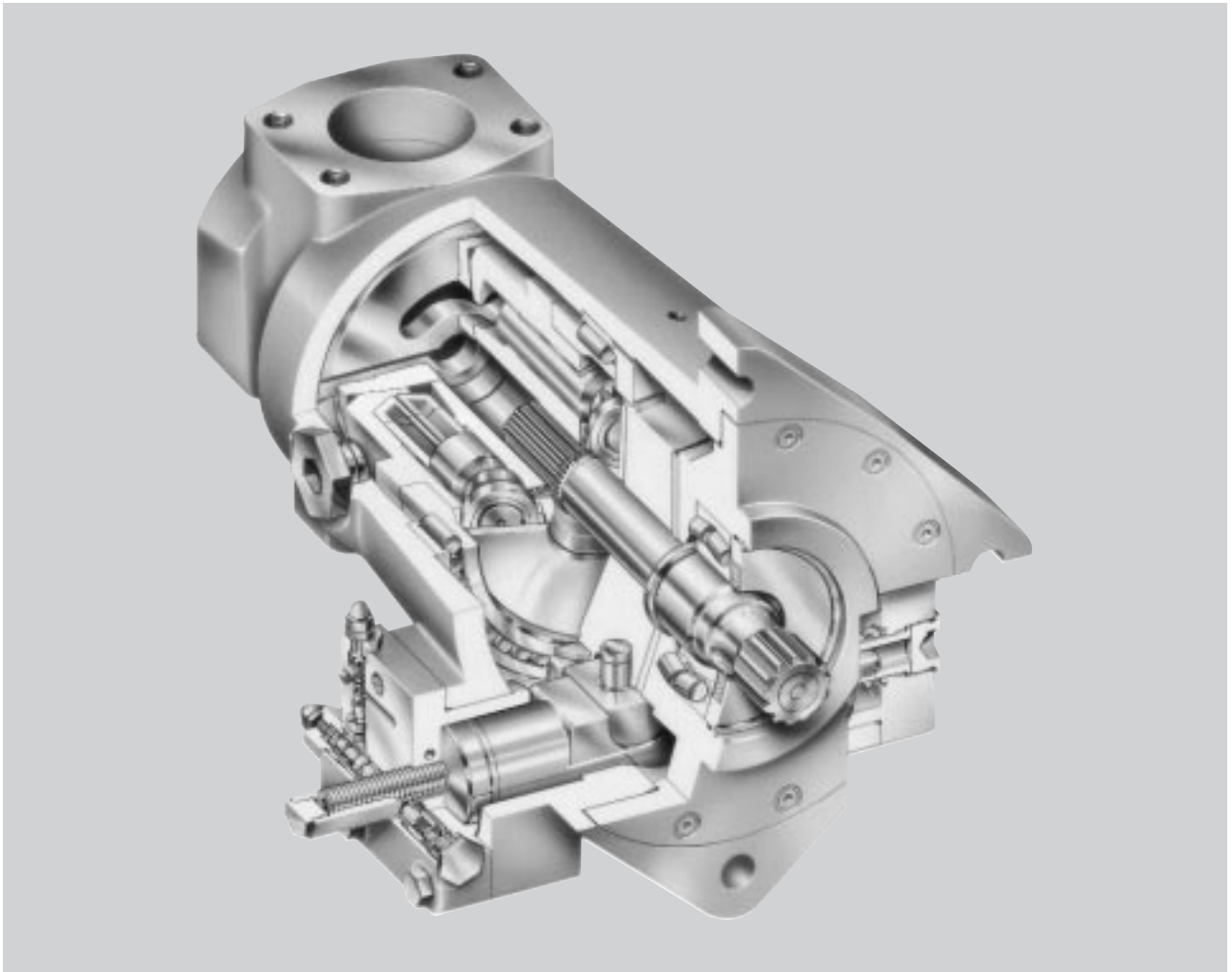


DENISON HYDRAULICS
Premier Series
open circuit pump controls
P16 B-mod, P09 A-mod
service information



Publ. S1-AM026-A replaces S1-AM026



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Note: Changes too extensive to identify separately

CHARACTERISTICS

TYPICAL CHARACTERISTICS

Specification		Term	P09	P16
• compensator response	off-stroke	sec.	0.070*	0.100*
	on-stroke	sec.	0.140*	0,150*
(per SAE J745 Apr. 87 at 5000 psi, 345 bar)				
• compensator adjustment		psi/turn	2000	2000
		bar/turn	138	138
• minimum compensating pressure		psi	200**	200**
(comp, load sensing, torque limiter)		bar	13,6**	13,6**
• minimum comp. override pressure at 1200 psi,		psi	1250**	1350**
83 bar servo pr. (servo, elec. & hyd. str.)		bar	86**	93,1**
• torque limiter adjustment range	code J	in-lbs	1400-2200	2500-6000
		Nm	160 - 250	282 - 706
	code K	in-lbs	over 2200	over 6000
		Nm	over 250	over 706
• typ. servo & stroker response @ 1200 psi, 83 bar servo pressure, zero to full stroke and vice versa		sec.	<0.7	<0.7
• servo flow required for this response (E, H, R10 controls)		in ³ /min.	693	693
		l/min.	11,4	11,4
• servo flow required for this response (*1J, *1K, *1P controls)		in ³ /min.	924	924
		l/min	15,2	15,2
• maximum servo pressure		psi	1500	1500
		bar	103	103
• servo shaft rotation, 0 to full volume		degrees	64	80
• displacement/rev./degree servo shaft rotation		in ³ /rev/deg.	0.134	0.20
		cc/rev/deg.	2,20	3,25
• torque to turn rotary servo shaft		in-lbs	20	20
		Nm	2,3	2,3
• hydraulic stroker control pressure	0 disp.	psi	50	50
		bar	3,45	3,45
	full disp.	psi	230	275
		bar	16	19
• electric stroker control current (24V)	0 disp.	mA	125	125
	full disp.	mA	315	335
• electric stroker control current (12V)	0 disp.	mA	250	250
	full disp.	mA	630	670
pulse width modulation frequency:		Hz	100-150	100-150
mating connector: Din 43650 type AF part no. 167-10008-8 (provided)				
• electric stroker nominal coil resistance (24v.)		ohms	41	41
• electric stroker nominal coil resistance (12v.)		ohms	10	10
• handwheel turns, full to zero stroke		turns	8.1	10.2
• torque to turn handwheel @ 1000 psi, 70 bar		in-lbs	125	150
		Nm	15	17
• torque to turn handwheel @ 7250 psi, 500 bar		in-lbs	275	350
		Nm	32	40
• port C1, C2 (cylinder gage ports)		SAE	-4	-4
• port E (electric stroker control pressure inlet)		SAE	-4	-4
• port H (hydraulic stroker control pressure inlet)		SAE	-4	-4
• port LS (load sensing port)		SAE	-4	-4
• port V (compensator vent)		SAE	-8	-8
• port X (rotary servo, electric & hydraulic stroker servo inlet)		SAE	-6	-6

* on-stroke response for compensator override is determined by servo/stroker response

**add case pressure

FLUID CONNECTIONS

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 piloted three-way valve spool and sleeve combination is the nucleus of the control function. For the compensator, torque limiter and load sensing controls, system pressure is applied to the input port of the valve, and to one end of the spool. A small orifice feeds this pressure to the other end of the spool, and limits pilot flow to approximately 115 in³/min., 1,9 L/m. 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 side of the control piston, a piston connected to system pressure, 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 200 psi, 13,6 bar difference, the spool shifts toward the spring, re-directing the control piston port to 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 shifts the other way to maintain the pump pressure at approximately 200 psi, 13,6 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".

COMPENSATOR WITH LOAD SENSING CONFIGURATION

For load sensing, this "V" port is connected to the load. The pump compensator will supply approximately 200 psi, 13,6 bar above the load pressure. The valve between the pump and the load meters the flow. The pump provides the flow to develop 200 psi, 13,6 bar drop across the valve independent of the load pressure and thus becomes a flow control independent of operating pressure. Adjustment of spring load on the three-way spool allows precise control of the differential pressure.

LOAD SENSING CONTROL

Where the approximately 115 in³/rev., 1,9 L/m vent flow cannot be accommodated by the load sensing circuit, and where multiple loads are to be controlled, a load sensing control is available. In the load sensing control, the vent flow is modulated by a valve which senses load pressure and establishes the pump compensator pressure at 300 psi, 20,7 bar above load pressure. There is essentially no flow in the sensing line.

TORQUE LIMITER

For torque limiting, system pressure and pump displacement are controlled by the formula $P \cdot V = C$. As pressure increases, displacement must reduce, and vice versa. A linkage to the pump control piston slides a spool over a pin. The spool and pin act as a metering valve. The pin contains a cross drilled hole, and a connecting drilling to one end. This pin passes through a bore in the torque limiter housing, which is ported to the vent port of the compensator. The pressure in the vent port applies a force on the pin, which is resisted on the other end by a two spring combination.

The pin positions itself to where the vent pressure force on the one end is balanced by the spring force on the other end. When the cross drilled hole opens, it causes the three-way spool to shift to direct system pressure into the control piston, reducing stroke. The linkage to the control piston causes the spool to move in the direction to close the cross-drilled hole. Thus, for every position of the pin, there is a corresponding position for the control piston. The position of the pin is determined by the pressure, the spring rate, and the initial adjustment on the springs. As pressure increases, pump stroke must reduce.

At low pressure, high flow, only the outer spring contacts the spool. As pressure increases, the second spring also makes contact. Thus the rate of change of pressure starts at a low initial rate when the pump is at full stroke and changes to a high rate at reduced stroke, to approximate the $P \cdot V = C$ relationship. The normal compensator function is retained to provide a maximum pressure limit.

ROTARY SERVO CONTROL

The rotary servo control is mounted on the off-stroke side of the control cylinder. The control piston has a large diameter on this side, and a smaller diameter on the opposite side. Servo pressure is connected to the input port on the three-way valve, and also to the smaller diameter side of the control piston.

When the three-way spool is at rest, this end of the control piston is ported to tank, and servo pressure applied to the opposite, smaller diameter piston causes the rocker cam to stroke to minimum. When the three-way spool shifts, pressure is directed into the larger diameter of the control piston causing the cam to shift towards full stroke.

The pin described above is spring loaded against a mechanism which converts rotary motion of the input shaft to linear motion of the pin, thus positioning pump stroke proportionately to input shaft rotation.

HYDRAULIC STROKER

In the hydraulic stroker, a spring loaded piston is attached to the above 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 stroke is achieved at 230 psi, 16 bar, (P09), and 275 psi, 19 bar (P16).

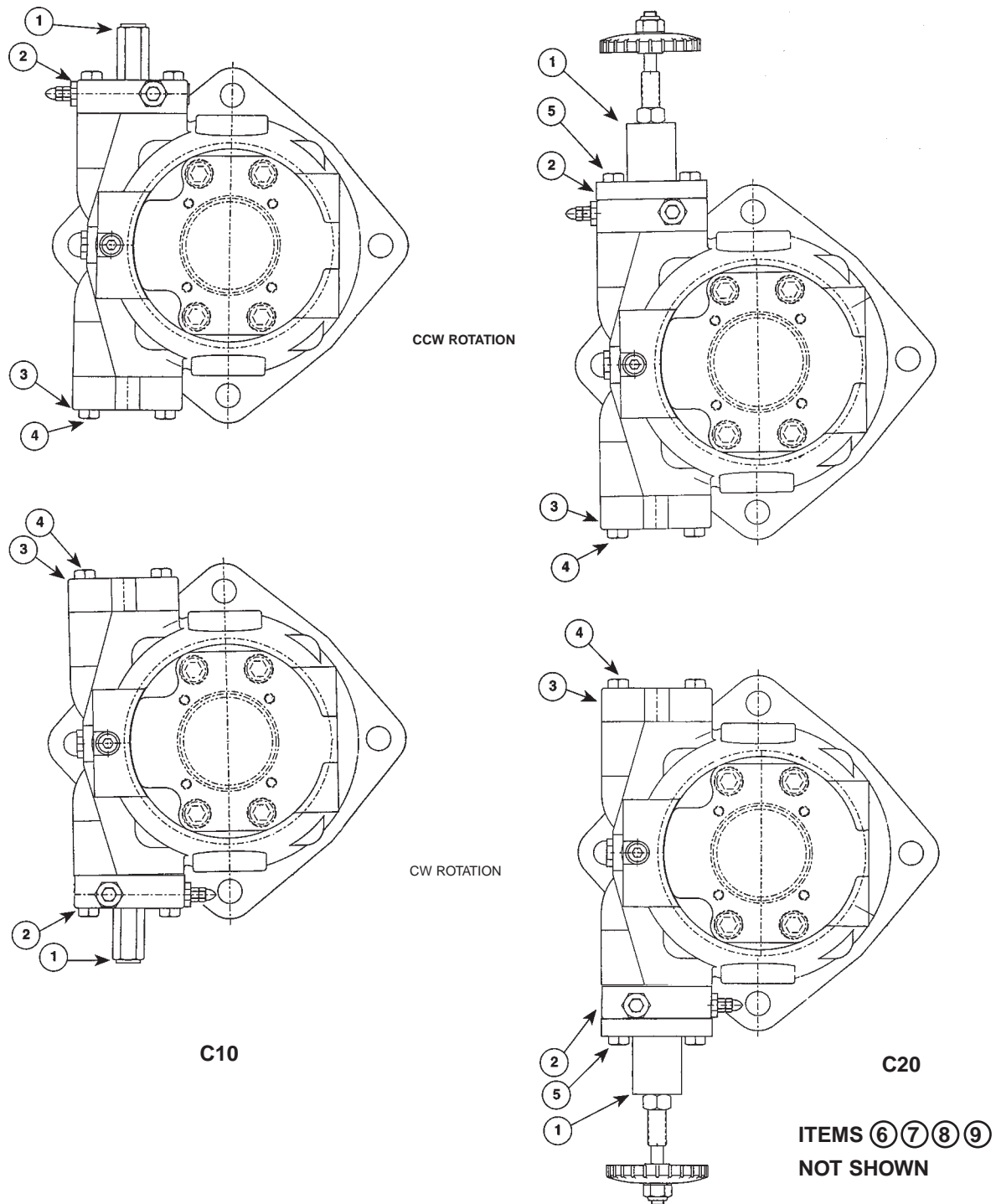
ELECTRIC STROKER

By mounting an electrically modulated pressure control valve on the hydraulic stroker to establish the control pressure, pump stroke is controlled by an electrical signal. At approximately 125 mA electrical signal, the pump commences to stroke, and at approximately 315 mA, (P09) and 335 mA, (P16), the pump will be at full stroke.

PRESSURE COMPENSATOR AND TORQUE LIMITER OVERRIDE

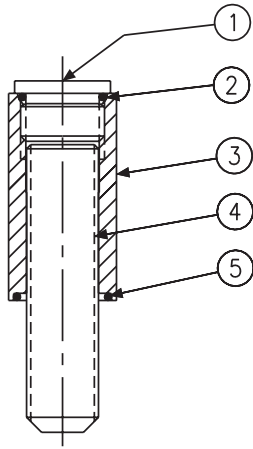
An override pressure compensator or a torque limiter control mounts on the smaller diameter of the control piston, opposite the servo, hydraulic or electric stroker. In the normal position, the spool in the override control connects this piston to servo pressure, allowing control by the stroker. When system pressure or torque exceed the override setting, this spool connects system pressure to the smaller diameter control piston, to override the command and reduce stroke according to the compensator or torque limiter setting

TROUBLESHOOTING CHART		
Effect of Trouble	Possible Cause	Fault Which Needs Remedy
Compensator, Compensator Override		
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
Load Sensing Control		
Low system pressure	See above	
Failure to compensate	See above	
Sluggish response	Differential adjustment	Differential set too high
	Modulating valve	Air in load sensing line
Wide pressure fluctuations (hunting)	Excessive line capacitance	Install check valve near pump outlet
	Modulating valve	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
Torque Limiter, Torque Limiter Override		
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
Rotary Servo		
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
Hydraulic Stroker		
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
Electric Stroker		
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
General		
Cannot achieve full volume	Maximum volume stop	Back out max. volume stop
Cannot achieve zero volume	Minimum volume stop	Back out min. volume stop
Noise	Air in system	Aerated reservoir Leaky inlet line Trapped air in system



PRESSURE COMPENSATOR
parts list

ITEM	DESCRIPTION	P09		QTY.	
		PART NO.	PART NO.	C10	C20
1	Max. Vol. Stop (Fig. 1)	S22-12983	S22-12983	1	—
	Max Vol. Handwheel (Fig. 2)	S22-12915	S22-12915	—	1
2	Compensator Control (Fig. 3)	S22-15311	S22-15311	1	1
3	Buck Up Cap (Fig. 4)	S22-15653	S22-12970	1	1
4	Screw-H.H.C., M12 x 60 mm	363-12210	363-12210	8	6
5	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	—	2
6	Control Piston	032-91585	032-91443	1	1
7	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2
8	O-Ring, 70 S-1 ARP 152	671-00152	671-00152	2	2
9	Piston Ring	032-91261	032-91261	2	2



**FIGURE 1
MAXIMUM VOLUME STOP**

PARTS LIST FOR FIGURE 1, MAX. VOL. STOP S22-12983

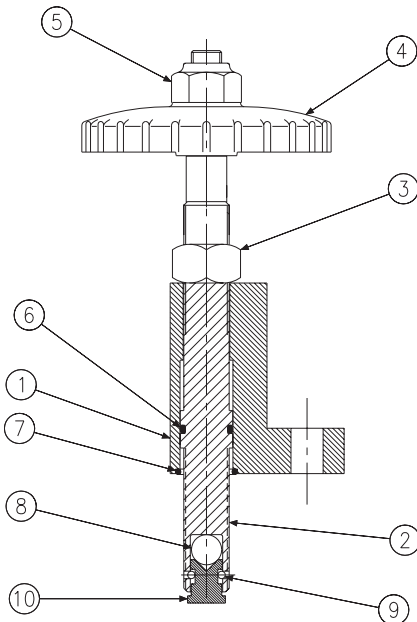
ITEM	DESCRIPTION	PART NO.	QTY.
1	Plug 10HP5N-S	488-35055	1
2	O-Ring, 90 S-1 ARP 910	691-00910	1
3	Nut, 3/4 -10UNC Hex	031-91049	1
4	Screw, Soc. Set 3/4 10 x 3	311-26320	1
5	O-Ring,70 S-1 ARP 118	671-00118	1

**MAXIMUM VOLUME HANDWHEEL
DISASSEMBLY**

1. See Fig. 2. 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) rotates and pivots 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 lbs.*ft., 102 N*m



**FIGURE 2
HANDWHEEL MAXIMUM
VOLUME STOP**

PARTS LIST FOR FIGURE 2, HANDWHEEL S22-12915

ITEM	DESCRIPTION	PART NO.	QTY.
1	Bracket	032-91456	1
2	Screw	032-91455	1
3	Nut, Hex 3/4 -16 UNC	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	201-16001	1
9	Ball	201-04001	2
10	Seat	032-91454	1

COMPENSATOR DISASSEMBLY

1. **See Figure 3.** Back off max. volume screw or handwheel to full displacement. Remove max. 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

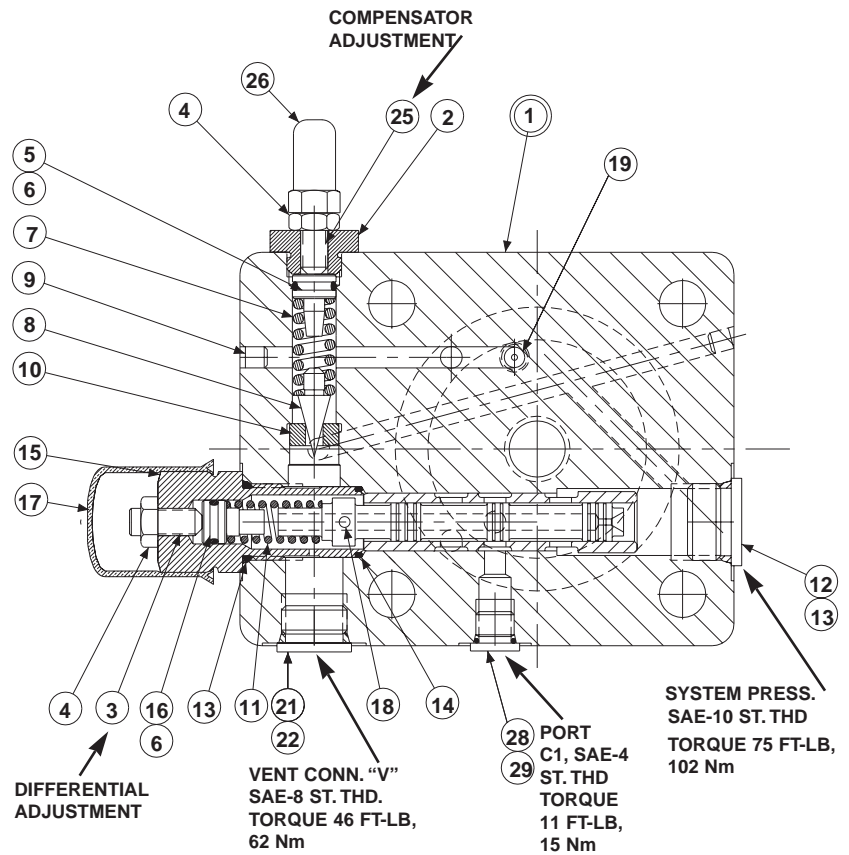
1. Install Avseal plugs (9) and orifice (27) in body.
2. Press seat (10) into bore squarely against shoulder in bore.
3. Install spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal (16). Lubricate and install into plug (15). Install plug (15) into cap. Install screw (3), nut (4) and acorn nut (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 plug (12) to 75 lb.*ft., 102 Nm. Torque plug (21) to 46 lb.*ft., 62 Nm.
6. Note proper location for cap on pump. 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.

COMPENSATOR TEST AND ADJUSTMENT

Compensator is to be tested on pump. Adjust maximum volume stop to full displacement by backing off stop till there is no contact with the control piston.

1. Install gages on system pressure and on compensator vent ports.
2. Turn compensator adjustment screw (25) CCW until there is no contact with spring, then adjust 1/2 turn CW after contact is made with spring.
3. Turn differential adjustment screw (3) CCW until there is no contact with spring, then adjust 1/2 turn CW after contact is made with spring.
4. System relief valve should be set at 500 PSI, 35 bar. If testing on application, apply a load to pump.
5. Start prime mover. Pump should be at full displacement at 500 PSI, 35 bar.
6. Increase system relief valve until compensator de-strokes pump to zero displacement. Set compensator to 1500 PSI, 103 bar.
7. Adjust compensator differential spool pressure to 200 PSI, 13,8 bar. This is accomplished by adjusting the differential screw until the difference in pressure readings between the system pressure and compensator vent gages installed in the compensator cap is 200 PSI, 13,8 bar. (It may be necessary to change differential to gain stability. Use caution when exceeding 250 PSI, 17 bar to avoid spring going solid, preventing compensator action.)
8. Set the compensator to 3000 PSI, 207 bar, 6000 PSI, 414 bar, and 7250 PSI, 500 bar.
9. At each condition, increase the system pressure until the pump fully de-strokes. At no time should the system pressure vary more than 150 PSI, 10,3 bar from the compensator setting. The control should be steady and stable at all conditions.
10. Reduce pressure to 150 PSI, 10,3 bar below the compensator setting. Pump should return to full stroke. Repeat two or more times. Compensator setting should be repeatable.
11. Set compensator adjustment to the required setting, or 6000 PSI, 414 Bar if not otherwise noted. Install cap (17) on differential adjustment.

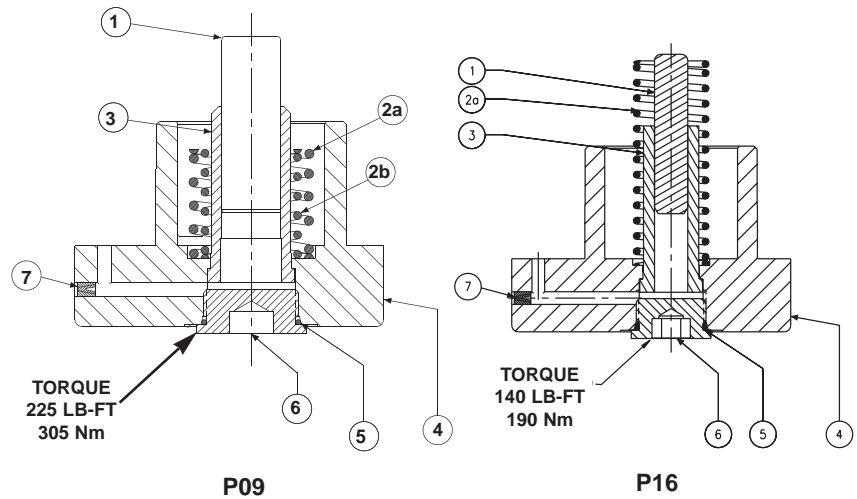
FIGURE 3
COMPENSATOR



PARTS LIST FOR FIGURE 3
compensator S22-15311

ITEM	DESCRIPTION	PART NO.	QTY.
1	Cap-Sleeve Assembly	S22-12880	1
2	Adj. Plug	032-91814	1
3	Soc. Setscrew 5/16-24 x 1	312-13160	1
4	Nut, 5/16-24	335-13100	2
5	Seal Piston	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2
7	Spring	032-91798	1
8	Cone	036-12288	1
9	Avseal Plug	447-00026	2
10	Seat	036-11692	1
11	Spring	033-71086	1
12	Plug, SAE-10	488-35055	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2
14	O-Ring, 90 S-1 ARP 017	691-00017	1
15	Plug	031-57368	1
16	Seal Piston	032-91305	1
17	Cap	449-00612	1
18	Spool	032-59482	1
19	Orifice Plug	033-25528	1
21	Plug, SAE -8	488-35018	1
22	O-Ring, 90 S-1 ARP 908	691-00908	1
25	Soc. Setscrew 5/16-24 x 1-1/4	312-13180	1
26	Acorn Nut	036-33474	1
28	Plug, SAE -4	488-35061	1
29	O-Ring, 90 S-1 ARP 904	691-00904	1

**FIGURE 4
BUCK-UP CAP**



BUCK-UP CAP DISASSEMBLY

1. See Figure 4 Set maximum volume stop to full stroke. Remove 4 screws holding cap to pump. Caution! Spring load could cause injury!
2. Remove cap assembly from pump.
3. Remove and examine spring(s) (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 (2a) and spring (2b) (in P09 only) into control piston. Install cap assembly on pump housing as indicated on the applicable view, guiding the control piston into the bore.
3. Torque the assembly bolts to 75 ft-lb, 102 Nm. Torque plug (6) to value indicated on fig. 4.

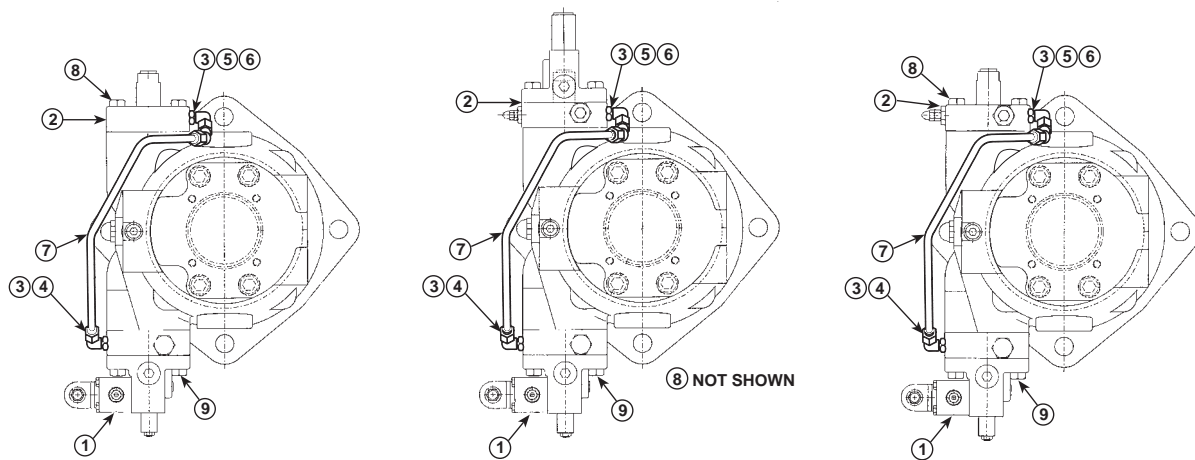
PARTS LIST FOR FIGURE 4

P09 buck-up cap S22-15653

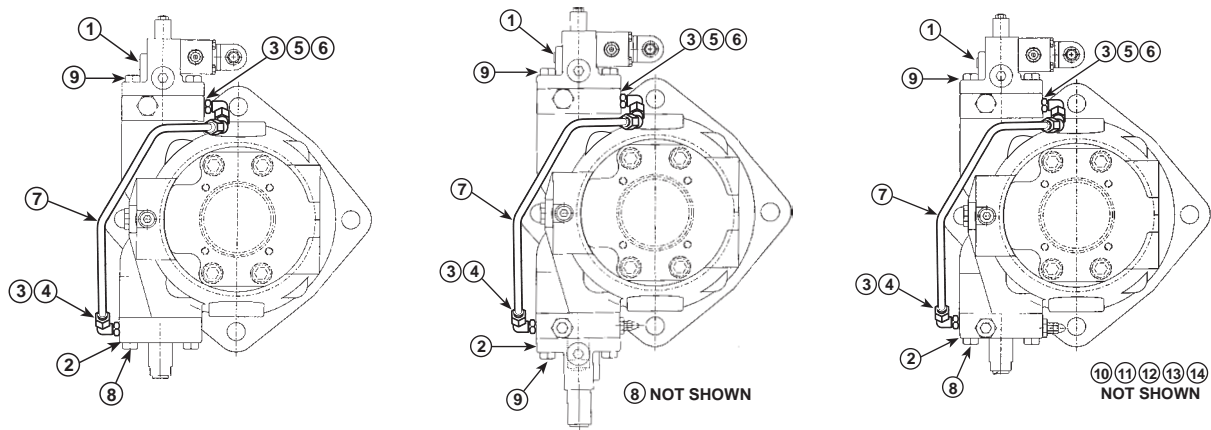
P16 buck-up cap S22-12970

ITEM	DESCRIPTION	P09		P16	
		PART NO.	QTY.	PART NO.	QTY.
1	Piston	324-26448	1	324-24048	1
2a	Spring	032-92244	1	032-91273	1
2b	Spring (P09 only)	032-92316	1		
3	Sleeve	032-92247	1	032-91344	1
4	Control Cap	032-92248	1	032-91266	1
5	O-Ring	691-00920	1	691-00916	1
6	Plug	488-35019	1	488-35024	1
7	Avseal Plug	447-00026	1	447-00026	1

ELECTRIC STROKER



CCW ROTATION



E10

E1J – E1K

E1P

CW ROTATION

ELECTRIC STROKER

parts list

ITEM	DESCRIPTION	P09	P16	QUANTITY			
		PART NO.	PART NO.	E10	E1J	E1K	E1P
1	Electric Stroker (Fig. 5)	S22-15305	S22-15305	1	1	1	1
2	Control Cap (Fig. 7)	S22-15256	S22-15256	1	—	—	—
	Low Torque Override (Fig. 8)	S22-15734	S22-15532	—	1	—	—
	High Torque Override (Fig. 8)	S22-15532	S22-15534	—	—	1	—
	Comp. Override (Fig. 10)	S22-15530	S22-15530	—	—	—	1
3	O-Ring, 90 S-1 ARP 906	691-00906	691-00906	2	2	2	2
4	Elbow	492-15017	492-15017	1	1	1	1
5	Elbow	498-00050	498-00050	1	1	1	1
6	45° Swivel Nut Ell	492-15190	492-15190	1	1	1	1
7	Tube	032-91887	032-92189	1	1	1	1
8	Screw-H.H.C., M12 x 60 mm	363-12210	363-12210	6	4	4	6
9	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	2	4	4	2
10	Control Piston	032-91881	032-91785	1	1	1	1
11	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
12	O-Ring, 70 S-1 ARP 152	671-00152	671-00152	2	2	2	2
13	Piston Ring	032-91261	032-91261	1	1	1	1
14	Piston Ring	032-91811	032-91811	1	1	1	1

ELECTRIC STROKER
DISASSEMBLY

1. **See Figure 5.** 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 6.** Remove tube lines to cap assembly.
6. Remove screws holding cap assembly to pump body.
7. Remove cap assembly (1). Remove plug (3) with attached parts. Remove spring (8) and spool (4).
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 (14) and nut (15). Push a rod through the cap to remove the retainer (12).

ASSEMBLY

1. **See Figure 6.** Install Avseal plug (6) in cap.
2. Install spool (4) into bore as shown. Install spring (8) over end of spool.
3. Install O-ring (13) on spring retainer (12). Install retainer (12), screw (14), and nut (15) in plug (3).
4. Install O-rings (7) and (16) on plug (3). Install plugs (3) and (9) in body (1). Torque plugs to 75 lb.·ft., 102 N m. Install O-ring (8) in cap.
5. Turn screw (15) in until spring retainer (12) contacts spring (8). Turn an additional 1-1/2 turns and lock in position.
6. Note proper location for control on pump. 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 5.** Apply Loctite 242 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 stroke, dimension for the P16 must be .45 +/- .03 in., 11,4 +/- 0,76 mm, dimension for the P09 must be .655 +/- .03 in., 16,6 +/- 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 Loctite 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 max.
15. Assemble all other components into body (16) per above drawing. Torque the plug (12) to 75 lb.·ft., 102 N m.
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.

TEST AND ADJUSTMENT

1. Plumb 1200 PSI, 82,8 bar servo supply to control. Supply 1200 PSI, 82,8 bar to the electric stroker servo supply port. **Note:** All pressure references are "above case pressure" (25 psi, 1,7 bar max.).
2. Thread zero screw (24) so that pump is on stroke.
3. Place a gage in the proportional valve gage port.
4. Start pump.

5. Adjust amperage (100-150 mA) to give 50 PSI, 34,5 bar reading on the proportional valve gage port. Back out zero screw (24) and adjust screw (9) until output flow is at zero stroke position. Lock both adjustments in place.
6. Increase amperage to 315 mA for the P09, 335 mA for the P16. Pump should go to full stroke. Set max. volume screw on opposite control cap for full stroke. Gage in proportional valve gage port should read approximately 225 psi, 16 bar for the P09, 275 psi, 19 bar for the P16.
7. If pump fails to go towards full stroke, or fails to go towards zero stroke, differential pressure may be improperly adjusted. Re-adjust the screw (15 figure 6) out to go towards full or in to go towards zero flow.
8. Increase and decrease the amperage between 0 and 375 mA several times at approximately 500 PSI, 34,5 bar, 3000 PSI, 207 bar and 6000 PSI, 414 bar system pressure. Pump stroke should follow amperage smoothly and proportionally. Full to zero or zero to full stroke should be achieved in .7 second. Adjust amperage up to 275 mA from zero stroke, then adjust down from full stroke to 275 mA. The flows at the two 275 mA settings shall not vary more than 5 gpm, 18,9 L/m from each other.

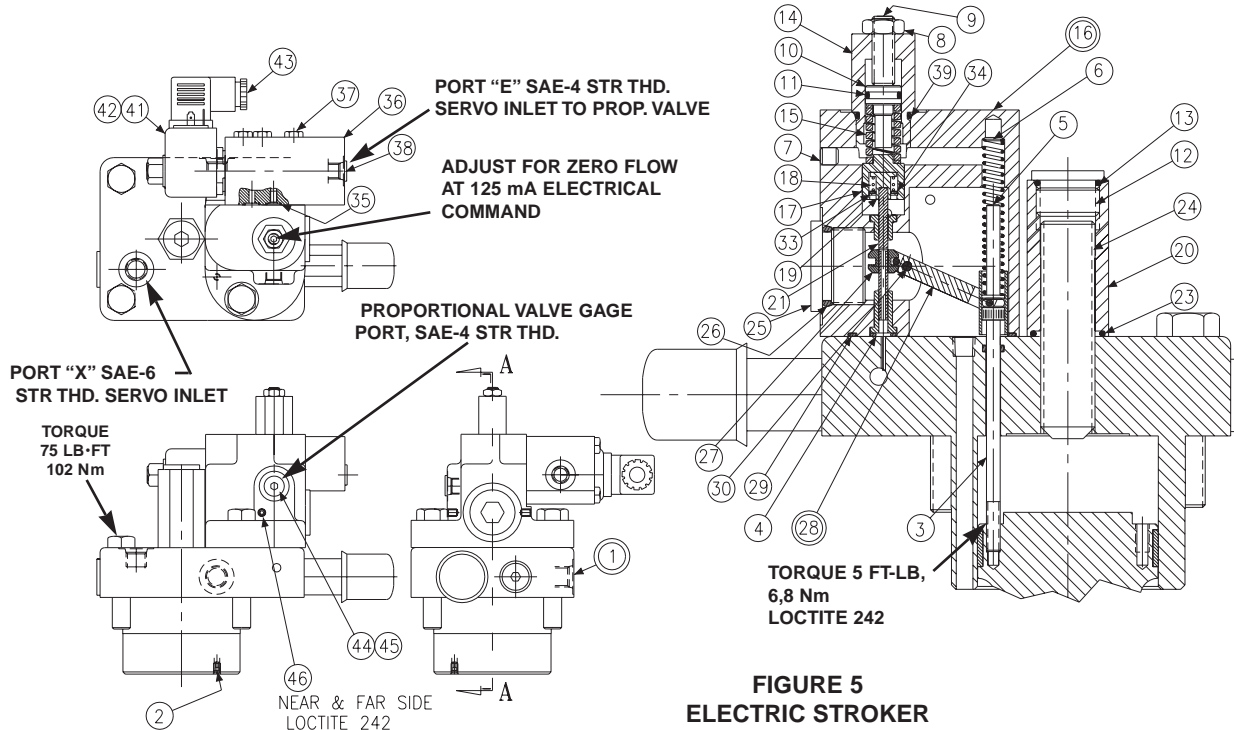


FIGURE 5
ELECTRIC STROKER

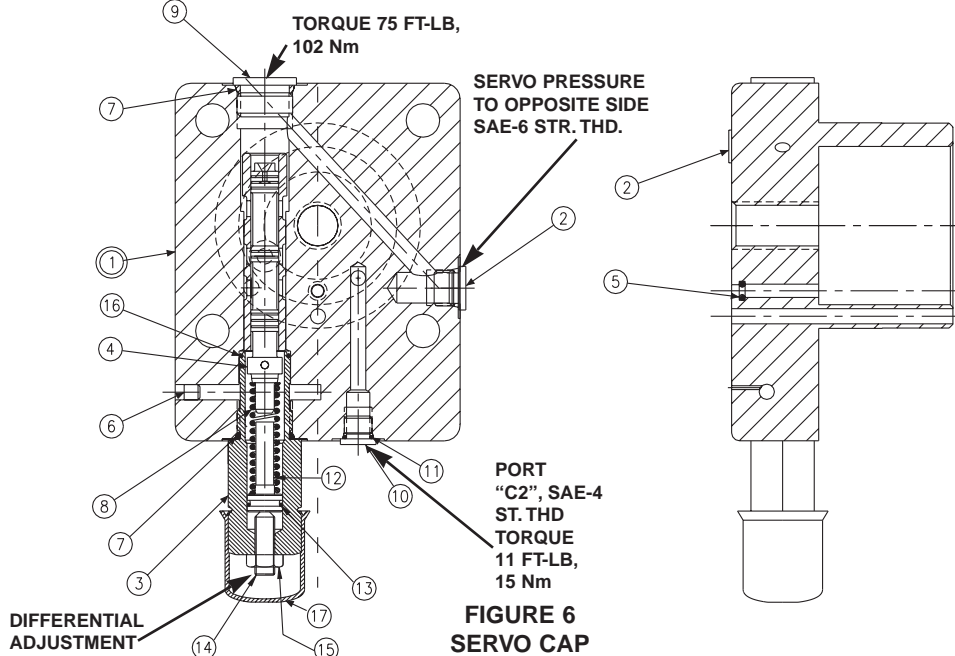


FIGURE 6
SERVO CAP

ELECTRIC STROKER

PARTS LIST FOR FIGURE 5

electric stroker S22-15305

ITEM	DESCRIPTION	PART NO.	QTY.
1	Cap (Figure 6)	S22-15262	1
2	Orifice	032-92399	1
3	Screw	032-91461	1
4	O-Ring, 70 S-1 ARP 010	671-00010	1
5	Clevis pin	321-40000	1
6	Spring, Compression	032-92100	1
7	Plug, Avseal	447-00026	1
8	Nut, 5/16-24	335-13100	1
9	Soc. Setscrew, 5/16-24 x 1-1/4	312-13180	1
10	Seal Piston	032-91918	1
11	O-Ring, 90 S-1 ARP 012	691-00012	1
12	Plug, 10HP5N-S	488-35055	1
13	O-Ring, 90 S-1 ARP 910	691-00910	1
14	Spring Cap	032-91511	1
15	Spring	225-92101	1
16	Body	S22-15393	1
17	Spool	032-91512	1
18	Spring	225-92109	1
19	Spring Retainer	032-91516	1
20	Nut, 3/4-10	031-91049	1
21	Spool	032-91438	1
23	O-Ring, 70 S-1 ARP 118	671-00118	1
24	Soc. Setscrew, 3/4-10 x 3	311-26320	1
25	Plug, 12 HP5N-S	488-35014	1
26	O-Ring, 90 S-1 ARP 912	691-00912	1
27	Sleeve	032-91437	1
28	Arm assembly	S22-15520	1
29	O-Ring, 70 S-1 ARP 035	671-00035	1
30	Dowel Pin, 1/8 Dia x 1.75 Lg.	324-20828	1
33	Ret. Ring	356-30037	1
34	Washer	032-91517	1
35	O-Ring, 70 S-1 ARP 011	671-00011	2
36	Block	032-91509	1
37	Screw, 1/4-20 x 2-1/4	306-40187	3
38	Plug, aluminum, 7/16-20	449-00013	1
39	O-Ring, 90 S-1 ARP 908	691-00908	1
41	Prop. Pr. Cont. Valve	517-00095	1
42	Coil, 24VDC	517-00096	1
	Coil, 12VDC	517-00097	
43	Connector	167-01008-8	1
44	O-Ring, 90 S-1 ARP 904	691-00904	1
45	Plug, SAE-4	488-35061	1
46	Screw, SHC 10-32 x 1/4	312-09041	2

PARTS LIST FOR FIGURE 6

servo cap S22-15262

ITEM	DESCRIPTION	PART NO.	QTY.
1	Cap/Sleeve	S22-15260	1
2	Plug	449-00015	2
3	Plug	032-91861	1
4	Spool	032-59482	1
5	O-Ring, 70 S-1 ARP 008	671-00008	1
6	Avseal Plug	447-00026	1
7	O-Ring, 90 S-1 ARP 910	691-00910	2
8	Spring	032-91863	1
9	Plug, SAE -10	488-35055	1
10	Plug, SAE -4	488-35061	1
11	O-ring, 90 S-1 ARP 904	691-00904	1
12	Spring retainer	032-91862	1
13	O-Ring, 90 S-1 ARP 013	691-00013	1
14	Screw, 5/16 -24 x 1	312-13160	1
15	Nut, 5/16-24	335-13100	1
16	O-Ring, 90 S-1 ARP 017	691-00017	1
17	Cap	449-00612	1

CONTROL CAP DISASSEMBLY

1. See Figure 7. Remove cover (5) and Max. volume screw (4).
2. Remove 4 screws holding cap to pump.
3. Remove cap assembly from pump.

ASSEMBLY

1. Install O-rings on interface between cap and pump control pad. Install cap on pump housing as indicated on the applicable view, guiding the control piston into the bore.
2. Torque the assembly bolts to 75 lb.•ft., 102 Nm.
3. Install screw (4) in cap. Install O-ring (3) on nut (5). Install nut (5) on screw.
3. Adjust screw till pump is slightly on stroke and lock nut (5).
4. Install O-ring (7) on plug (6). Install plug in nut (5). Torque plug (6) to 46 lb.•ft., 62 Nm.

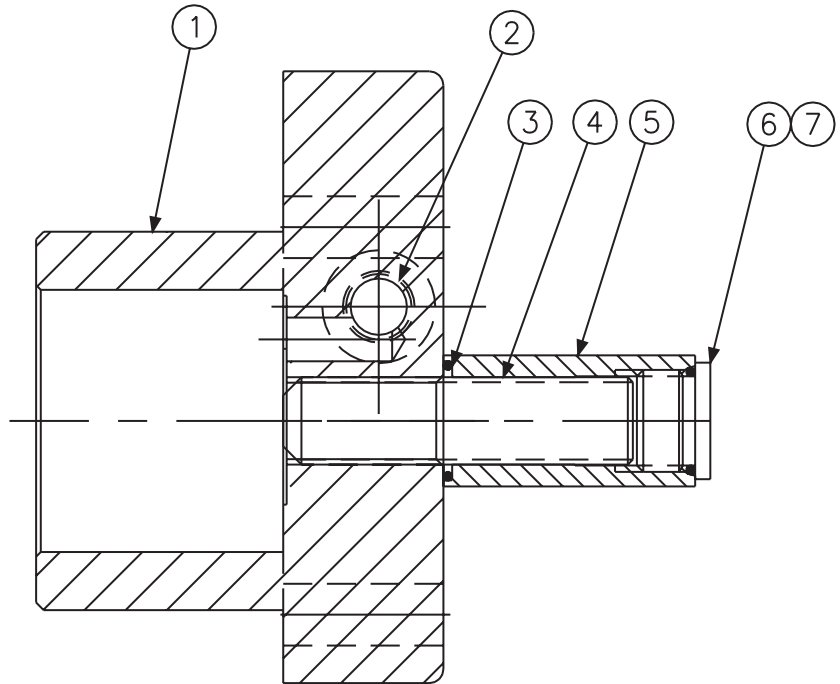


FIGURE 7
CONTROL CAP ASSEMBLY

PARTS LIST FOR FIGURE 7
control cap assembly S22-15256

ITEM	DESCRIPTION	PART NO.	QTY.
1	Control Cap	032-91764	1
2	Plug	449-00015	1
3	O-ring, 70 S-1 ARP 118	671-00118	1
4	Screw, 3/4-10 x 3	311-26320	1
5	Nut	031-91049	1
6	Plug	488-35055	1
7	O-ring 90 S-1 ARP 910	691-00910	1

TORQUE LIMITER OVERRIDE DISASSEMBLY

1. **See figure 8.** 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 9.** Remove maximum volume stop assembly (items 19, 20, 21, 22, 27).
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

1. **See figure 9.** Install Avseal plugs (9) and orifice (32).
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 (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 acorn nut (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 adj. plug (2), screw (25), nut (4), and acorn nut (25).
6. Install plug (12) and torque to 75 lb.·ft., 102 Nm. Install plug (21). Torque to 46 lb.·ft., 62 Nm.
7. Carefully install O-ring (31) into the cap.
8. Note proper location for cap. 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 (20), cover (19), O-ring (30) and plug (29) with O-ring (24).
10. **See figure 8.** Apply Loctite 242 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 stroke, dimension for the P16 must be .45 +/- .03 in., 11,4 +/- 0,76 mm, dimension for the P09 must be .655 +/- .03 in., 16,6 +/- 0,76 mm.
12. Press dowel (30) into body (16), through the link assembly (28), to 1/4", 6,35 mm below surface. Apply Loctite 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) to 46 lb.·ft., 62 Nm.
15. While spring retainer is engaging screw (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.

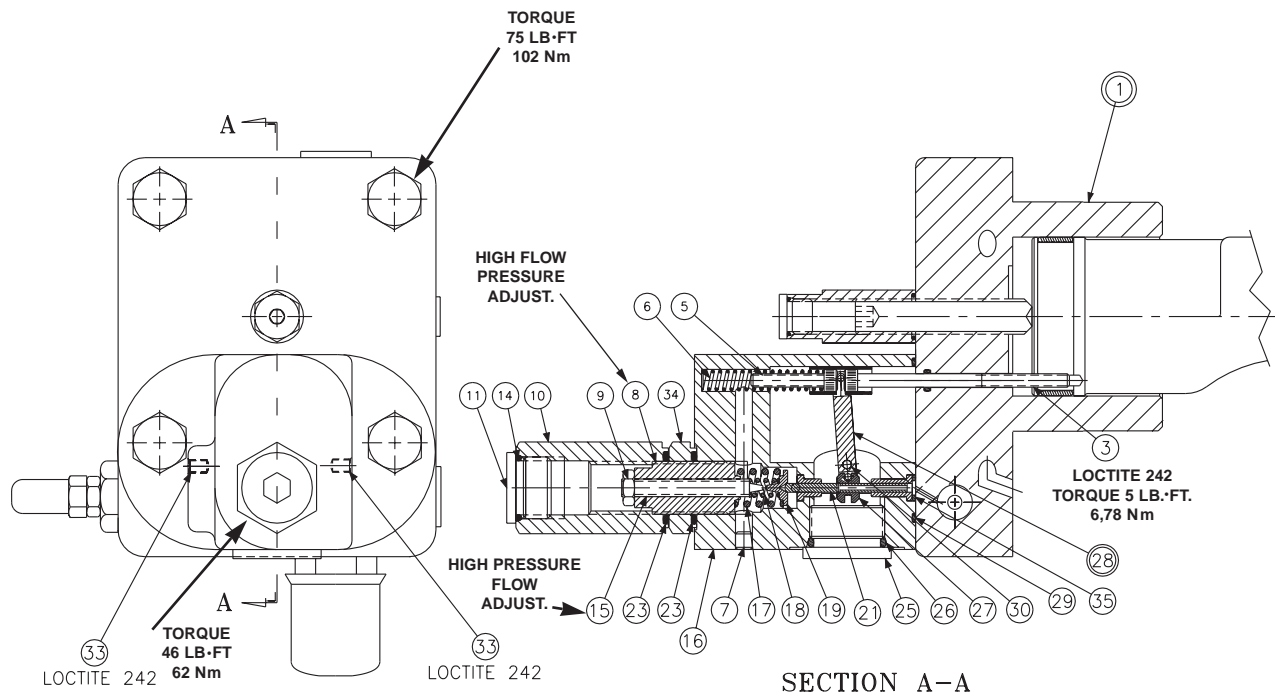


FIGURE 8
TORQUE LIMITER OVERRIDE

PARTS LIST FOR FIGURE 8

torque limiter override
P09 code J S22-15734
P09 code K S22-15532
P16 code J S22-15532
P16 code K S22-15534

ITEM	DESCRIPTION	P09	P16	QTY.	
		PART NO.	PART NO.	**J	**K
1	Cap (Figure 9)	S22-15274	S22-15274	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 Adjust	032-91446	032-91446	1	1
16	Body assembly	S22-15397	S22-15397	1	1
17	Outer Spring – J Version	032-91440	032-91440	1	—
	Outer Spring – K Version	032-91440	032-91448	—	1
18	Inner Spring – J Version	032-92240	032-91441	1	—
	Inner Spring – K Version	032-91441	032-91447	—	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 1.75 Lg..	324-20828	324-20828	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

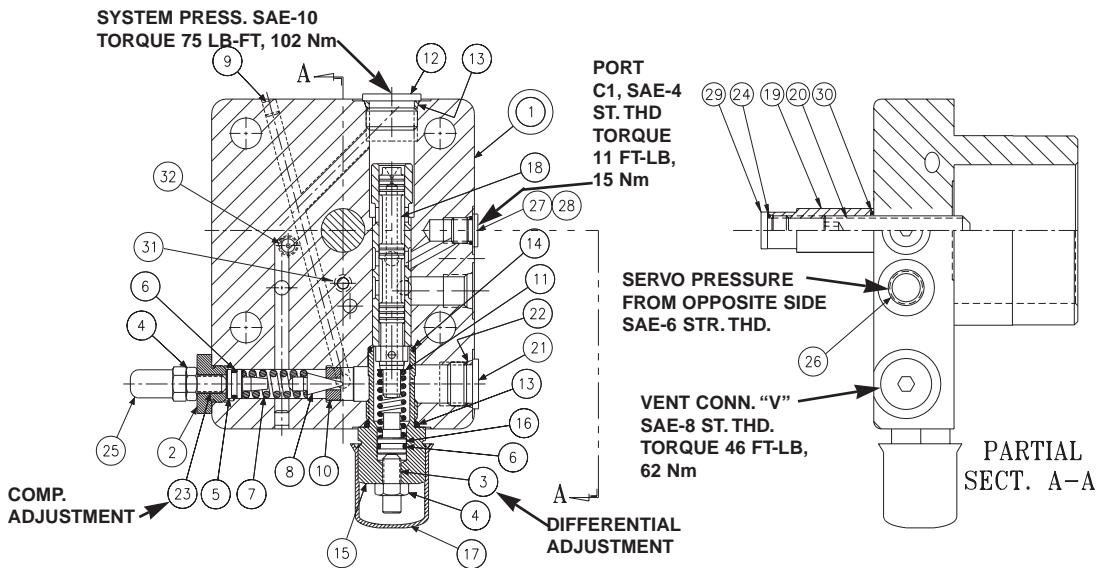


FIGURE 9
TORQUE LIMITER OVERRIDE CAP

PARTS LIST FOR FIGURE 9,
torque limiter override cap S22-15274

ITEM	DESCRIPTION	PART NO.	QTY.
1	Cap-Sleeve Assembly	S22-15279	1
2	Adj. Plug	032-91814	1
3	Soc. Setscrew 5/16-24 x 1	312-13160	1
4	Nut, 5/16-24	335-13100	2
5	Seal Piston	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2
7	Spring	032-91798	1
8	Cone	036-12288	1
9	Avseal Plug	447-00026	2
10	Seat	036-11692	1
11	Spring	033-71086	1
12	Plug, SAE -10	488-35055	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2
14	O-Ring, 90 S-1 ARP 017	691-00017	1
15	Plug	031-57368	1
16	Seal Piston	032-91305	1
17	Cap	449-00612	1
18	Spool	032-91820	1
19	Cover	032-91761	1
20	Screw, 1/2-20 x 2-1/2	312-35060	1
21	Plug, SAE -8	488-35018	1
22	O-ring 90 S-1 ARP 908	691-00908	1
23	Soc. Setscrew 5/16-24 x 1-1/4	312-13180	1
24	O-Ring, 90 S-1 ARP 905	671-00905	1
25	Acorn Nut	036-33474	1
26	Plug	449-00015	1
27	Plug, SAE -4	488-35061	1
28	O-ring, 90 S-1 ARP 904	691-00904	
29	Plug, SAE -5	488-35020	1
30	O-Ring, 70 S-1 ARP 015	691-00015	1
31	O-Ring, 70 S-1 ARP 008	671-00008	1
32	Orifice	035-40489	1

TORQUE LIMITER OVERRIDE TEST AND ADJUSTMENT

1. Install gages on system pressure and on compensator vent ports.
2. Turn compensator adjustment screw out to remove spring load, then 1/2 turn in.
3. Turn differential adjustment screw out to remove spring load, then 1/2 turn in.
4. Back out maximum volume stop to full volume.
5. For setting and testing compensator override function, disable torque limiter in this manner: Back out primary adjusting screw (15) to remove all load. Turn in outer adjusting screw (8) to go solid. Caution! do not apply over 10 lb.*in., 1,2 Nm torque to avoid damage to internal parts!
6. Start prime mover with system relief set at 500 PSI., 35 bar.
7. Stroke pump to full displacement. Apply a load to the pump.
8. Increase system relief valve until compensator de-strokes pump to zero displacement. Set compensator to 1500 PSI, 103 bar.
9. Adjust compensator differential spool pressure to 200 PSI, 13,8 bar. This is accomplished by adjusting the differential screw until the difference in pressure readings between the system pressure and compensator vent gages installed in the compensator cap is 200 PSI, 9,3 bar. (It may be necessary to change differential to gain stability. Use caution when exceeding 250 PSI, 17 bar to avoid spring going solid, preventing compensator action.) When correct, lock in place and install cap on differential adjustment.
10. Set the compensator to 3000 PSI, 207 bar, 6000 PSI, 414 bar, and 7250 PSI, 500 bar. At each condition, increase the system pressure until the pump fully de-strokes. At no time should the system pressure vary more than 150 PSI, 10,3 bar from the compensator setting. The control should be steady and stable at all conditions.
11. Reduce pressure to 150 PSI, 10,3 bar below the compensator setting. Pump should return to full stroke. Repeat two or more times. Compensator setting should be repeatable.
12. Set compensator adjustment to at least 500 PSI, 34.5 bar above the required setting, or 7000 PSI, 483 bar.

Set the torque limiter by using the formula:

$$HP = P \cdot Q / (Eff. \cdot 1714)$$

where P = Pressure in PSI
Q = flow in GPM
Eff. = overall efficiency

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

where P = pressure in Bar
Q = flow in l/m
Eff. = overall efficiency

calculate these two values:

- a. System pressure at full pump flow.
 - b. Pump flow at full system pressure.
13. Set system relief valve to pressure (a) calculated above. Back out primary adjusting screw to remove all load. Set outer adjusting screw (8) so that pump just commences to de-stroke.
 14. Set the system relief valve to the required maximum system pressure. Set primary adjusting screw (15) to obtain the calculated flow (b) at full system pressure.
 15. Set compensator adjustment to the required setting, or 6000 PSI, 414 Bar if not otherwise noted.

Note: Electric motor current may be used instead of calculated flows to set power. In step 13, set the outer adjusting screw (8) to achieve the rated motor current. In step 14, set the adjustment (15) to achieve the rated motor current.

COMPENSATOR OVERRIDE DISASSEMBLY

1. **See Figure 10.** Remove tube line to cap.
2. Remove maximum volume stop assembly (items 12, 13, 19, 20, 24).
3. Remove cap assembly.
4. Remove plug (15) and attached parts. Remove spring (11) and spool (18).
5. Remove adj. 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

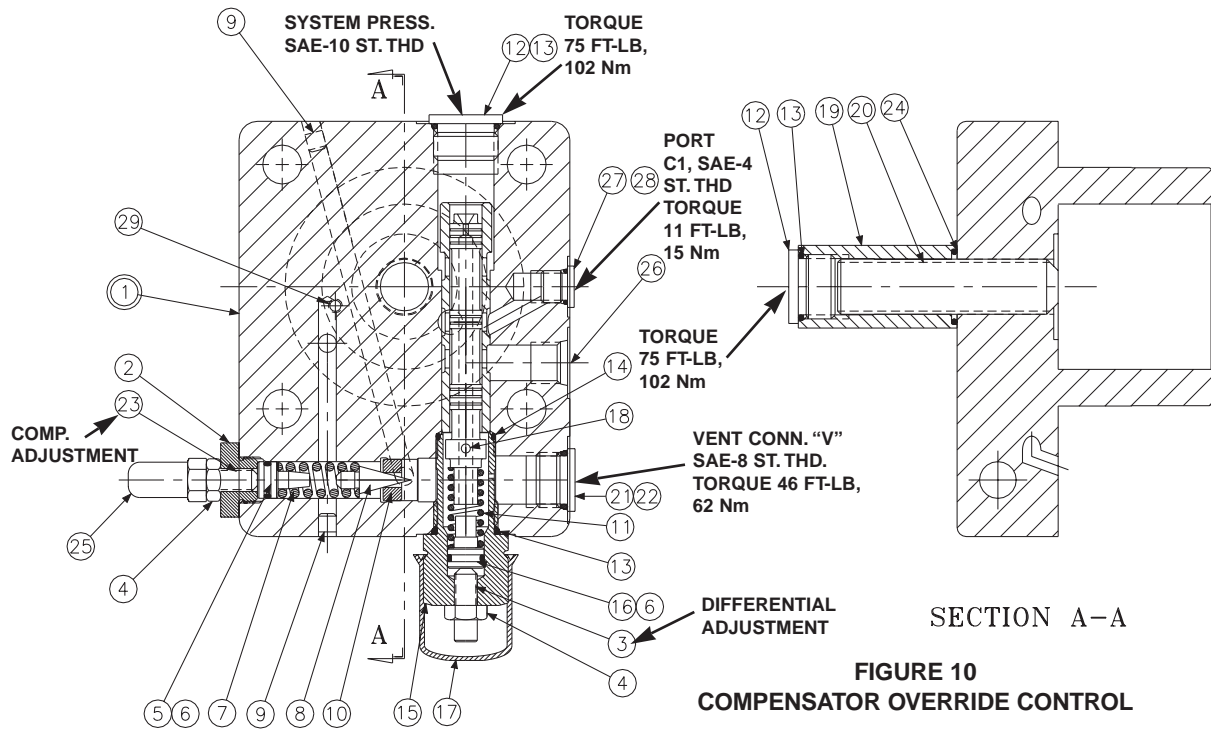
1. Install Avseal plugs (9) in body. Install orifice (29) in body.
2. Press seat (10) into bore to shoulder in bore.
3. Install spool (18) into bore as shown. Install spring (11) over end of spool. Install O-ring (6) on seal (16). Lubricate and install into plug (15). Install O-rings (13) and (14) on plug (15). Install plug (15) into cap. Install screw (3), nut (4) and acorn nut (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 plug (12) to 75 lb.·ft., 102 Nm. Torque plug (21) to 46 lb.·ft., 62 Nm.
7. Note proper location for cap on pump. 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 tube fitting and tube line connecting to opposite cap.

TEST AND ADJUSTMENT

Compensator is to be tested on pump. Adjust maximum volume stop to full displacement.

1. Install gages on system pressure and on compensator vent ports.
2. Turn compensator adjustment screw (23) CCW until there is no contact with spring, then adjust 1/2 turn CW after contact is made with spring.
3. Turn differential adjustment screw (3) CCW until there is no contact with spring, then adjust 1/2 turn CW after contact is made with spring.
4. Start prime mover with system relief valve set at 500 PSI, 35 bar. Apply a load to the pump.
5. Set pump control to full displacement. Pump should go to full displacement at 500 PSI, 35 bar.
6. Increase system relief valve until compensator de-strokes pump to zero displacement. Set compensator to 1500 PSI, 103 bar.
7. Adjust compensator differential spool pressure to 200 PSI, 13,8 bar. This is accomplished by adjusting the differential screw until the difference in pressure readings between the system pressure and compensator vent gages installed in the compensator cap is 200 PSI, 13,8 bar. (It may be necessary to change differential to gain stability. Use caution when exceeding 250 PSI, 17 bar to avoid spring going solid, preventing compensator action.) When correct, lock in place and install cap on differential adjustment.
8. Set the compensator to 3000 PSI, 207 bar, 6000 PSI, 414 bar, and 7250 PSI, 500 bar.
9. At each condition, increase the system pressure until the pump fully de-strokes. At no time should the system pressure vary more than 150 PSI, 10,3 bar from the compensator setting. The control should be steady and stable at all conditions.
10. Reduce pressure to 150 PSI, 10,3 bar below the compensator setting. Pump should return to full stroke. Repeat two or more times. Compensator setting should be repeatable.
11. Set compensator adjustment to the required setting, or 6000 PSI, 414 Bar if not otherwise noted.

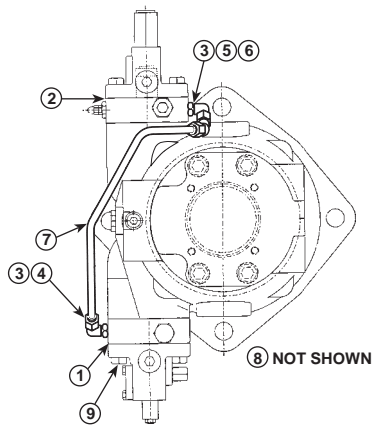
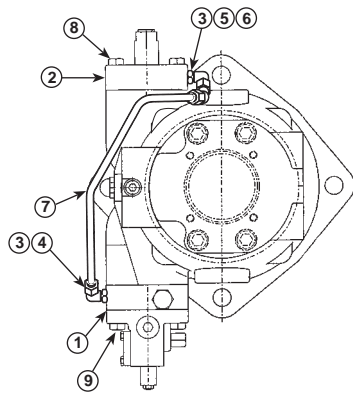
COMPENSATOR OVERRIDE



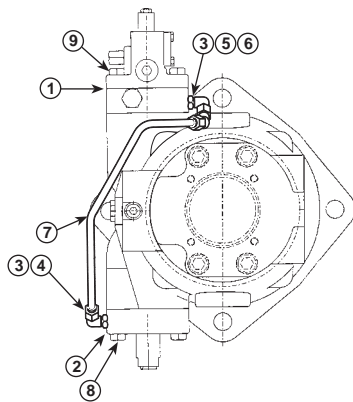
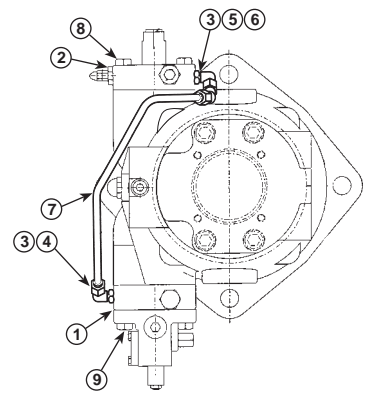
PARTS LIST FOR FIGURE 10
compensator override control
S22-15530

ITEM	DESCRIPTION	PART NO.	QTY.
1	Cap-Sleeve Assembly	S22-15261	1
2	Adj. Plug	032-91814	1
3	Soc. Setscrew 5/16-24 x 1	312-13160	1
4	Nut, 5/16-24	335-13100	2
5	Seal Piston	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2
7	Spring	032-91798	1
8	Cone	036-12288	1
9	Avseal Plug	447-00026	3
10	Seat	036-11692	1
11	Spring	033-71086	1
12	Plug, 10HP5N-S	488-35055	2
13	O-Ring, 90 S-1 ARP 910	691-00910	3
14	O-Ring, 90 S-1 ARP 017	691-00017	1
15	Plug	031-57368	1
16	Seal piston	032-91305	1
17	Cap	449-00612	1
18	Spool	032-91820	1
19	Cover	032-91049	1
20	Screw, 3/4-10 x 3	311-26320	1
21	Plug, SAE -8	488-35018	1
22	O-ring, 90 S-1 ARP 908	691-00908	1
23	Soc. Setscrew 5/16-24 x 1-1/4	312-13180	1
24	O-ring, 70 S-1 ARP 118	671-00118	1
25	Acorn Nut	036-33474	1
26	Plug	449-00015	1
27	Plug, SAE -4	488-35061	1
28	O-ring, 90 S-1 ARP 904	691-00904	1
29	Orifice	035-40489	1

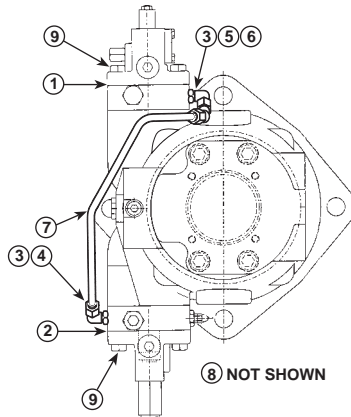
HYDRAULIC STROKER



CCW ROTATION

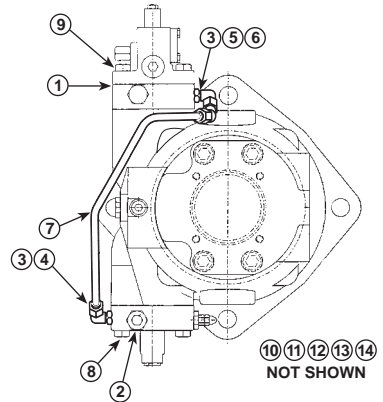


H10



H1J – H1K

CW ROTATION



H1P

HYDRAULIC STROKER

parts list

ITEM	DESCRIPTION	P09	P16	QUANTITY			
		PART NO.	PART NO.	H10	H1J	H1K	H1P
1	Hydraulic Stroker (Fig. 11)	S22-15307	S22-15307	1	1	1	1
2	Control Cap (Fig. 7)	S22-15256	S22-15256	1	—	—	—
	Low Torque Override (Fig. 8)	S22-15734	S22-15532	—	1	—	—
	High Torque Override (Fig. 8)	S22-15532	S22-15534	—	—	1	—
	Comp. Override (Fig. 10)	S22-15530	S22-15530	—	—	—	1
3	O-Ring, 90 S-1 ARP 906	691-00906	691-00906	2	2	2	2
4	Elbow	492-15017	492-15017	1	1	1	1
5	Elbow	498-00050	498-00050	1	1	1	1
6	45° Swivel Nut Ell	492-15190	492-15190	1	1	1	1
7	Tube	032-91887	032-92189	1	1	1	1
8	Screw-H.H.C., M12 x 60 mm	363-12210	363-12210	6	4	4	6
9	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	2	4	4	2
10	Control Piston	032-91881	032-91785	1	1	1	1
11	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
12	O-Ring, 70 S-1 ARP 152	671-00152	671-00152	2	2	2	2
13	Piston Ring	032-91261	032-91261	1	1	1	1
14	Piston Ring	032-91811	032-91811	1	1	1	1

HYDRAULIC STROKER DISASSEMBLY

1. **See figure 11.** 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 6.** Remove tube lines to cap assembly.
5. Remove screws holding cap assembly to pump body.
6. Remove cap assembly (1). Remove plug (3) with attached parts. Remove spring (12) and spool (4).
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 (14) and nut (15). Push a rod through the cap to remove the retainer (12).

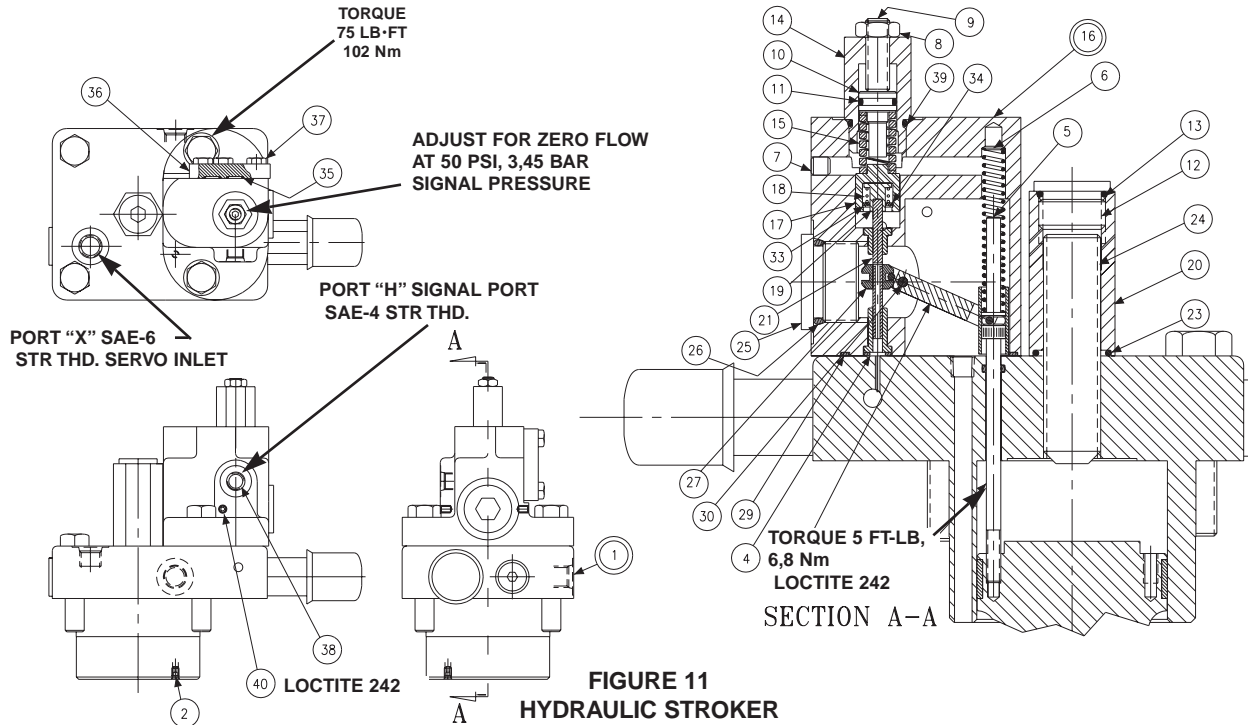
ASSEMBLY

1. **See figure 6.** Install Avseal plug (6) in cap.
2. Install spool (4) into bore as shown. Install spring (8) over end of spool.
3. Install O-ring (13) on spring retainer (12). Install retainer (12), screw (14), and nut (15) in plug (3).
4. Install O-rings (7) and (16) on plug (3). Install plugs (3) and (9) in body (1). Torque plugs to 75 lb.·ft., 102 Nm. Install O-ring (5) in cap.
5. Turn screw (14) in until spring retainer (12) contacts spring (8). Turn an additional 1-1/2 turns and lock in position.
6. Note proper location for control on pump. 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 11.** Apply Loctite 242 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 stroke, dimension for the P16 must be .45 +/- .03 in., 11,4 +/- 0,76 mm, dimension for the P09 must be .655 +/- .03 in., 16,6 +/- 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 Loctite 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) to 75 lb.·ft., 102 Nm.
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.

TEST AND ADJUSTMENT

1. Plumb 1200 PSI, 82,8 bar servo supply to control port "X".
2. Supply signal pressure to hydraulic stroker control port "H".
3. Thread zero screw (24) so that pump is on stroke.
4. Start pump.
6. Set signal pressure to 50 PSI, 3,45 bar. Back out zero screw (24) and adjust screw (9) until pump is at zero stroke. Lock both in place.
7. Slowly increase and decrease signal pressure between 0 and 275 PSI, 19 bar several times at approximately 500 PSI, 34,5 bar, 3000 PSI, 207 bar, and 6000 PSI, 414 bar system pressure. Pump stroke should follow control pressure smoothly and proportionally. Rapidly adjust signal pressure between 0 and 275 PSI, 19 bar Full to zero or zero to full stroke should be achieved in no more than 0,7 second. Full stroke should be achieved at 225 psi, 16 bar for the P09, and 275 psi, 19 bar for the P16. Zero stroke should be achieved at 50 +/- 10 PSI, 3,45 +/- 0,7 bar. Adjust signal pressure up to 175 PSI, 12 bar from zero stroke, then adjust down from full stroke to 175 PSI, 12 bar. The flows at the two settings shall not vary more than 4 GPM, 15 L/m from each other. When all adjustments are correct, lock in place and install cap on differential adjustment.

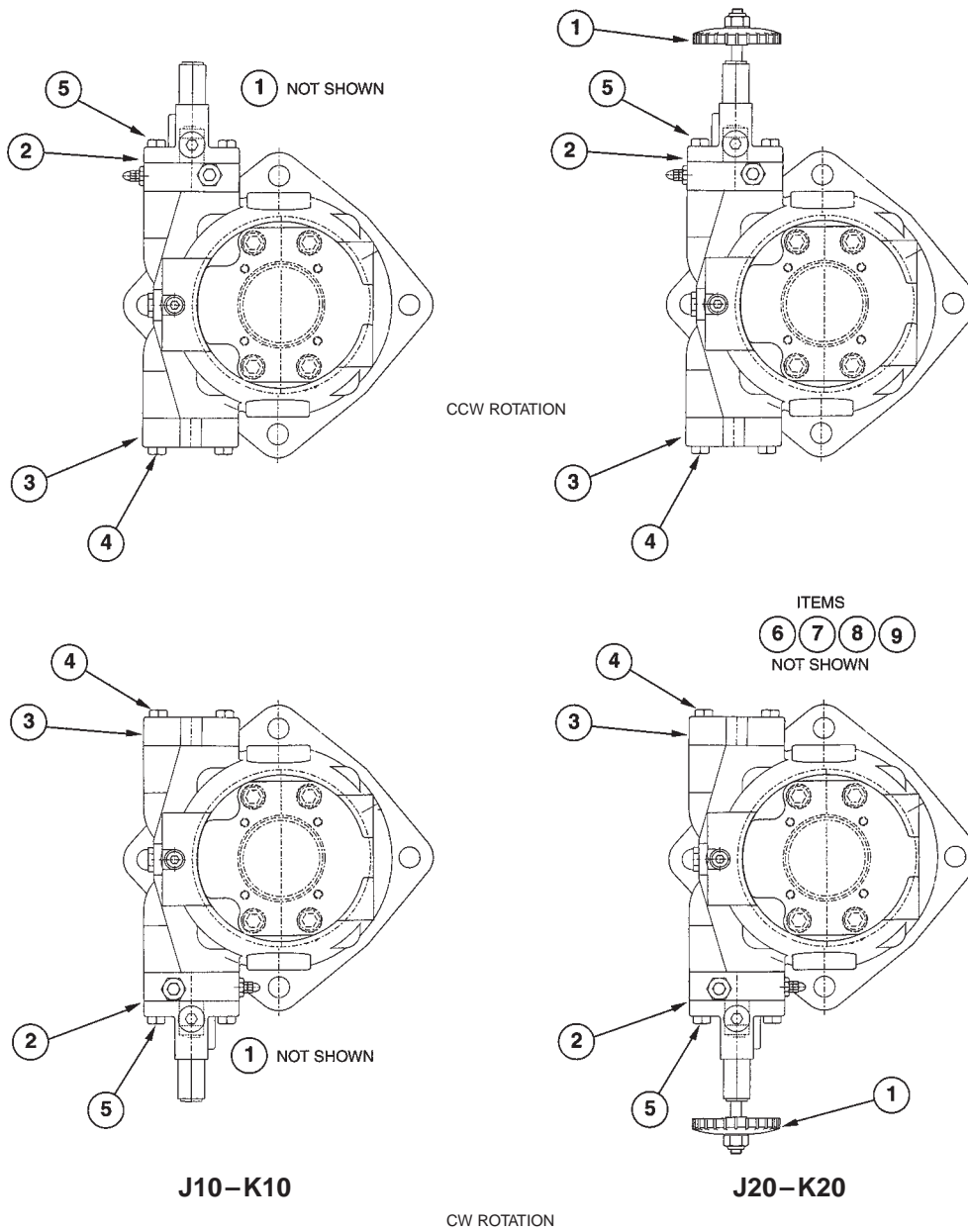
Note: All pressure references are "above case pressure" (25 psi, 1,7 bar max)



PARTS LIST FOR FIGURE 11
hydraulic stroker S22-15307

ITEM	DESCRIPTION	PART NO.	QTY.
1	Cap (Figure 6)	S22-15262	1
2	Orifice	032-92399	1
3	Screw	032-91461	1
4	O-Ring, 70 S-1 ARP 010	671-00010	1
5	Clevis pin	321-40000	1
6	Spring, Compression	032-92100	1
7	Plug, Avseal	447-00026	1
8	Nut, 5/16-24	335-13100	1
9	Soc. Setscrew, 5/16-24 x 1-1/4	312-13180	1
10	Seal Piston	032-91918	1
11	O-Ring, 90 S-1 ARP 012	691-00012	1
12	Plug, 10HP5N-S	488-35055	1
13	O-Ring, 90 S-1 ARP 910	691-00910	1
14	Spring Cap	032-91511	1
15	Spring	225-92101	1
16	Body	S22-15393	1
17	Spool	032-91512	1
18	Spring	225-92109	1
19	Spring Retainer	032-91516	1
20	Nut, 3/4-10	031-91049	1
21	Spool	032-91438	1
23	O-Ring, 70 S-1 ARP 118	671-00118	1
24	Soc. Setscrew, 3/4-10 x 3	311-26320	1
25	Plug, 12 HP5N-S	488-35014	1
26	O-Ring, 90 S-1 ARP 912	691-00912	1
27	Sleeve	032-91437	1
28	Arm assembly	S22-15520	1
29	O-Ring, 70 S-1 ARP 035	671-00035	1
30	Dowel Pin, 1/8 Dia x 1.75 Lg.	324-20828	1
33	Ret. Ring	356-30037	1
34	Washer	032-91517	1
35	O-Ring, 70 S-1 ARP 011	671-00011	2
36	Plate	032-91510	1
37	Screw, HHC, 1/4-20 x 3/4	306-40142	3
38	Plug, aluminum 7/16-20	449-00013	1
39	O-Ring, 90 S-1 ARP 908	691-00908	1
40	Screw, SHC 10-32 x 1/4	312-09041	2

TORQUE LIMITER



TORQUE LIMITER

PARTS LIST

torque limiter

ITEM	DESCRIPTION	P09	P16	QUANTITY			
		PART NO	PART NO.	J10	K10	J20	K20
1	Max. Vol. Stop (Fig. 1)	S22-12983	S22-12983	1	1	—	—
	Max Vol. Handwheel (Fig. 2)	S22-12915	S22-12915	—	—	1	1
2	Low Torque Limiter (Fig. 12)	S22-15732	S22-15313	1	—	1	—
	High Torque Limiter (Fig. 12)	S22-15313	S22-15315	—	1	—	1
3	Buck Up Cap (Fig. 4)	S22-15653	S22-12970	1	1	1	1
4	Screw-H.H.C., M12 x 60 mm	363-12210	363-12210	6	6	4	4
5	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	2	2	4	4
6	Control Piston	032-91585	032-91443	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 152	671-00152	671-00152	2	2	2	2
9	Piston ring	032-91261	032-91261	2	2	2	2

TORQUE LIMITER DISASSEMBLY

1. **See Figure 12.** 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 13.** 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

1. **See Figure 13.** Install Avseal plugs (9) and 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 (16). Lubricate and install into plug (15). Install plug (15) into cap. Install screw (3), nut (4) and acorn nut (17). Install plug (12). Torque plugs to 75 lb.·ft., 102 Nm. Install plug (21). Torque to 46 lb.·ft., 62 Nm. Install plug (28). Torque to 11 lb.·ft., 15 Nm.
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 adj. 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. 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 12.** Apply Loctite 242 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 stroke, 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 Loctite 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.

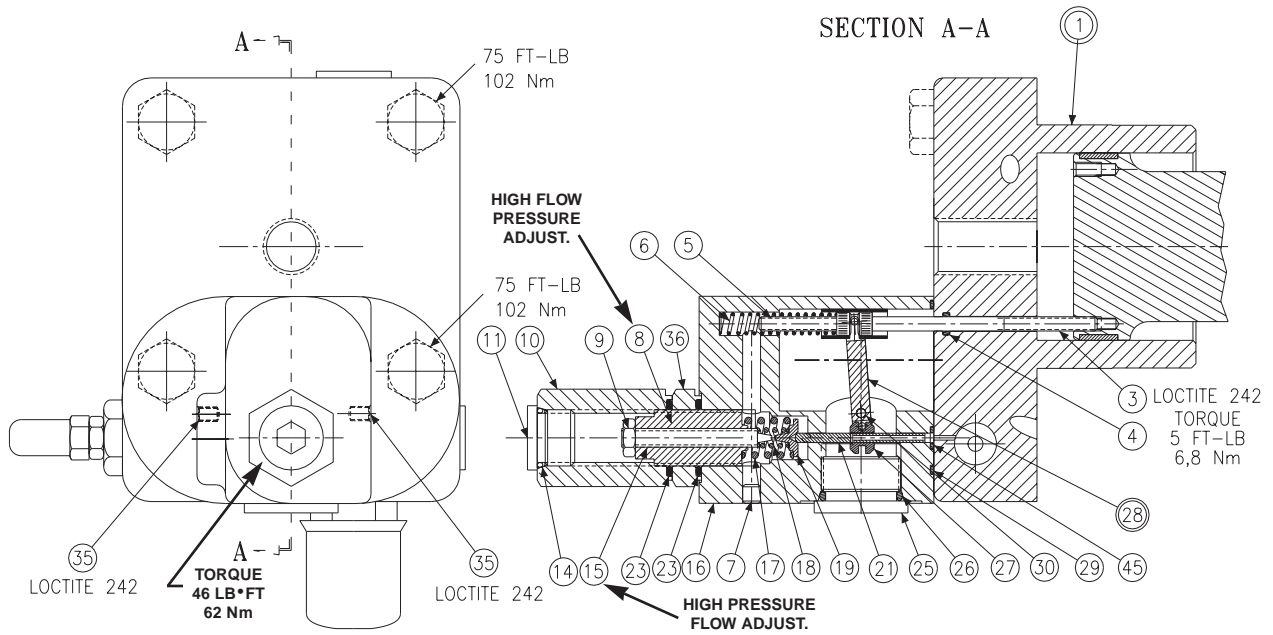


FIGURE 12 – TORQUE LIMITER ASSEMBLY

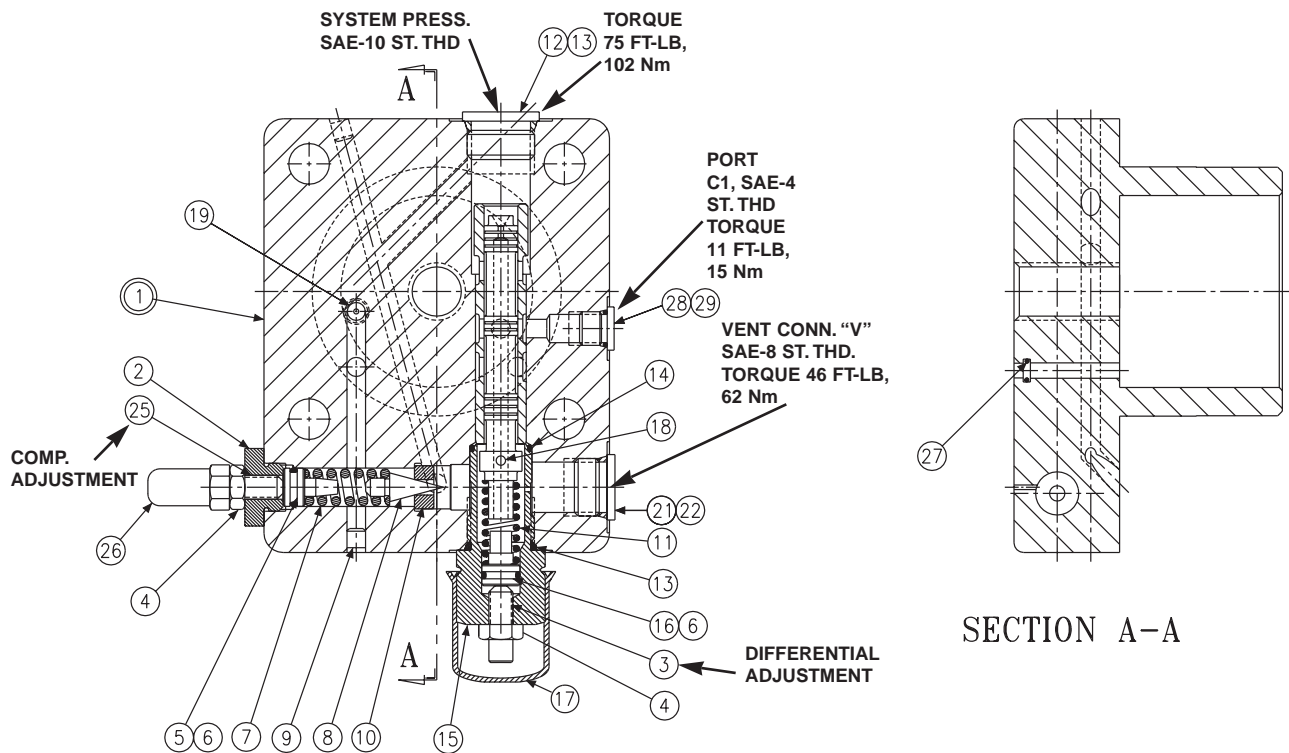


FIGURE 13
TORQUE LIMITER CAP

TORQUE LIMITER

PARTS LIST FOR FIG. 12

P09 code J, S22-15732

P09 code K, S22-15313

P16 code J, S22-15313

P16 code K, S22-15315

ITEM	DESCRIPTION	P09	P16	QTY.	
		PART NO.	PART NO.	J	K
1	Cap (Figure 9)	S22-12913	S22-12913	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 Adjust	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	032-91448	—	1
18	Inner Spring – J Version	032-92240	032-91441	1	—
	Inner Spring – K Version	032-91441	032-91447	—	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 1.75 Lg.	324-20828	324-20828	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

PARTS LIST FOR FIGURE 13

torque limiter cap S22-12913

ITEM	DESCRIPTION	PART NO.	QTY.
1	Cap-Sleeve Assembly	S22-12912	1
2	Adj. Plug	032-91814	1
3	Soc. Setscrew 5/16-24 x 1	312-13160	1
4	Nut, 5/16-24	335-13100	2
5	Seal Piston	031-59367	1
6	O-Ring, 90 S-1 ARP 012	691-00012	2
7	Spring	032-91798	1
8	Cone	036-12288	1
9	Avseal Plug	447-00026	2
10	Seat	036-11692	1
11	Spring	033-71086	1
12	Plug, SAE-10	488-35055	1
13	O-Ring, 90 S-1 ARP 910	691-00910	2
14	O-Ring, 90 S-1 ARP 017	691-00017	1
15	Plug	031-57368	1
16	Seal Piston	032-91305	1
17	Cap	449-00612	1
18	Spool	032-59482	1
19	Orifice	033-25528	1
21	Plug SAE-8	488-35018	1
22	O-ring, 70 S-1 ARP 908	691-00908	1
25	Soc. Setscrew 5/16-24 x 1-1/4	312-13180	1
26	Nut, Acorn 5/16-24	036-33474	1
27	O-Ring, 70 S-1 ARP 008	671-00008	1
28	Plug, SAE-4	488-35061	1
29	O-ring 90 S-1 ARP 904	691-00904	1

TORQUE LIMITER TEST AND ADJUSTMENT

1. Install gages on system pressure and on compensator vent ports.
2. Turn compensator adjustment screw out to remove spring load, then 1/2 turn in.
3. Turn differential adjustment screw out to remove spring load, then 1/2 turn in.
4. Back out maximum volume stop to full volume.
5. For setting and testing compensator override function, disable torque limiter in this manner: Back out primary adjusting screw (15) to remove all load. Turn in outer adjusting screw (8) to go solid. Caution! do not apply over 10 in.*lb., 1,2 Nm torque to avoid damage to internal parts!
6. Start prime mover with system relief set at 500 PSI, 35 bar. Apply a load to the pump.
7. Pump should be at full displacement at 500 PSI, 35 bar.
8. Increase system relief valve until compensator de-strokes pump to zero displacement. Set compensator to 1500 PSI, 103 bar.
9. Adjust compensator differential spool pressure to 200 PSI, 13,8 bar. This is accomplished by adjusting the differential screw until the difference in pressure readings between the system pressure and compensator vent gages installed in the compensator cap is 200 PSI, 13,8 bar.
10. Set the compensator to 3000 PSI, 207 bar, 6000 PSI, 414 bar, and 7250 PSI, 500 bar.
11. At each condition, increase the system pressure until the pump fully de-strokes. At no time should the system pressure vary more than 150 PSI, 10,3 bar from the compensator setting. The control should be steady and stable at all conditions.
12. Reduce pressure to 150 PSI, 10,3 bar below the compensator setting. Pump should return to full stroke. Repeat two or more times. Compensator setting should be repeatable.
13. Set compensator adjustment to at least 500 PSI, 34,5 bar above the required setting, or 7000 PSI, 483 bar.

Set the torque limiter by using the formula:

$$HP = P \cdot Q / (Eff. \cdot 1714)$$

where P = Pressure in PSI

Q = flow in GPM

Eff. = overall efficiency

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

where P = pressure in Bar

Q = flow in l/m

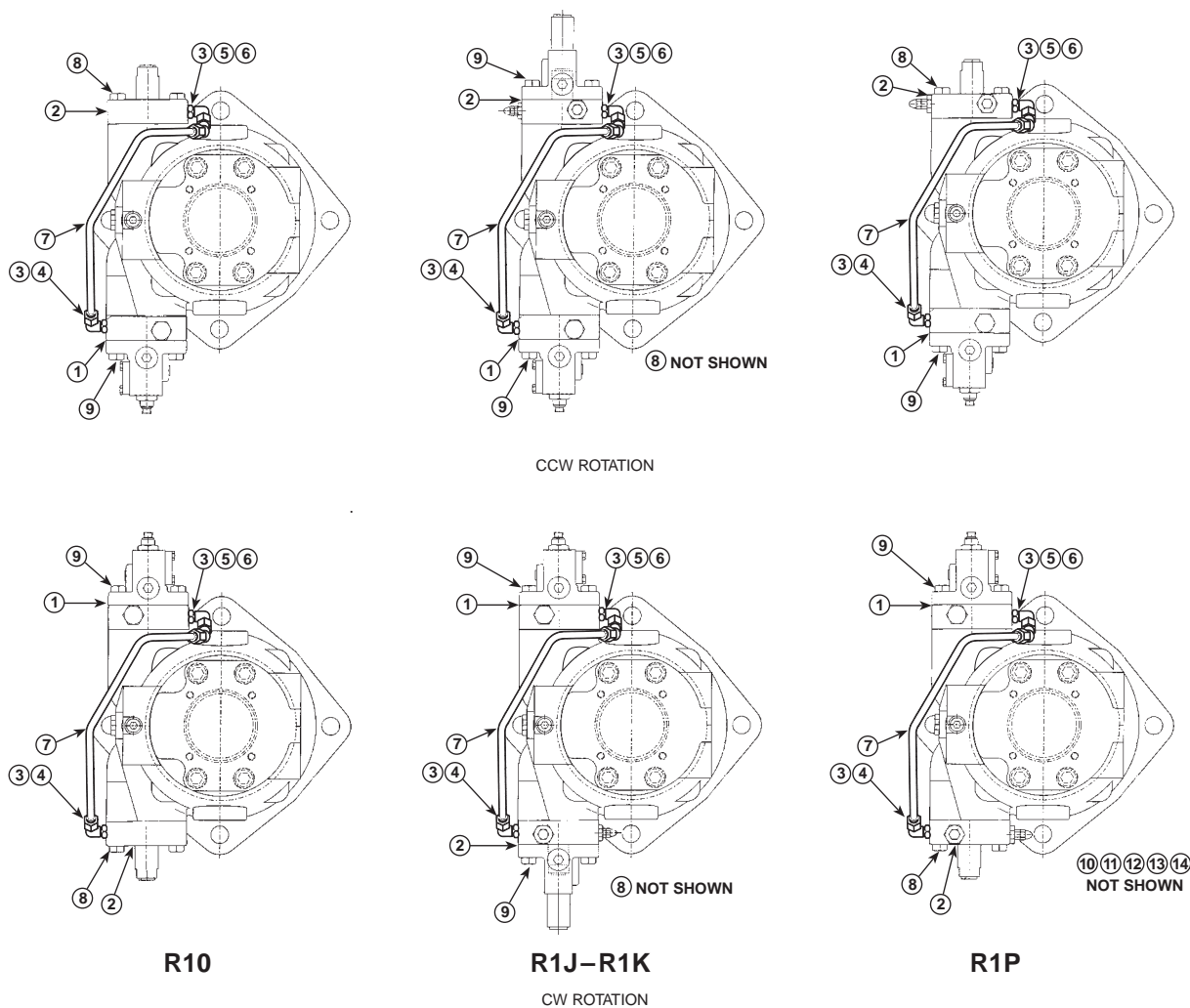
Eff. = overall efficiency

calculate these two values:

- a. System pressure at full pump flow.
 - b. Pump flow at full system pressure.
14. Set system relief valve to pressure (a) calculated above. Back out primary adjusting screw to remove all load. Set outer adjusting screw (8) so that pump just commences to de-stroke.
 15. Set the system relief valve to the required maximum system pressure. Set primary adjusting screw (15) to obtain the calculated flow (b) at full system pressure.
 16. Set compensator adjustment to the required setting, or 6000 PSI, 414 Bar if not otherwise noted.

Note: Electric motor current may be used instead of calculated flows to set power. In step 14, set the outer adjusting screw (8) to achieve the rated motor current. In step 15, set the adjustment (15) to achieve the rated motor current.

ROTARY SERVO



PARTS LIST

rotary servo

ITEM	DESCRIPTION	P09	P16	QUANTITY			
		PART NO.	PART NO.	R10	R1J	R1K	R1P
1	Rotary Servo (Fig. 14)	S22-15309	S22-15309	1	1	1	1
2	Control Cap (Fig. 7)	S22-15256	S22-15256	1	—	—	—
	Low Torque Override (Fig. 8)	S22-15734	S22-15532	—	1	—	—
	High Torque Override (Fig. 8)	S22-15532	S22-15534	—	—	1	—
	Comp. Override (Fig. 10)	S22-15530	S22-15530	—	—	—	1
3	O-Ring, 90 S-1 ARP 906	691-00906	691-00906	2	2	2	2
4	Elbow	492-15017	492-15017	1	1	1	1
5	Elbow	498-00050	498-00050	1	1	1	1
6	45° Swivel Nut Ell	492-15190	492-15190	1	1	1	1
7	Tube	032-91887	032-92189	1	1	1	1
8	Screw-H.H.C., M12 x 60 mm	363-12210	363-12210	6	4	4	6
9	Screw-H.H.C., M12 x 80 mm	363-12225	363-12225	2	4	4	2
10	Control Piston	032-91881	032-91785	1	1	1	1
11	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2	2	2
12	O-Ring, 70 S-1 ARP 152	671-00152	671-00152	2	2	2	2
13	Piston Ring	032-91261	032-91261	1	1	1	1
14	Piston Ring	032-91811	032-91811	1	1	1	1

ROTARY SERVO DISASSEMBLY

1. **See Figure 14.** 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 6.** Remove tube lines to cap assembly.
5. Remove screws holding cap assembly to pump body.
6. Remove cap assembly (1). Remove plug (3) with attached parts. Remove spring (8) and spool (4).
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 (14) and nut (15). Push a rod through the cap to remove the retainer (12).

ASSEMBLY

1. **See Figure 6.** Install Avseal plug (6) in cap.
2. Install spool (4) into bore as shown. Install spring (8) over end of spool.
3. Install O-ring (13) on spring retainer (12). Install retainer (12), screw (14) and nut (15) in plug (3).
4. Install O-rings (7) and (16) on plug (3). Install plugs (3) and (9) in body (1). Torque plugs to 75 lb.·ft., 102 N.m. Install O-ring (8) in cap.
5. Turn screw (12) in until spring retainer (12) contacts spring (8). Turn an additional 1-1/2 turns and lock in position.
6. Note proper location for control on pump. 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 14,** Apply Loctite 242 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 stroke. Measure height from control cap to top of screw (3). With control piston at full stroke, dimension for the P16 must be .45 +/- .03 in., 11,4 +/- 0,76 mm, dimension for the P09 must be .655 +/- .03 in., 16,6 +/- 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 Loctite 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 above drawing. Torque plug (12) to 90 lb.·ft., 122 N.m.
15. While spring retainer is engaging screw (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.

TEST AND ADJUSTMENT

1. Plumb 1200 PSI , 82,8 bar servo supply to control.
2. Thread zero screw (24) so that pump is on stroke.
3. Start pump.
4. With shaft (10) rotated fully clockwise, thread cam (9) until output flow is at the full stroke position. Lock in place.
5. Fully rotate shaft (10) counter-clockwise. Pump flow should go towards zero stroke. Back out zero screw (24) until pump is at zero stroke. Lock in place.
6. If pump fails to go towards full stroke, or fails to go towards zero stroke, differential pressure may be improperly adjusted. Re-adjust the screw (15 figure 6) out to go towards full or in to go towards zero flow.
7. Rotate shaft clockwise and counterclockwise at approximately 500 PSI, 34,5 bar, 3000 PSI, 207 bar and 6000 PSI, 414 bar system pressure. Pump stroke should follow shaft rotation between full and zero stroke smoothly and proportionally. Full to zero or zero to full stroke should be achieved in no more than .7 second.

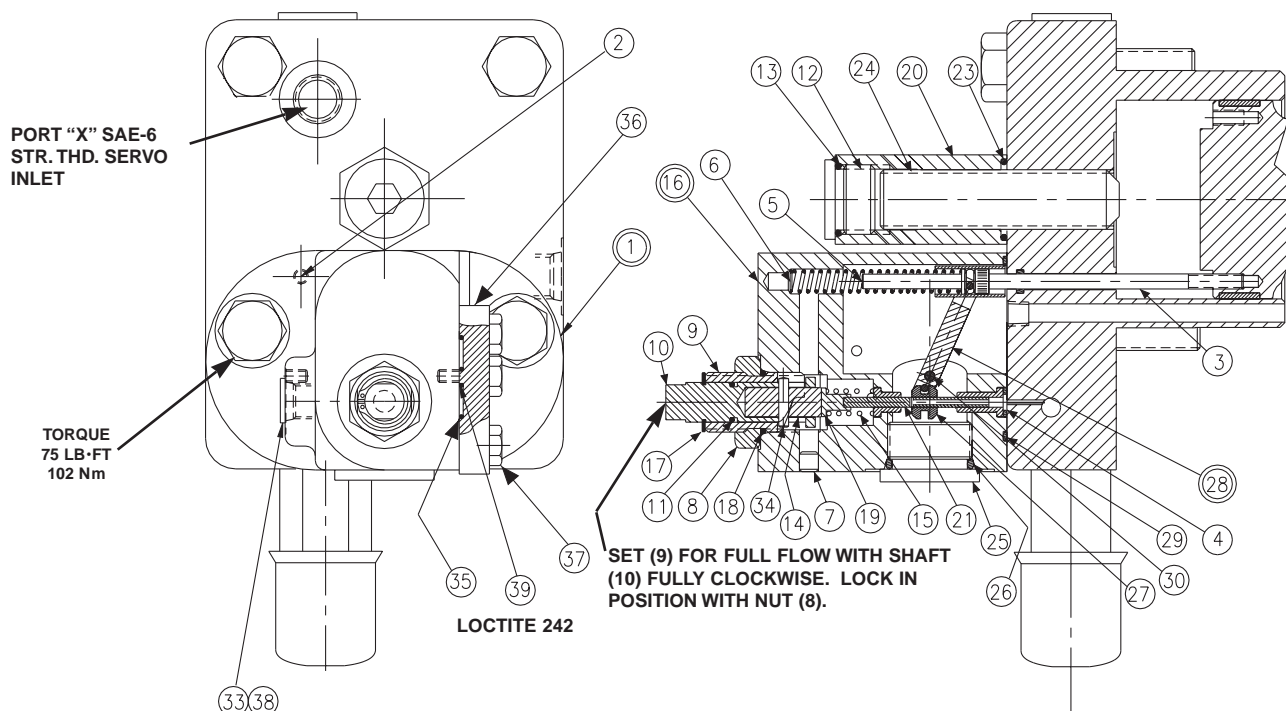
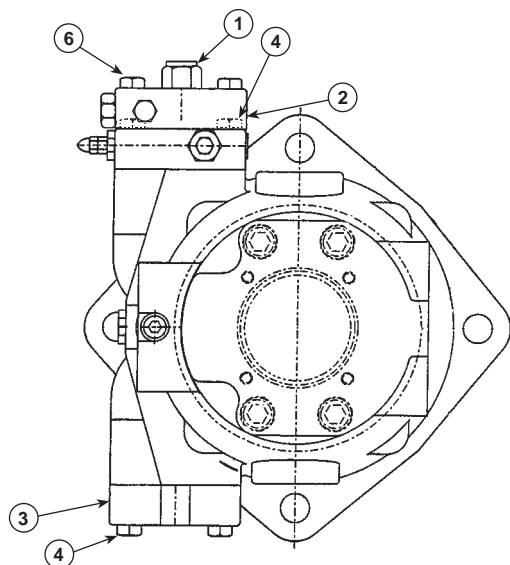


FIGURE 14
ROTARY SERVO

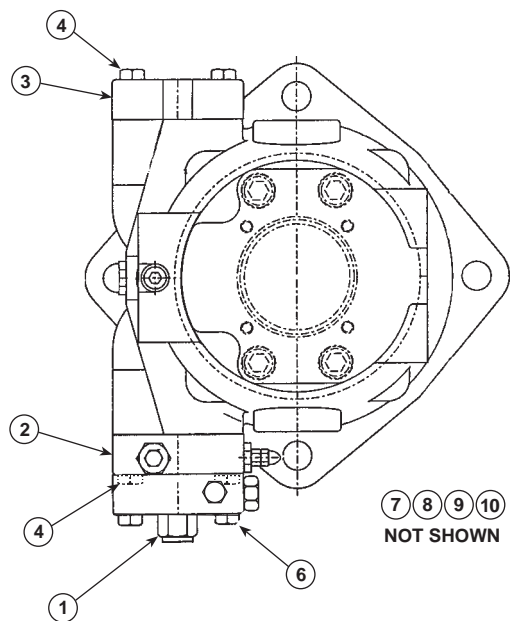
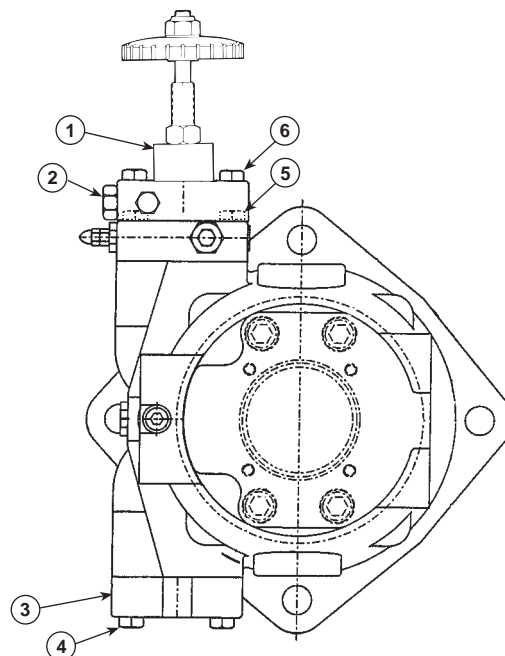
PARTS LIST FOR FIGURE 14

Assembly No.. S22-15309

ITEM	DESCRIPTION	PART NO.	QTY.
1	Cap (Figure 6)	S22-15262	1
2	Orifice set screw	032-92399	1
3	Screw	032-91461	1
4	O-Ring, 70 S-1 ARP 010	671-00010	1
5	Pin, Clevis	321-40000	1
6	Spring, Compression	032-92100	1
7	Plug, Avseal	447-00026	1
8	Locknut 8-LSN-S	492-15116	1
9	Cam	032-91515	1
10	Shaft	032-91514	1
11	O-Ring, 90 S-1 ARP 012	691-00012	1
12	Plug, 10HP5N-S	488-35055	1
13	O-Ring, 90 S-1 ARP 910	691-00910	1
14	Slide Pin	032-91513	1
15	Spring	225-92105	1
16	Body	S22-15393	1
17	Retaining Ring	356-31050	1
18	O-Ring, 90 S-1 ARP 908	691-00908	1
19	Spring Retainer	032-91516	1
20	Nut, 3/4-10	031-91049	1
21	Spool	032-91438	1
23	O-Ring, 70 S-1 ARP 118	671-00118	1
24	Soc. Setscrew, 3/4-10 x 3	311-26320	1
25	Plug, 12 HP5N-S	488-35014	1
26	O-Ring, 90 S-1 ARP 912	691-00912	1
27	Sleeve	032-91437	1
28	Arm assembly	S22-15520	1
29	O-Ring, 70 S-1 ARP 035	671-00035	1
30	Dowel Pin, 1/8 Dia x 1.75 Lg.	324-20828	1
33	O-Ring, 70 S-1 ARP 904	671-00904	1
34	Dowel Pin, 1/8 x 5/8	324-20810	1
35	O-Ring, 70 S-1 ARP 011	671-00011	2
36	Plate	032-91510	1
37	Screw, HHC, 1/4-20 x 3/4	306-40142	3
38	Plug, SAE-4	488-35061	1
39	Screw, SHC 10-32 x 1/4	312-09041	2



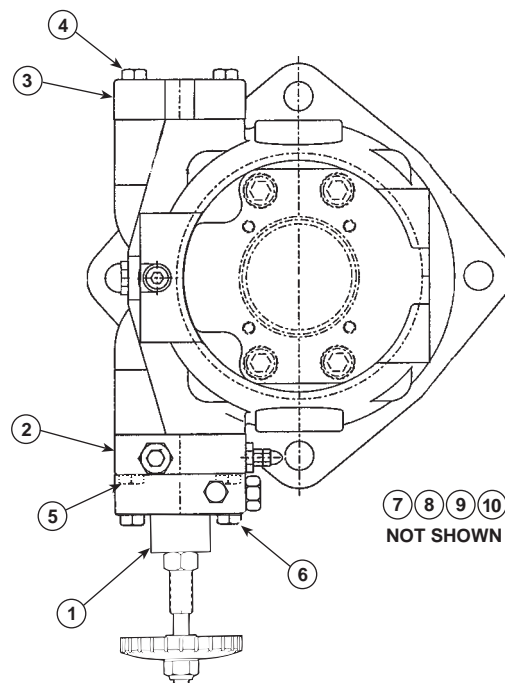
CCW ROTATION



CW ROTATION

7 8 9 10
NOT SHOWN

L10



7 8 9 10
NOT SHOWN

L20

LOAD SENSING CONTROL parts list

ITEM	DESCRIPTION	P09	P16	QTY.	
		PART NO.	PART NO.	L10	L20
1	Max. Vol. Stop (Fig. 1)	S22-12983	S22-12983	1	—
	Max Vol. Handwheel (Fig. 2)	S22-12915	S22-12915	—	1
2	Load Sensing Control (Fig. 15)	S22-15536	S22-15536	1	1
3	Buck Up Cap (Fig. 4)	S22-15653	S22-12970	1	1
4	Screw-H.H.C., M12 x 60 mm	363-12210	363-12210	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	032-91585	032-91443	1	1
8	O-Ring, 90 S-1 ARP 013	691-00013	691-00013	2	2
9	O-Ring, 70 S-1 ARP 152	671-00152	671-00152	2	2
10	Piston Ring	032-91261	032-91261	2	2

LOAD SENSING CONTROL
DISASSEMBLY

1. **See Figure 15** Back off max. volume screw to full displacement. Remove max. volume screw 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 adj. 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

1. Install Avseal plugs (9) and orifice (35) 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 (16). Lubricate and install into plug (15). Install plug (15) into cap. Install screw (3), nut (4) and acorn nut (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). Torque plug (36) to 75 lb.*ft., 102 Nm. Torque plug (21) to 46 lb-ft, 62 Nm.
6. Install O-rings (29-a) and (29-b) on valve (29). 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. Install O-ring (32) on plug (31). Install plug in block (28). Install plug (22) in adapter.
8. Note proper location for cap on pump. 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.

TEST AND ADJUSTMENT

Connect pump to a circuit with system flow metered by a needle valve or suitable metering valve. Connect load sensing line downstream of the metering valve. Connect gage to pump output, and to load sensing line, capable of measuring 300 psi, 20,7 bar pressure difference at 5000 psi, 345 bar.

Connect a relief valve downstream of the metering valve, and a flowmeter to measure pump flow.

1. Adjust maximum volume stop to full displacement by backing off stop till there is no contact with the control piston.
2. Turn compensator adjustment screw (25) CCW until there is no contact with spring, then adjust 1/2 turn CW after contact is made with spring.
3. Turn differential adjustment screw (3) CCW until there is no contact with spring, then adjust 1/2 turn CW after contact is made with spring.
4. Open metering valve and set relief valve at 500 PSI, 35 bar.
5. Start prime mover. Pump should be at full displacement at 500 PSI, 35 bar.
6. Adjust relief valve higher until compensator de-strokes pump to zero displacement. Compensator pressure should be approximately 1000 PSI, 70 bar with the 1/2 turn pre-adjustment.
7. Close the metering valve. Check the pressure difference from pump output to load sensing line. Using the differential adjustment, set this pressure difference to 350 psi \pm 25psi, 24,1 \pm 1.7 bar or shop order requirement.
8. Set the compensator to 3000 PSI, 207 bar, and 5000 PSI, 345 bar. At each condition, increase the system pressure until the pump fully de-strokes. At no time should the system pressure vary more than 150 PSI, 10,3 bar from the compensator setting. The control should be steady and stable at all conditions.
9. Open the metering valve till pump reaches full flow at 1000 psi , 69 bar. Reduce flow by 10 GPM, 38 L/m. Raise the relief valve setting till the pump compensates at 5000 psi., 345 bar. Reduce relief valve setting 200 psi, 14 bar. Flow to return to previous value \pm 2 GPM, 7,6 L/m.
10. Check pressure differential at 1000, 2000, and 3000 psi \pm 100 psi, (69, 138, and 207 bar \pm 6,9 bar). Pressure differential to remain the same as in (7) above.
11. Set the flow to 10 GPM, 37,8 L/m at 1000 psi., 69 bar. Observe flow as pressure is varied from 500 psi to 4800 psi, 34,5 to 331 bar. Flow shall not vary by more than \pm 2 GPM, 7,6 L/m.
12. Repeat at 30 \pm 1 GPM, 113 \pm 3,8 L/m.
13. Set load relief valve at 2000 psi, 138 bar. Check pressure differential at 10, 30, 50 GPM \pm 2 GPM, (37,8, 114, and 189 L/m \pm 7,6 L/m). Pressure differential shall be the same as in (7) above.
14. Set compensator adjustment to the required setting, or 5000 PSI, 345 Bar if not otherwise noted. Install cap on differential adjustment.

LOAD SENSING CONTROL

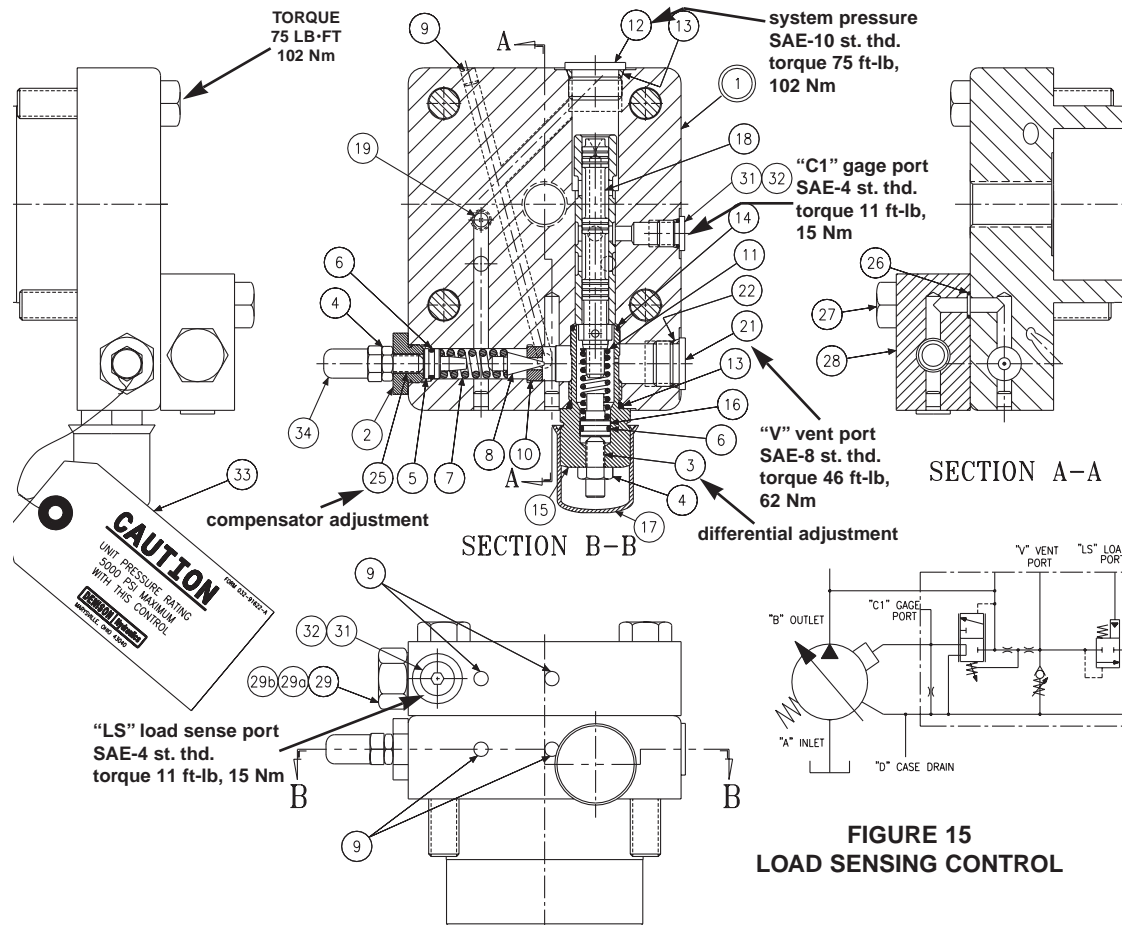


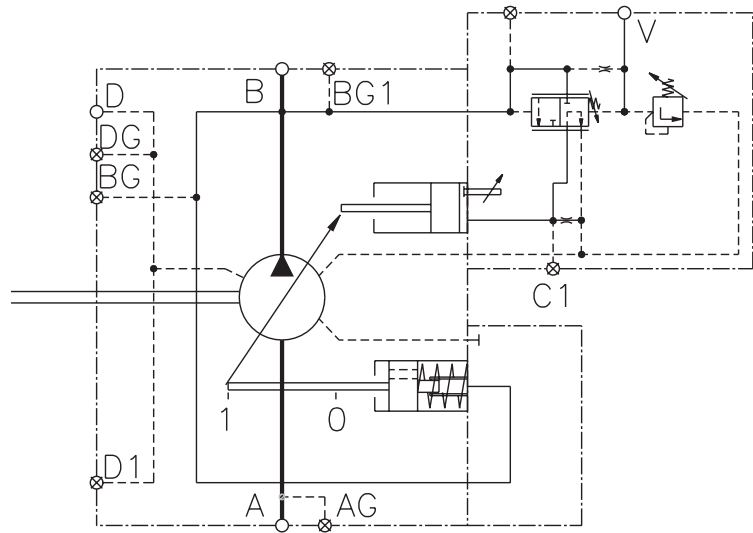
FIGURE 15
LOAD SENSING CONTROL

PARTS LIST FOR FIGURE 15

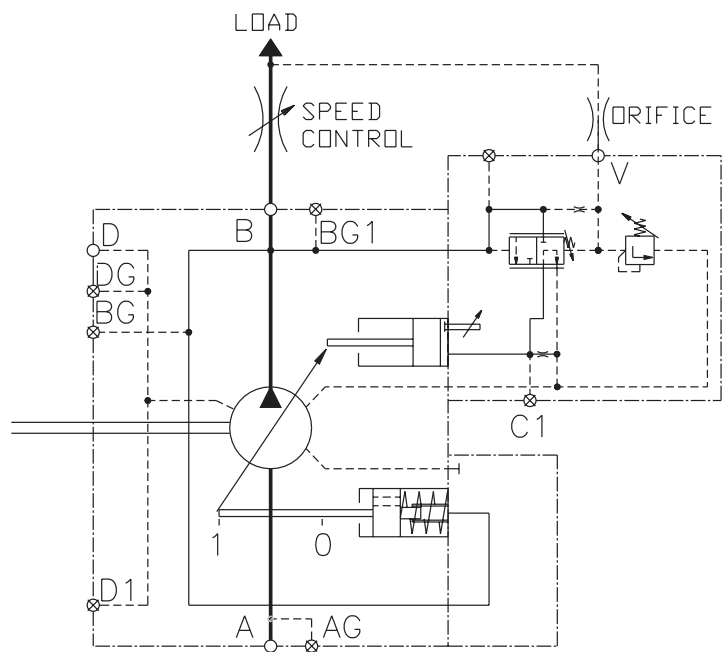
Assembly No. S22-15536

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

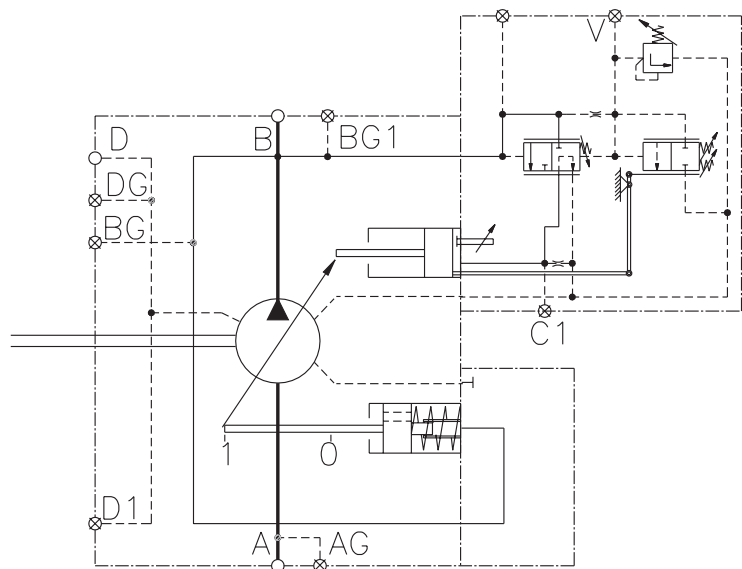
**HYDRAULIC CIRCUIT
PRESSURE COMPENSATOR**



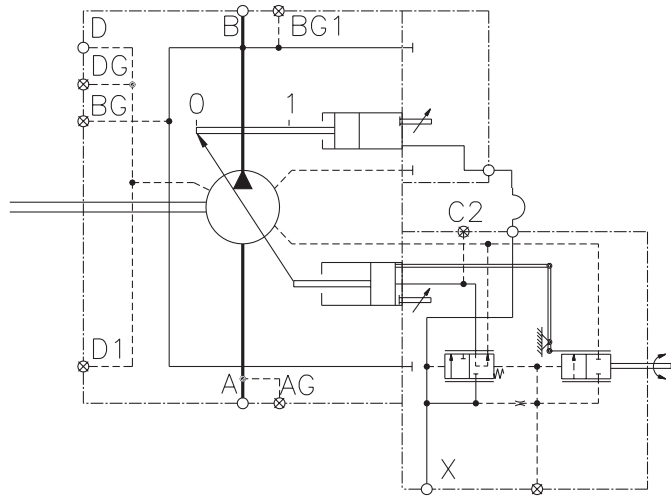
**HYDRAULIC CIRCUIT
PRESSURE COMPENSATOR,
*load sensing configuration***



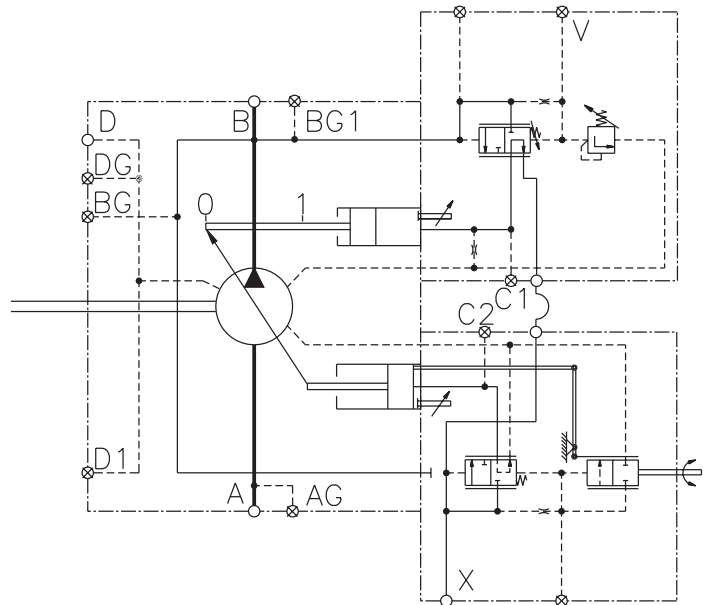
**HYDRAULIC CIRCUIT
TORQUE LIMITER**



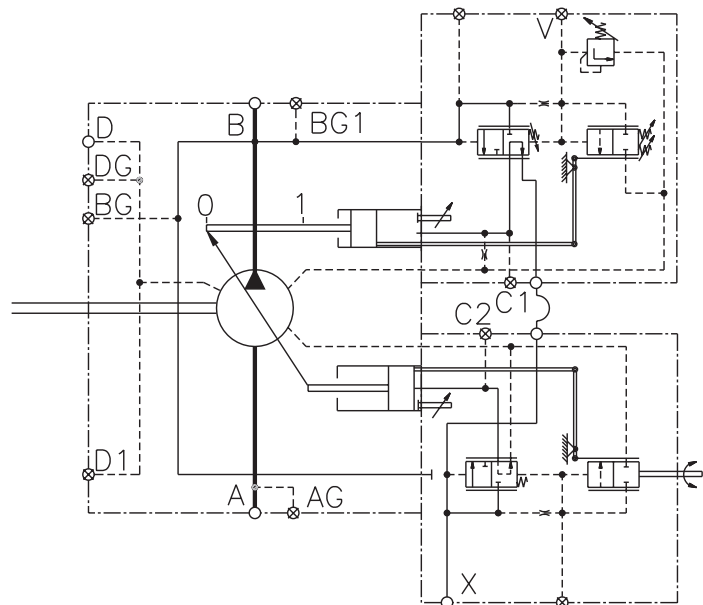
HYDRAULIC CIRCUIT ROTARY SERVO



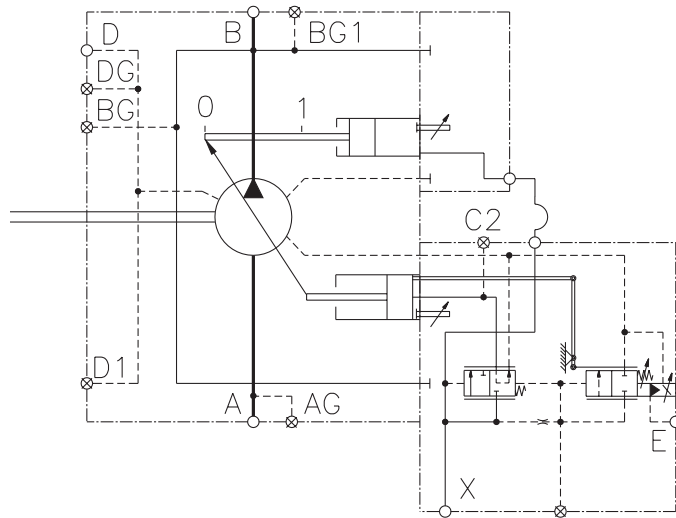
HYDRAULIC CIRCUIT ROTARY SERVO WITH COMPENSATOR OVERRIDE



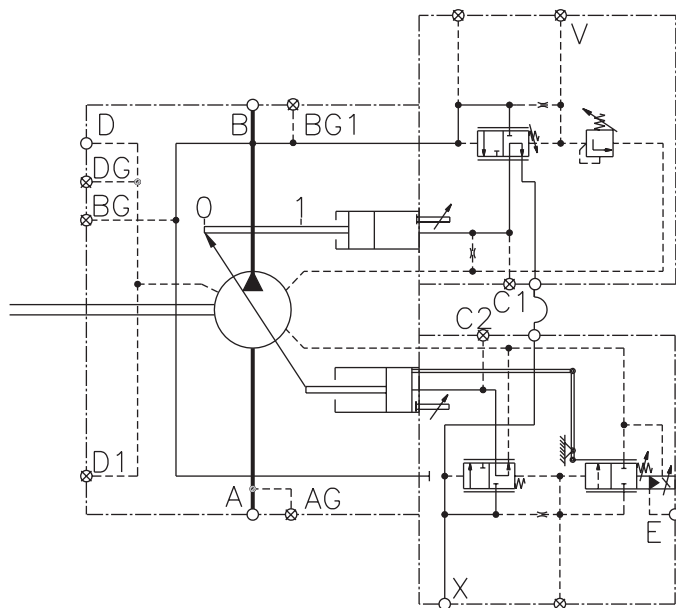
HYDRAULIC CIRCUIT ROTARY SERVO WITH TORQUE LIMITER OVERRIDE



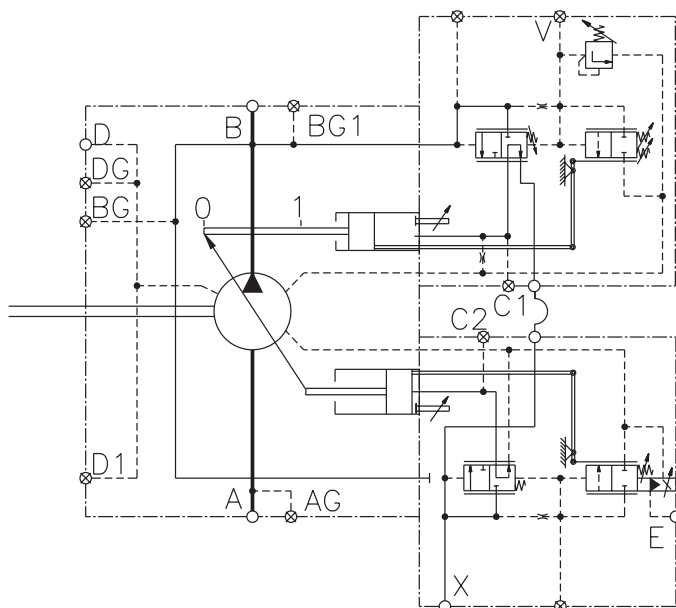
**HYDRAULIC CIRCUIT
ELECTRIC STROKER**



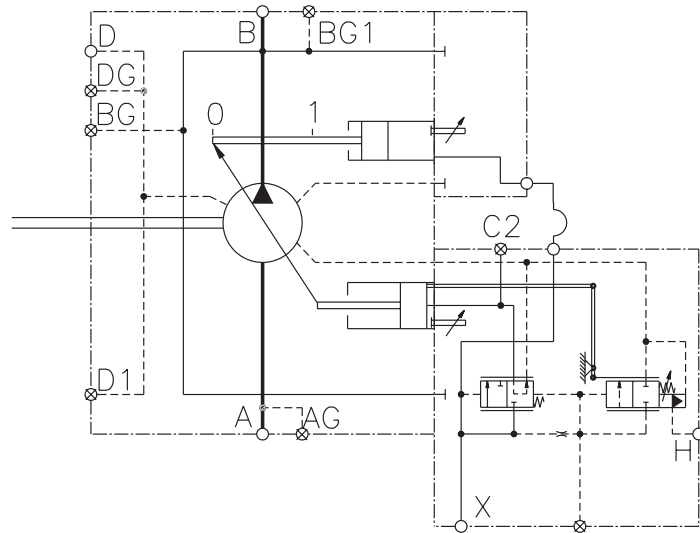
**HYDRAULIC CIRCUIT
ELECTRIC STROKER WITH
COMPENSATOR OVERRIDE**



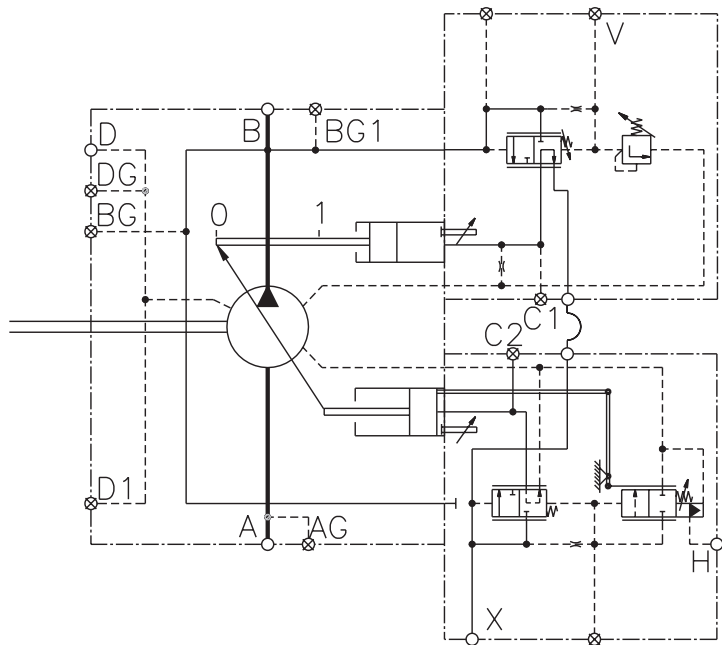
**HYDRAULIC CIRCUIT
ELECTRIC STROKER WITH
TORQUE LIMITER OVERRIDE**



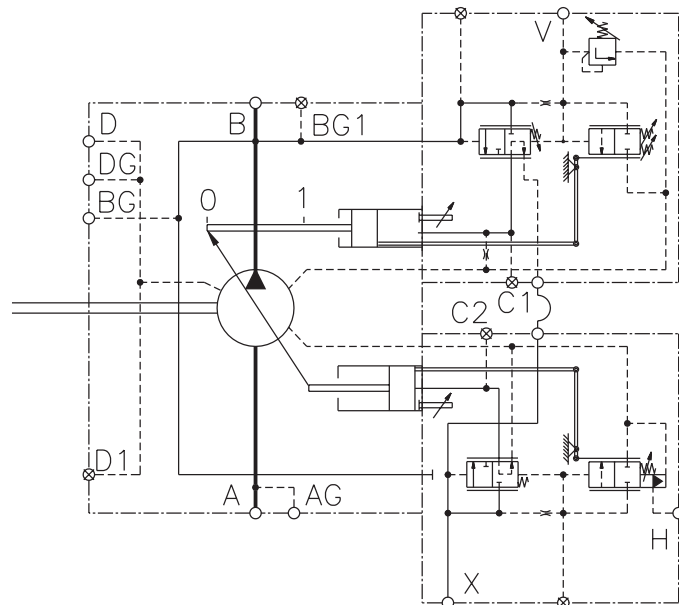
**HYDRAULIC CIRCUIT
HYDRAULIC STROKER**



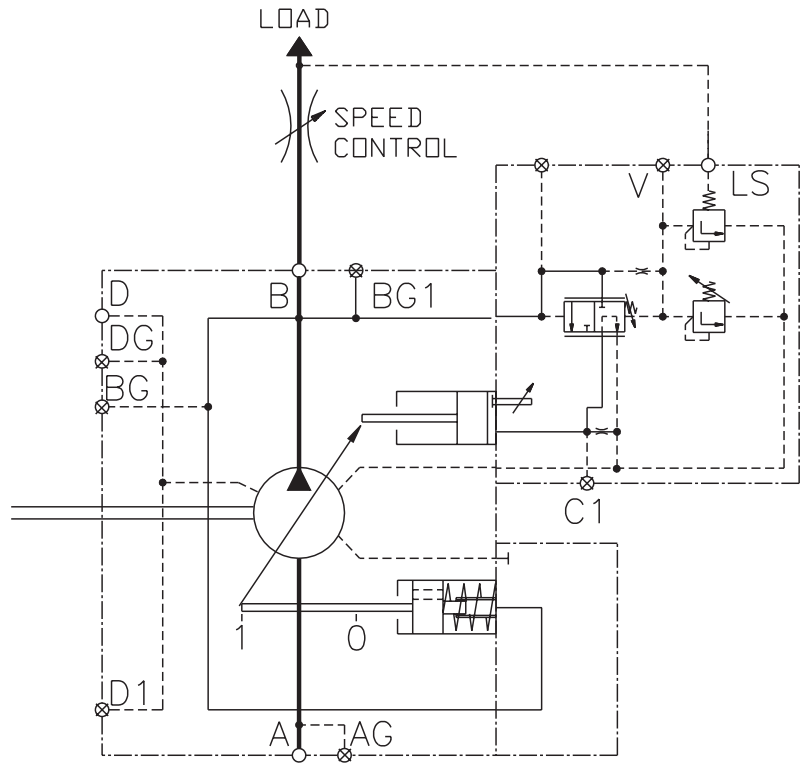
**HYDRAULIC CIRCUIT
HYDRAULIC STROKER WITH
COMPENSATOR OVERRIDE**



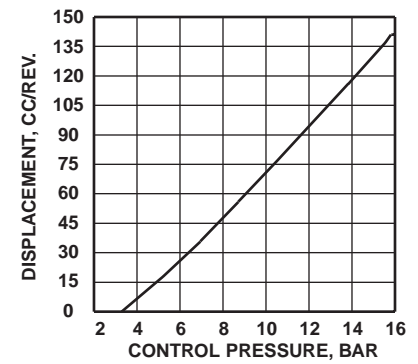
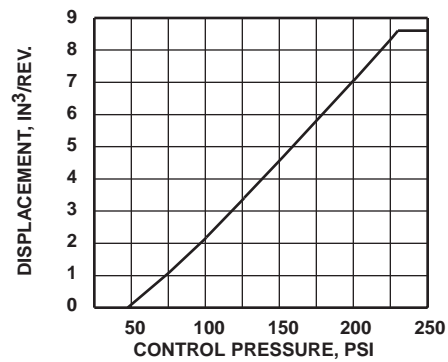
**HYDRAULIC CIRCUIT
HYDRAULIC STROKER WITH
TORQUE LIMITER OVERRIDE**



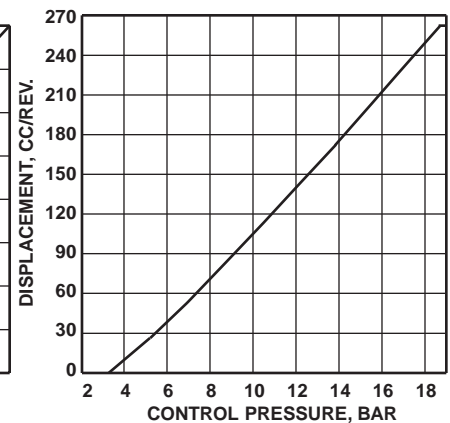
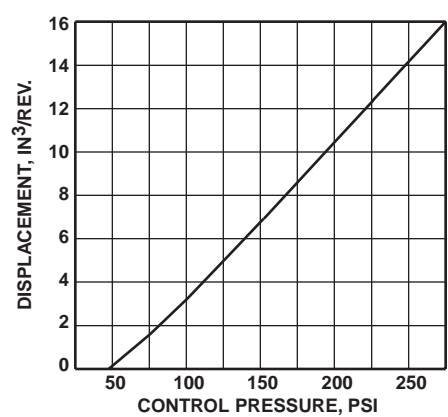
HYDRAULIC CIRCUIT
LOAD SENSING CONTROL



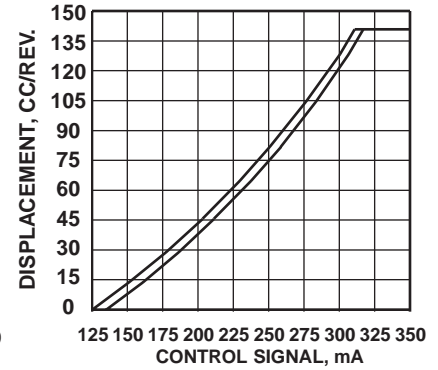
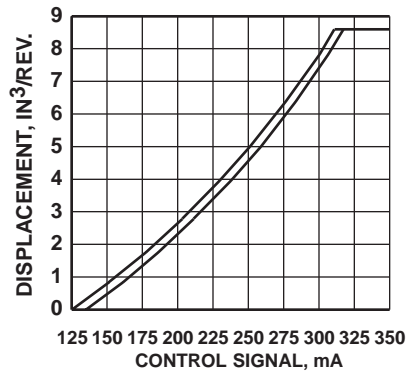
HYDRAULIC STROKER
PERFORMANCE - P09



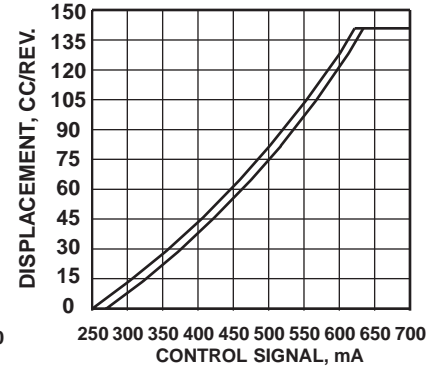
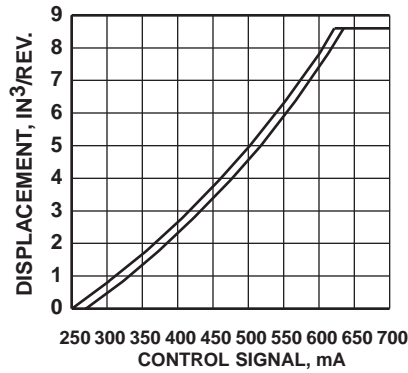
HYDRAULIC STROKER
PERFORMANCE - P16



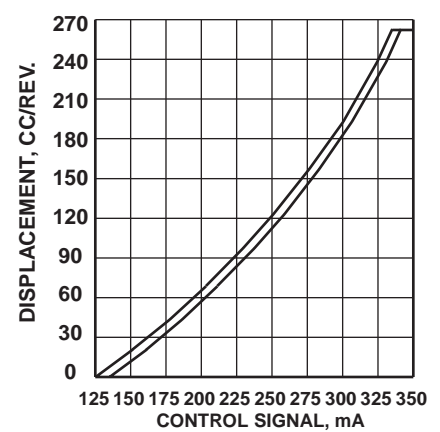
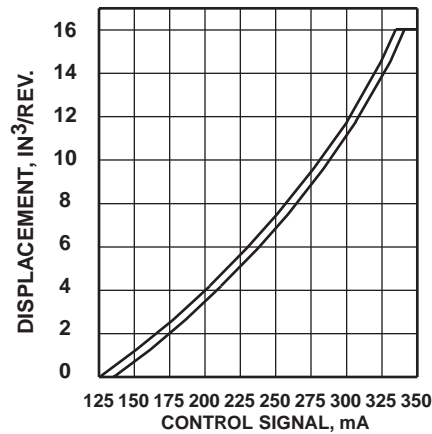
**ELECTROHYDRAULIC
STROKER PERFORMANCE
P09, 24 VOLT**



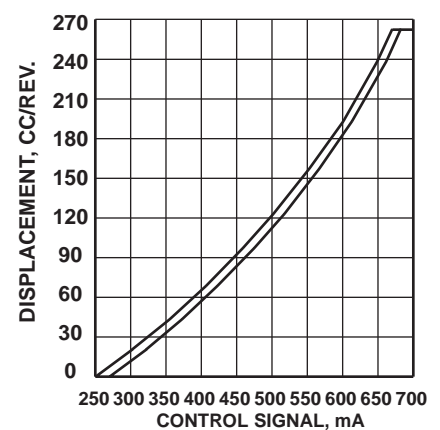
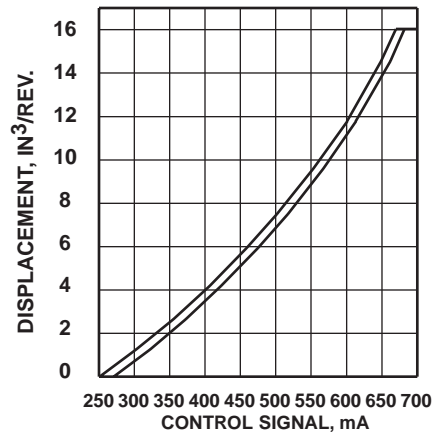
**ELECTROHYDRAULIC
STROKER PERFORMANCE
P09, 12 VOLT**



**ELECTROHYDRAULIC
STROKER PERFORMANCE
P16, 24 VOLT**

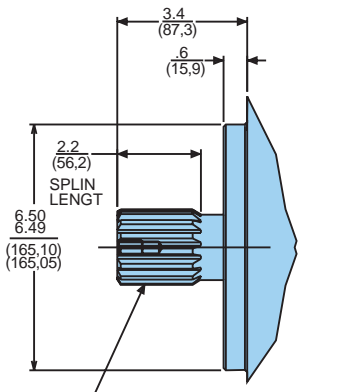


**ELECTROHYDRAULIC
STROKER PERFORMANCE
P16, 12 VOLT**



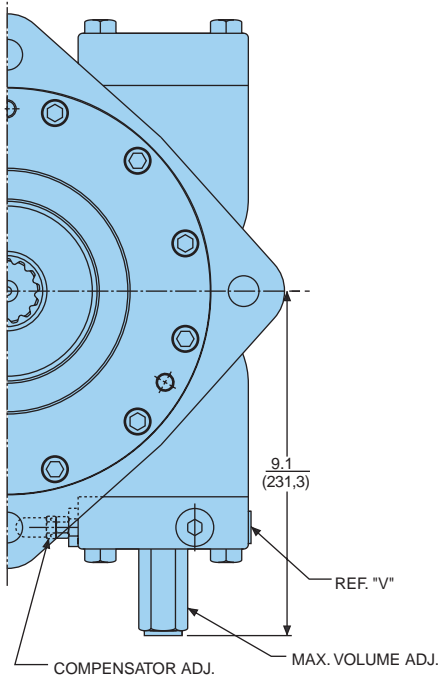
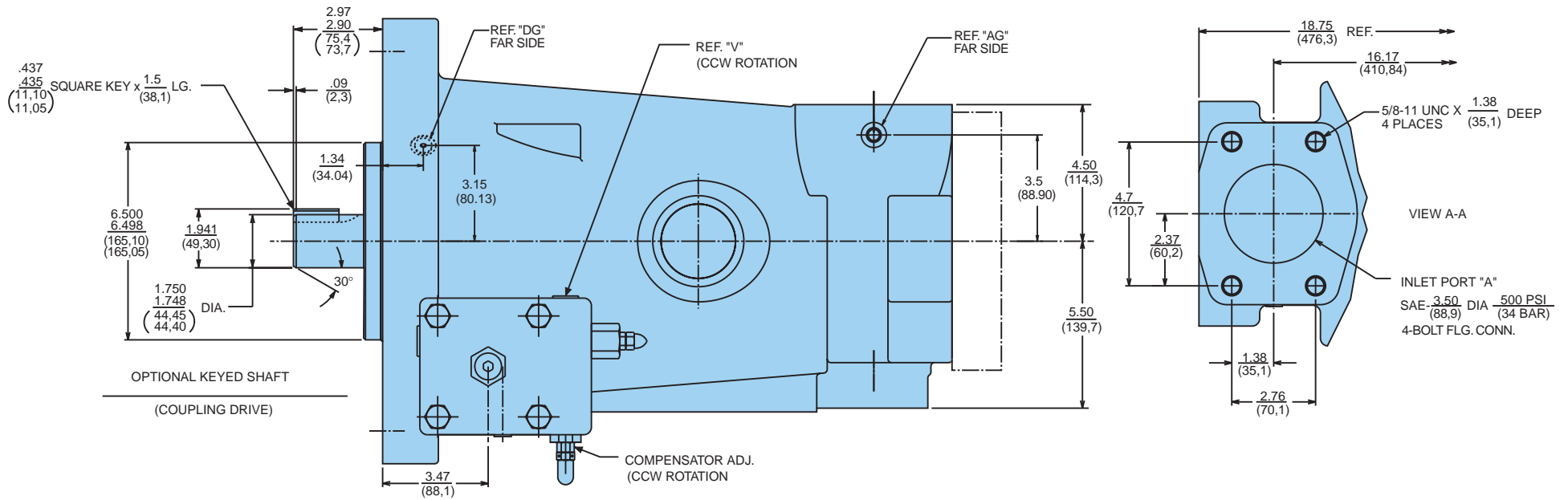
FLUID CONNECTIONS		P09	P16
• port A (inlet)	in.	3	3-1/2
SAE code 61 3000 psi, 209 bars split flange	mm	76.2	88.9
• port B (system)	in.	1 1/2	1 1/2
SAE code 62 7250 psi, 505 bars split flange	mm	38.1	38.1
• port C1, C2 (cylinder gage ports)	SAE	-4	-4
• port D, D1 (case drains)	SAE	-20	-24
• ports AG, DG (inlet, drain gage conn's)	SAE	-4	-4
• port BG (outlet gage connection)	SAE	-4	-6
• port BG1 (alternate outlet gage connection)	SAE	-4	-6
• port E (electric stroker control pressure inlet)	SAE	-4	-4
• port H (hydraulic stroker control pressure inlet)	SAE	-4	-4
• port LS (load sensing port)	SAE	-4	-4
• port V (compensator vent)	SAE	-8	-8
• port X (rotary, electric & hydraulic stroker servo inlet)	SAE	-6	-6

- COMPENSATOR WITH ADJ. MAX. VOLUME SCREW STOP-C1*
OR COMPENSATOR WITH HANDWHEEL ADJ. MAX. VOLUME STOP-C2*

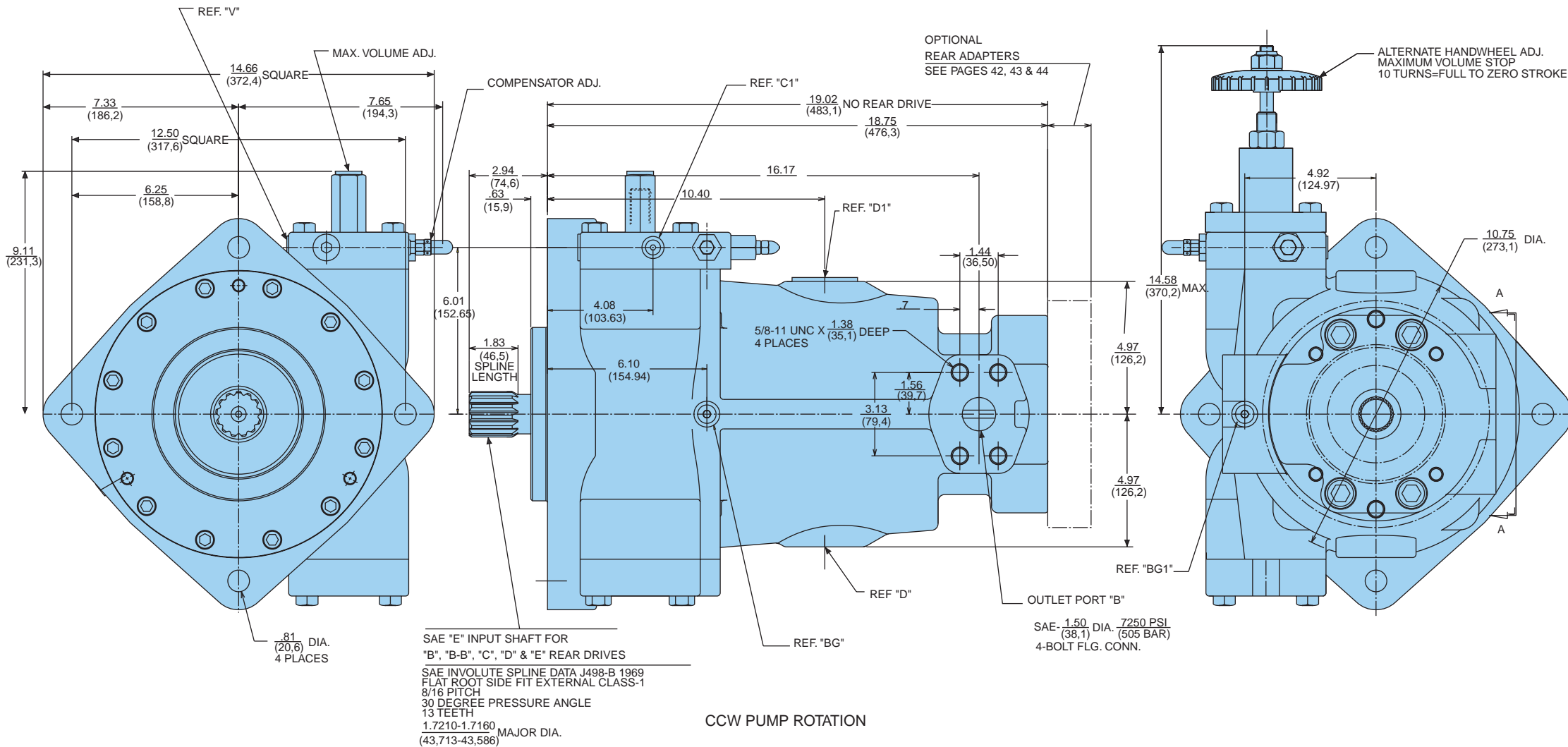


SAE "F" INPUT SHAFT FOR HIGH
TORQUE "D" & "E" REAR DRIVES

SAE INVOLUTE SPLINE DATA J498-B 1969
FLAT ROOT SIDE FIT EXTERNAL CLASS-
8/16 PITCH
30° PRESSURE
15
2.0000-1.9650
(50,800-49,911)

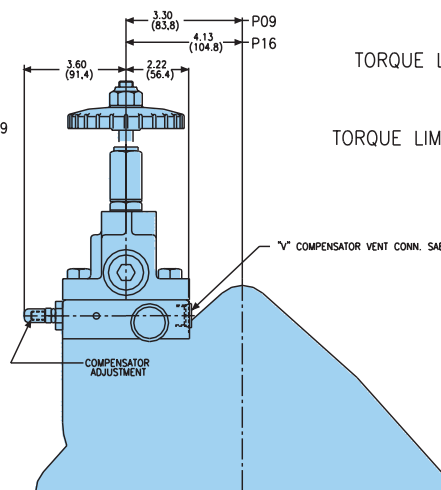
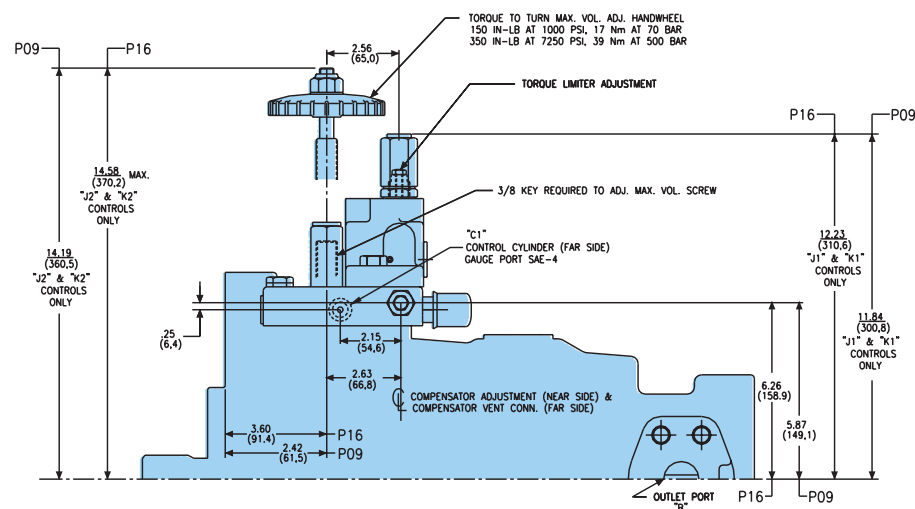


CW PUMP ROTATION

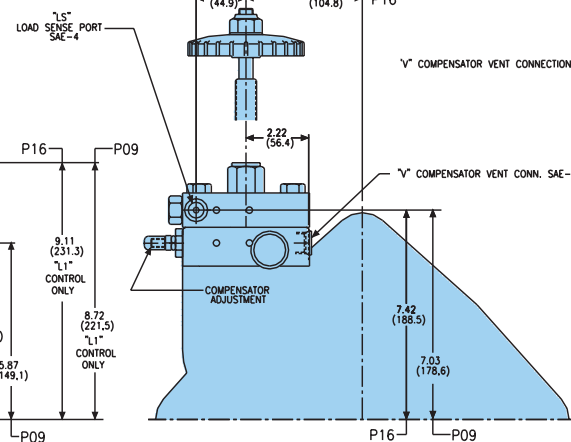
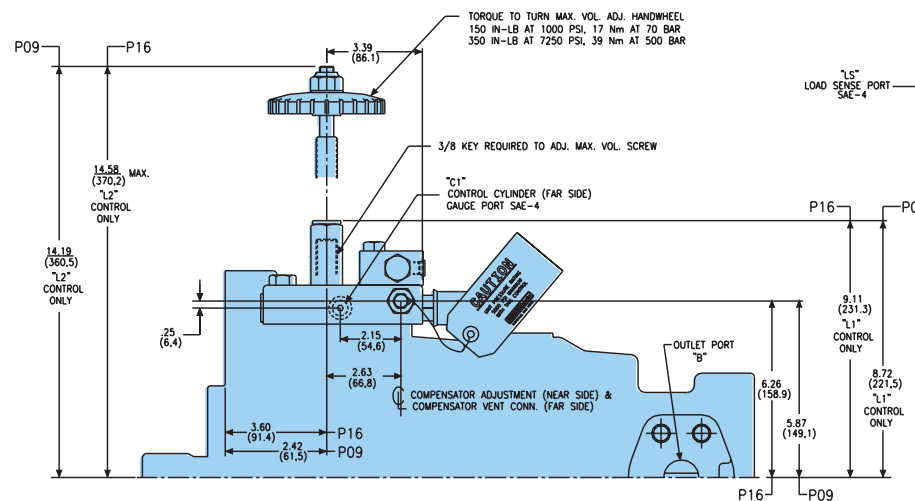


CCW PUMP ROTATION

SAE "E" INPUT SHAFT FOR
"B", "B-B", "C", "D" & "E" REAR DRIVES
SAE INVOLUTE SPLINE DATA J498-B 1969
FLAT ROOT SIDE FIT EXTERNAL CLASS-1
8/16 PITCH
30 DEGREE PRESSURE ANGLE
13 TEETH
1.7210-1.7160
(43,713-43,586) MAJOR DIA.



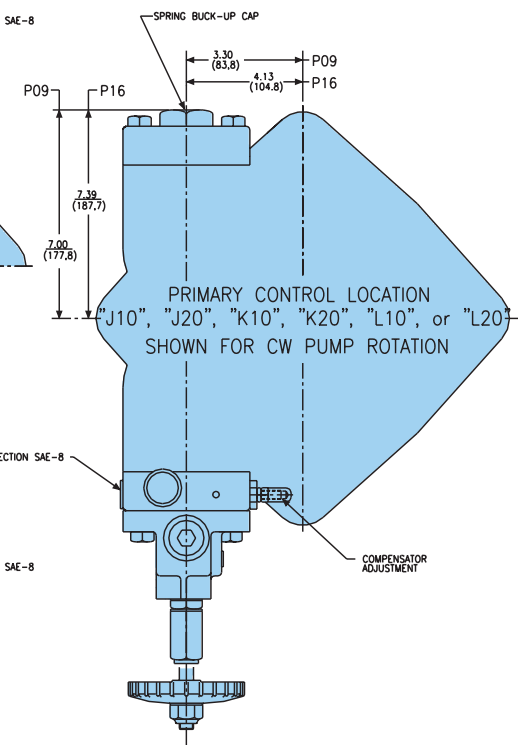
TORQUE LIMITER WITH ADJ. MAX. VOL. SCREW STOP
CCW PUMP ROTATION SHOWN
"J10" OR "K10" AS NOTED
AND
TORQUE LIMITER WITH HANDWHEEL ADJ. MAX. VOL. STOP
CCW PUMP ROTATION SHOWN
"J20" OR "K20" AS NOTED



LOAD SENSING WITH ADJ. MAX. VOL. SCREW STOP
CCW PUMP ROTATION SHOWN
"L10" AS NOTED
AND

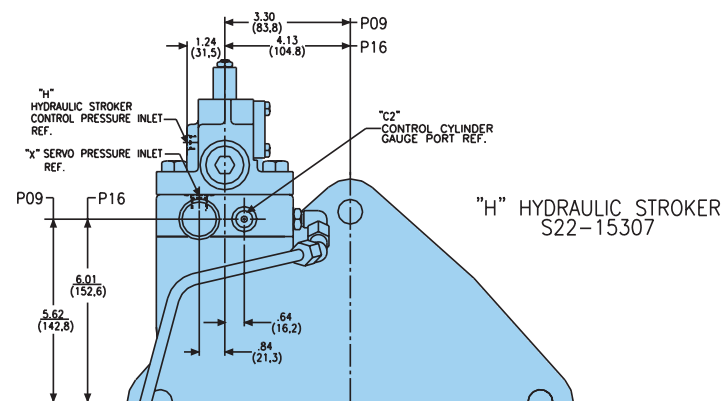
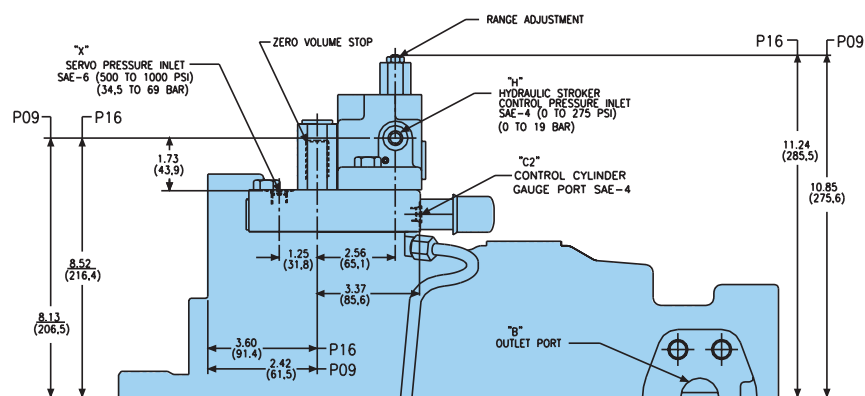
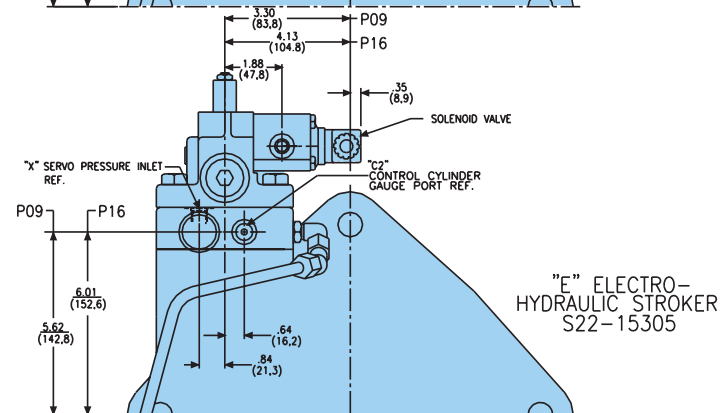
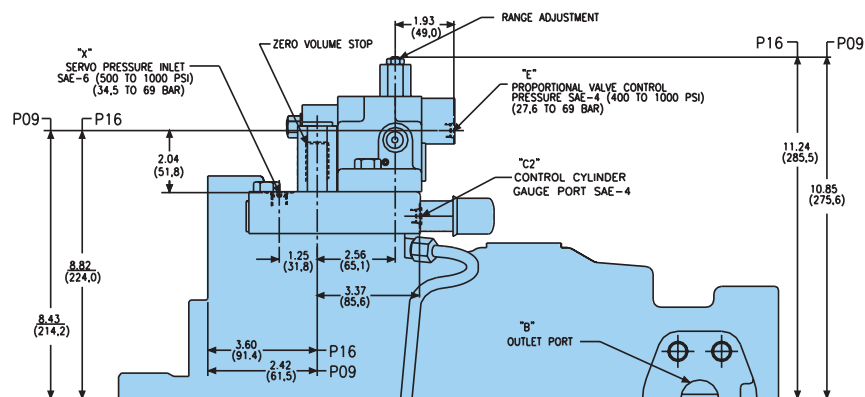
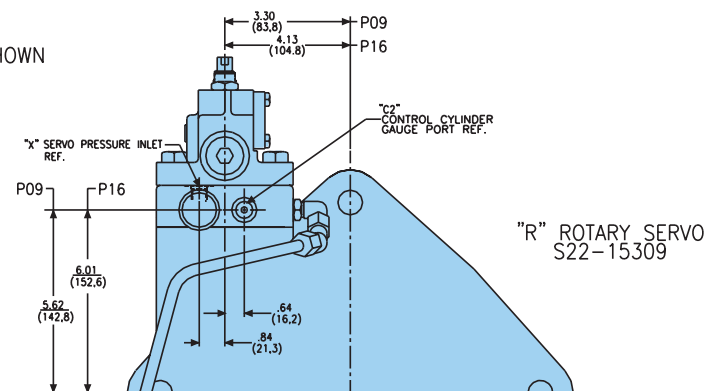
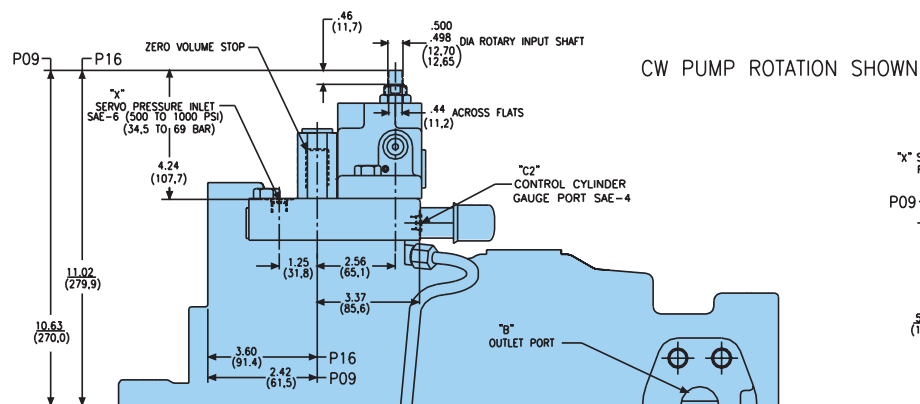
LOAD SENSING WITH HANDWHEEL ADJ. MAX. VOL. STOP
CCW PUMP ROTATION SHOWN
"L20" AS NOTED

"J" & "L" PRIMARY CONTROLS

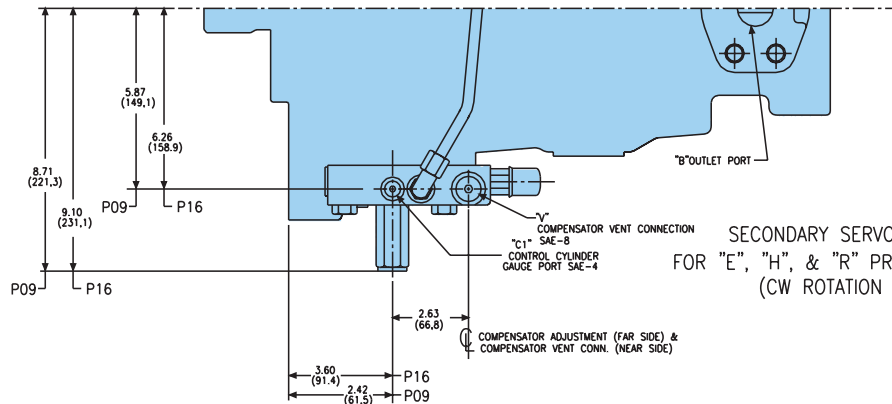
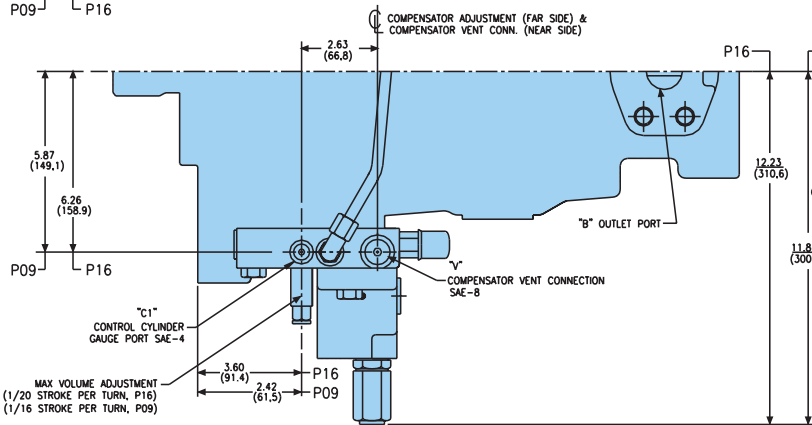
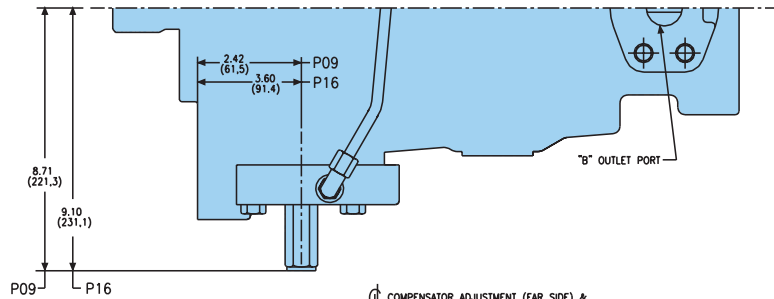


NOTES:

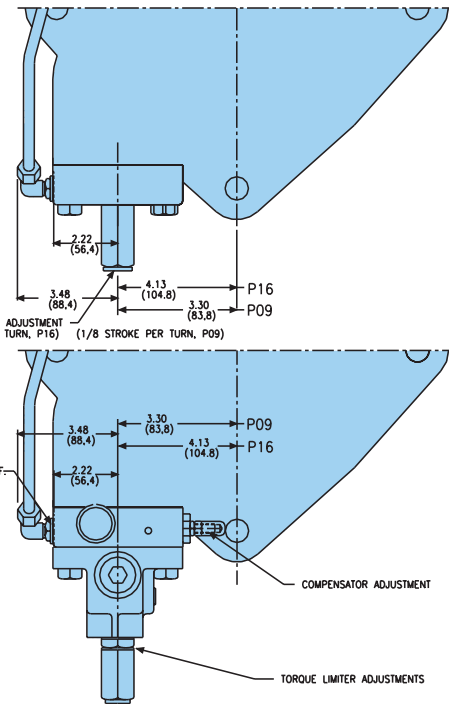
1. REFERENCE TO PUMP ROTATION, R-CW & L-CCW, IS AS VIEWED FROM SHAFT END.
2. DIMENSIONS IN PARENTHESIS ARE METRIC (SI UNITS).



"E", "H", & "R" PRIMARY CONTROLS



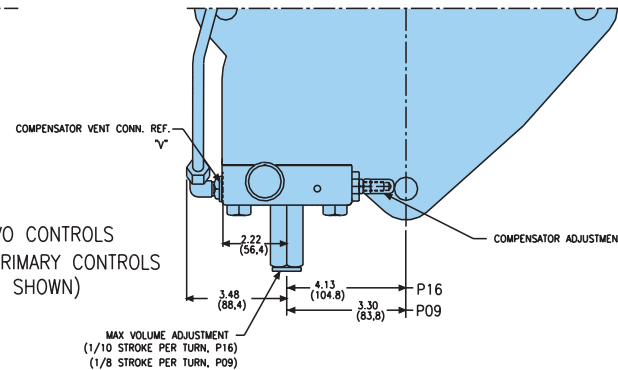
SECONDARY SERVO CONTROLS
FOR "E", "H", & "R" PRIMARY CONTROLS
(CW ROTATION SHOWN)



"*10" CONTROL CAP
WITH MAX VOLUME STOP
S22-15528

"*1J" TORQUE LIMITER
OVERRIDE W/MAX VOLUME STOP
S22-15532
OR

"*1K" TORQUE LIMITER
OVERRIDE W/MAX VOLUME STOP
S22-15534



"*1P" COMPENSATOR
OVERRIDE W/MAX VOLUME STOP
S22-15530

DEFINITION & UNIT

<i>displacement</i>	$\text{in}^3/\text{rev} \times 16.387 = \text{cm}^3/\text{rev}$	$\text{cm}^3/\text{rev} \times 0.06102 = \text{in}^3/\text{rev}$
<i>flow</i>	$\text{gpm} \times 3.78 = \text{L}/\text{min}$	$\text{L}/\text{min} \times 0.2642 = \text{gpm}$
<i>power</i>	$\text{hp} \times 0.7457 = \text{kW}$	$\text{kW} \times 1.341 = \text{hp}$
<i>torque</i>	$\text{lb-ft} \times 1.3567 = \text{Nm}$	$\text{Nm} \times 0.7376 = \text{lb-ft}$
<i>pressure</i>	$\text{lbs}/\text{in}^2 (\text{psi}) \times 0.06895 = \text{bar}$ $\text{lbs}/\text{in}^2 (\text{psi}) \times 6.895 = \text{kPa}$	$\text{bar} \times 14.50 = \text{lbs}/\text{in}^2 (\text{psi})$ $\text{kPa} \times 0.1450 = \text{lbs}/\text{in}^2 (\text{psi})$
<i>weight</i>	$\text{lb} \times 0.4536 = \text{kg}$	$\text{kg} \times 2.205 = \text{lbs}$
<i>force</i>	$\text{lb} \times 4.448 = \text{N}$	$\text{N} \times 0.2248 = \text{lbs}$
<i>volume</i>	$\text{in}^3 \times 16.387 = \text{cm}^3$	$\text{cm}^3 \times 0.06102 = \text{in}^3$
<i>area</i>	$\text{in}^2 \times 6.452 = \text{cm}^2$	$\text{cm}^2 \times 0.1550 = \text{in}^2$
<i>length</i>	$\text{in} \times 25.4 = \text{mm}$	$\text{mm} \times 0.03937 = \text{in}$
<i>temperature</i>	$\text{degree F}-32 = \text{°C}$ 1.8	$1.8 \times \text{°C}+32 = \text{°F}$
<i>viscosity</i>	$\text{cSt} \times 1.0 = \text{mm}^2/\text{sec}$ $(\text{SSU}-14) \div 4.25 \approx \text{cSt}$	$\text{mm}^2/\text{sec} \times 1.0 = \text{cSt}$ $\text{cSt} \times 4.25 + 14 \approx \text{SSU}$

FLUID POWER FORMULAS

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

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P16 - * * 1 B - C 1 0 - *

Secondary control options

O-S22-15256 – None
P-S22-15530 – Compensator Override
J-(see below) Low Torque Limiter Override
K-(see below) High Torque Limiter Override

Primary control options

1-S22-12983 – Standard maximum volume screw
2-S22-12915 – Handwheel (Available on Compensator, Load Sensing and Torque Limiter)

Primary controls

C-S22-15311 – Pressure Compensator
E-S22-15305 – Electric Stroker
H-S22-15307 – Hydraulic Stroker
J-(see below) – Low Torque Limiter
K-(see below) – High Torque Limiter
L-S22-15536 – Load Sensing
R-S22-15309 – Rotary Servo

Design letter

P16 - B
P09 - A

Fluid class

Pump seal kit

	P09	P16
1- compatible with Buna N	S22-15084-0	S22-12830-0
4- compatible with EPR	S22-15084-4	S22-12830-4
5- compatible with Viton	S22-15084-5	S22-12830-5

Seal kits include all seals required for pump and controls.

Available control combinations

C10, C20
E10, E1J, E1K, E1P
H10, H1J, H1K, H1P
J10, J20
K10, K20
L10, L20
R10, R1J, R1K, R1P

Torque Limiter control data

	P09		P16	
	Assembly	Torque Range	Assembly	Torque Range
Low Torque Limiter	S22-15732	1400-2200 in-lb 160-250 Nm	S22-15313	2500-6000 in-lb 280-680 Nm
High Torque Limiter	S22-15313	over 2200 in-lb over 250 Nm	S22-15315	over 6000 in-lb over 680 Nm
Low Torque Limiter Override	S22-15734	1400-2200 in-lb 160-250 Nm	S22-15532	2500-6000 in-lb 280-680 Nm
High Torque Limiter Override	S22-15532	over 2200 in-lb over 250 Nm	S22-15534	6000-10000 in-lb over 680 Nm

Note: All control assemblies come pre-tested, complete with mounting bolts, seals and standard maximum or minimum volume screw

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