEST**

Operate the pump with the following outlet pressures for the times indicated.

3000 psi $\pm$ 100 psi, 207 bar $\pm$ 6,9 bar	2 minutes minimum
5000 psi $\pm$ 100 psi, 345 bar $\pm$ 6,9 bar	1 minute minimum
6000 psi $\pm$ 100 psi, 414 bar $\pm$ 6,9 bar	1 minute minimum

While breaking in, destroke the pump several times at each pressure setting, by either reducing compensator setting, servo/stroker command, or Q command to PQ control, as applicable.

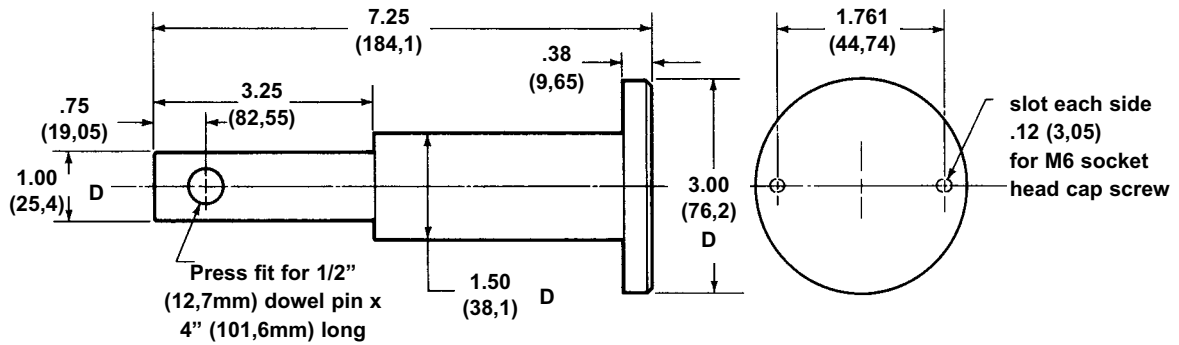
PUMP SERIES	FULL DISPLACEMENT REQUIREMENTS AT 6000 PSI, 414 BAR			
	MINIMUM OUTPUT FLOW		MAX CASE DRAIN FLOW	
	GPM	LPM	GPM	LPM
P07/P110 @ 1750 RPM	47.0	178	3.0	11,4
P07/P110 @ 1450 RPM	41.3	156	3.0	11,4

Raise compensator setting from minimum to maximum outlet pressure. **Caution:** Load sensing control is limited to 5000 psi, 345 bar maximum pressure.

At each condition, increase the outlet pressure until the pump fully de-strokes. At no time should the outlet pressure vary over 150 psi, 10,3 bar from full to zero flow. The control should be steady and stable at all conditions.

Reduce outlet pressure to 150 psi, 10,3 bar below the compensator setting. Pump should return to full displacement. Repeat two or more times. Compensator settings should be repeatable. Set compensator at 1000 psi  $\pm$  100 psi, 69 bar  $\pm$  6,9 bar standard, or desired value.

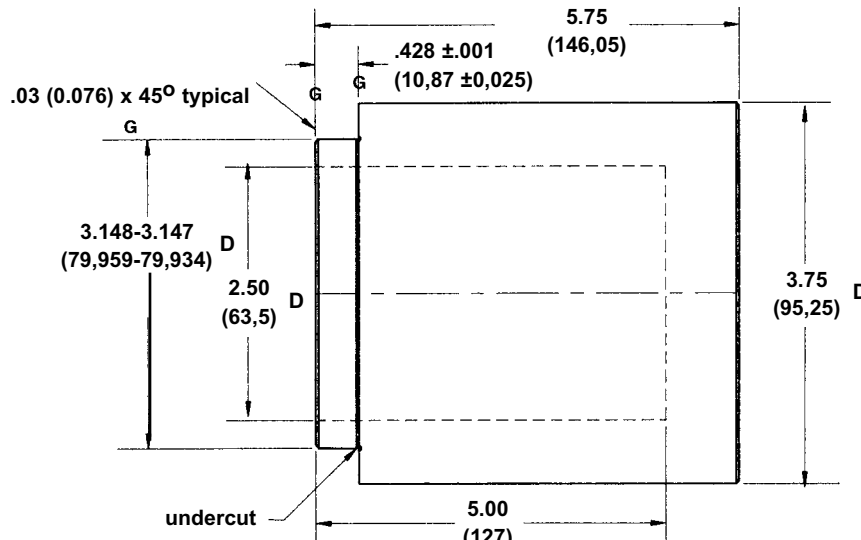
Check for leaks. NO external leaks are permitted. The shaft seal can be dry or damp. (Damp: A very small amount of oil at the seal and shaft joint, but NOT running onto the seal face).



T-1

(Lifting tool)

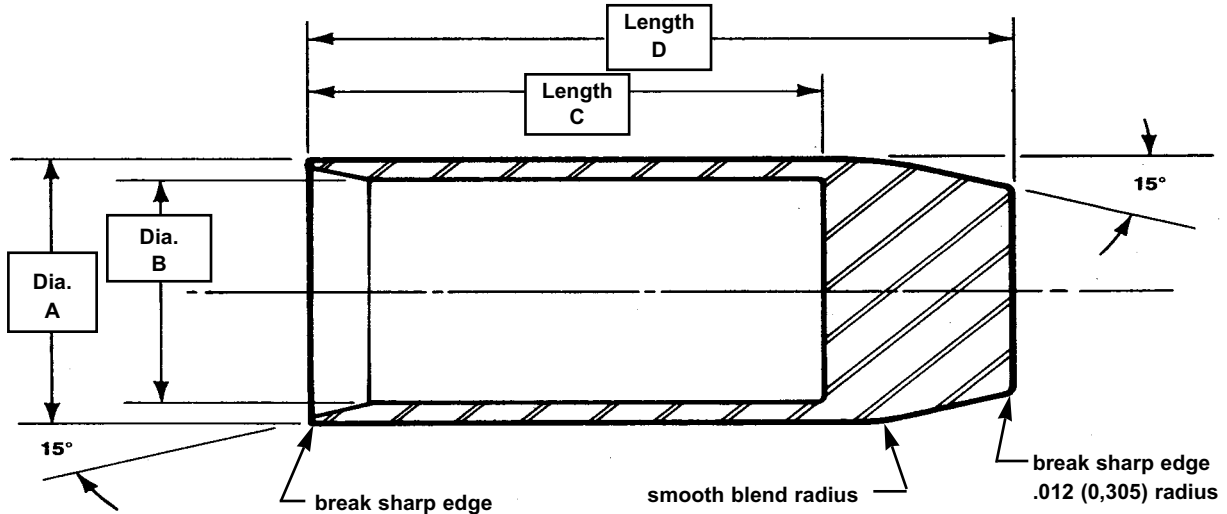
barrel & inner race assembly



T-2

(installation tool)

retainer & shaft bearing in cradle



T-3

(installation tool)

shaft seal over shaft

Shaft	A		B		C		D	
	in.	mm	in.	mm	in.	mm	in.	mm
P07 keyed	1.878/1/880	47,70/47,75	1.755/1.760	44,58/44,70	3.00	76,2	4.50	114,3
P07 splined	1.878/1/880	47,70/47,75	1.725/1.730	43,82/43,94	3.00	76,2	4.50	114,3
P110 (all)	1.878/1/880	47,70/47,75	1.580/1.582	40,13/40,18	3.25	82,5	4.75	120,6

# TYPICAL CHARACTERISTICS

Specification	Term	P07	P110
• displacement at maximum angle.....	<b>in<sup>3</sup>/rev.</b>	6.7	6.7
	<b>cm<sup>3</sup>/rev</b>	109,8	109,8
• pressure continuous .....	<b>psi</b>	6000	6000
	<b>bar</b>	420	420
• pressure intermittent (not to exceed 6 sec./minute) .....	<b>psi</b>	7250	7250
	<b>bar</b>	500	500
• speed, @ atmospheric inlet .....	<b>rpm</b>	2450	2450
maximum with boost .....	<b>rpm</b>	3000	3000
• rotating inertia .....	<b>lbs/in<sup>2</sup></b>	92	92
	<b>kg.m<sup>2</sup></b>	0,027	0,027
• compensator response off-stroke .....	<b>sec.</b>	0.100	0,100
on-stroke .....	<b>sec.</b>	0.150	0,150
• compensator adjustment.....	<b>psi/turn</b>	2000	2000
	<b>bar/turn</b>	138	138
• minimum compensating pressure (comp, torque limiter) .....	<b>psi</b>	250	250
	<b>bar</b>	17,2	17,2
• minimum compensating pressure (override controls) (at 800 psi, 55,2 bar servo) .....	<b>psi</b>	1500	1500
	<b>bar</b>	103	103
• typ. servo & stoker response @ 800 psi, 55,2 bar servo .....	<b>sec.</b>	<0.2	<0.2
pressure, zero to full displacement and vice versa			
• servo flow required for this response .....	<b>gpm</b>	5	5
	<b>l/min</b>	19	19
• minimum servo pressure.....	<b>psi</b>	800	800
	<b>bar</b>	55	55
• maximum servo pressure .....	<b>psi</b>	1500	1500
	<b>bar</b>	103	103
• electric stoker nominal coil resistance (24v. coil).....	<b>ohms</b>	41	41
• electric stoker nominal coil resistance (12v. coil).....	<b>ohms</b>	10	10
• handwheel turns, full to zero displacement.....	<b>turns</b>	9,3	9,3
• torque to turn handwheel @ 1000 psi,, 70 bar .....	<b>in-lbs</b>	100	100
	<b>Nm</b>	11	11
• torque to turn handwheel @ 7250 psi,, 500 bar .....	<b>in-lbs</b>	225	225
	<b>Nm</b>	25,4	25,4
• rotary servo shaft rotation, 0 to full displacement .....	<b>degrees</b>	49-54 <sup>0</sup>	49-54 <sup>0</sup>
• torque to turn rotary servo shaft .....	<b>in-lbs</b>	20	20
	<b>Nm</b>	2,3	2,3
• maximum/minimum case pressure (continuous) .....	<b>psi</b>	25/3	25/3
	<b>bar</b>	1,7/0,2	1,7/0,2
• maximum/minimum case pressure (intermittent) .....	<b>psi</b>	50/3	50/3
	<b>bar</b>	3,4/0,2	3,4/0,2
• input mounting-4 bolt flange .....	<b>SAE</b>	152-4 (D)	
	<b>ISO 3019/2</b>		180 B4HW
• input shaft, keyed .....	<b>SAE</b>	44-1 (D)	
• input shaft, splined .....	<b>SAE</b>	44-4 (D)	
• input shaft, keyed ISO 3019/2.....	<b>ISO</b>		G40N
• input shaft, splined ISO 3019/2.....	<b>ISO</b>		K40N
• input shaft, keyed DIN.....	<b>DIN</b>		6885 40 mm
• input shaft, splined DIN .....	<b>DIN</b>		5480 40 mm
• weight .....	<b>pounds</b>	177	177
	<b>kg.</b>	80,3	80,3

## GENERAL

The **DENISON HYDRAULICS** P07/P110 Series is a variable displacement open circuit axial piston pump with advance pumping and control concepts.

## MOUNTING

This pump is designed to operate in any position. The pump shaft must be in alignment with the shaft of the prime mover and should be checked with a dial indicator. The mounting pad or adapter into which the pump pilots must be concentric with the pump shaft to prevent bearing failure. This concentricity is particularly important if the shaft is rigidly connected to the prime mover without a flexible coupling.

## SHAFT INFORMATION

**Splined:** The shafts will accept a maximum misalignment of .006", 0.15 mm TIR. Angular misalignment at the male and female spline axis must be less than 0.001 in. per in. radius, 0.001 mm per mm. The coupling interface must be lubricated. DENISON HYDRAULICS recommends lithium molydisulfide or similar grease. The female coupling should be hardened to 27-34 Rc. and must conform to SAE J498B (1971) class 1 flat root side fit. (P07), ISO 4156 fillet root side fit module 1.00 or DIN 5480 (9H) flat root side fit module 2.00 as applicable. (P110)

**Keyed:** High strength heat treated keys must be used. Replacement keys must be hardened to 27-34 Rc. The key corners must be chamfered .030"-.040", 0.75-1.00 mm at 45° to clear radii that exist in the keyway.

## PORTING INFORMATION

**See port identification section for port locations and sizes.**

The maximum case pressure is 25 psi, 1.7 bar continuous, 50 psi, 3.4 bar intermittent. Case pressures must never exceed inlet pressure by more than 25 psi, 1.7 bar. When connecting case drain line make certain that drain plumbing passes above highest point of the pump before returning 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 drain line must be of sufficient size to prevent back pressure in excess of 25 psi, 1.7 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 of adequate size and strength to assure free flow through the pump. An undersize inlet line will prevent the pump from reaching full speed and torque. An undersized outlet line will create back pressure and cause improper operation. Flexible hose lines are recommended. If rigid piping is used, the workmanship must be accurate to eliminate strain on the pump port block or to the fluid connections. Sharp bends in the lines must be eliminated wherever possible. All system piping must be cleaned with solvent or equivalent before installing pump. Make sure the entire hydraulic system is free of dirt, lint, scale, or other foreign material.

**CAUTION:** Do not use galvanized pipe. Galvanized coating can flake off with continued use.

## INLET CONDITIONS AT SEA LEVEL, FULL DISPLACEMENT

SPEED	GAGE PRESSURE				ABS. PRESS.	
	psig	bar	in. hg	mm hg	psi	bar
1200	-3	-0,2	-6.1	-155	11.7	0.8
1800	-3	-0,2	-6.1	-155	11.7	0.8
2100	-3	-0,2	-6.1	-155	11.7	0,8
2450	0	0	0	0	0	1,01
3000	6.3	0,44	12.8	326	22.1	1,52

**NOTE:** Inlet conditions apply for petroleum base fluids. Contact **DENISON HYDRAULICS** for inlet conditions with other fluids.

## RECOMMENDED FLUIDS

See DENISON HYDRAULICS bulletin **SPO-AM305** for more information

## MAINTENANCE

This pump is self-lubricating and preventative maintenance is limited to keeping system fluid clean by changing filters frequently. Keep all fittings and screws tight. Do not operate at pressures and speeds in excess of the recommended limit. If the pump does not operate properly, check the troubleshooting chart before attempting to overhaul the unit. Overhauling is relatively simple and may be accomplished by referring to the disassembly, rework limits of wear parts and assembly procedures.

## FLUID CLEANLINESS

Fluid must be cleaned before adding to the system, and continuously during operation by filters that maintain a cleanliness level of NAS 1638 Class 8. This approximately corresponds to ISO 17/14.

Ordering Code

P07/110 - 02R1C - C10 - 00 - M2

Pump service

Displacement, max\*

07 - 6.7 in<sup>3</sup>/rev.

110 - 109,8 cm<sup>3</sup>/rev.

Shaft

02-Keyed -SAE 44-1 (D) (P07)

- ISO 3019/2 G40N (P110)

03-Splined -SAE 44-4 (D) (P07)

- ISO 3019/2 K40N (P110)

06-Keyed - DIN 6885 40mm (P110)

07-Splined DIN 5480 40mm (P110)

Shaft rotation

(viewed from shaft end)

R-CW (standard, high speed)

L-CCW (standard, high speed)

Fluid class

1-compatible with Buna N

4-compatible with EPR

5-compatible with Viton

Design letter

Primary controls

C-Pressure compensator

E-Electric stroker

H-Hydraulic stroker

J-Low torque limiter \*1100-1850 lbs-in., 124-209Nm

K-High torque limiter \*over 1850 lbs-in., 209 Nm

L-Load sensing

R-Rotary servo

V- Low torque limiter with Load sensing \*1100-1850 lbs-in., 124-209Nm

W- High torque limiter with Load sensing \*over 1850 lbs-in., 209 Nm

X- 24 VDC PQ high response (pending)

\* Minimum torque values to maintain 5000 psi, 345 bar at 1800 rpm. Consult DENISON Hydraulics for minimums at lesser pressures and speeds.

Omit-Standard model

M2- Special modification to standard units

NP- No paint

Modification

O No pump mounted

1- Auxiliary pump (only) with M- modification

(user must advise attitude of rear pump/s mounting. For ordering two standard or three or more units refer to ordering code for multiple units)

Rear drive mounting

(Appropriate coupling and seals are included)

O-None

M-Rear drive blanking plate

A-SAE 82-2 (A) flange, SAE 16-4 (A) shaft

G-SAE 82-2 (A) flange, SAE 22-4 (B) shaft

B-SAE 101-2/4 (B) flange, SAE 22-4 (B) shaft

Q-SAE 101-2/4 (B) flange, SAE 25-4 (BB) shaft

C-SAE 127-2/4 (C) flange, SAE 32-4 (C) shaft

N-SAE 127-2/4 (C) flange, SAE 38-4 (CC) shaft

D-SAE 152-4 (D) flange, SAE 44-4 (D&E) shaft

Z-ISO 3019/2 (100 B4HW) flange, K25N shaft

Y-ISO 3019/2 (125 B4HW) flange, K32N shaft

X-ISO 3019/2 (160 B4HW) flange, K40N shaft

T-ISO 3019/2, (180 B4HW) flange, K40N shaft

L-ISO 3019/2, (180 B4HW flange, DIN 40-18 shaft

Secondary controls

O-None

P-\*Pressure compensator override

J-\*Torque limiter override (low) 1100-1850 in-lbs., 124-209 Nm

K-\*Torque limiter override (high) over 1850 in-lbs., 209 Nm

(\*E, H & R primary controls only)

Primary control options

1-Standard maximum volume screw, without indicator

2-Handwheel maximum volume control without indicator (available on C, J, K, L, V & W primary controls only)

3-Maximum volume screw with cam position potentiometer (pending)

4-Maximum volume screw with cam position LVDT (pending)

5-Maximum volume screw with cam position indicator

6-Handwheel maximum volume control with cam position potentiometer (pending)

7-Handwheel maximum volume control with cam position LVDT (pending)

8-Handwheel maximum control with cam position indicator (available on C, J, K, L, V & W primary controls only)

Available control combinations

C10, C20, C50, C80

E10, E50, E1P, E5P,

E1J, E5J, E1K, E5K,

H10, H50, H1P, H5P,

H1J, H5J, H1K, H5K

R10, R50, R1P, R5P,

R1J, R5J, R1K, R5K

J10, J20, J50, J80

K10, K20, K50, K80

L10, L20, L50, L80

V10, V20, V50, V80

W10, W20, W50, W80

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