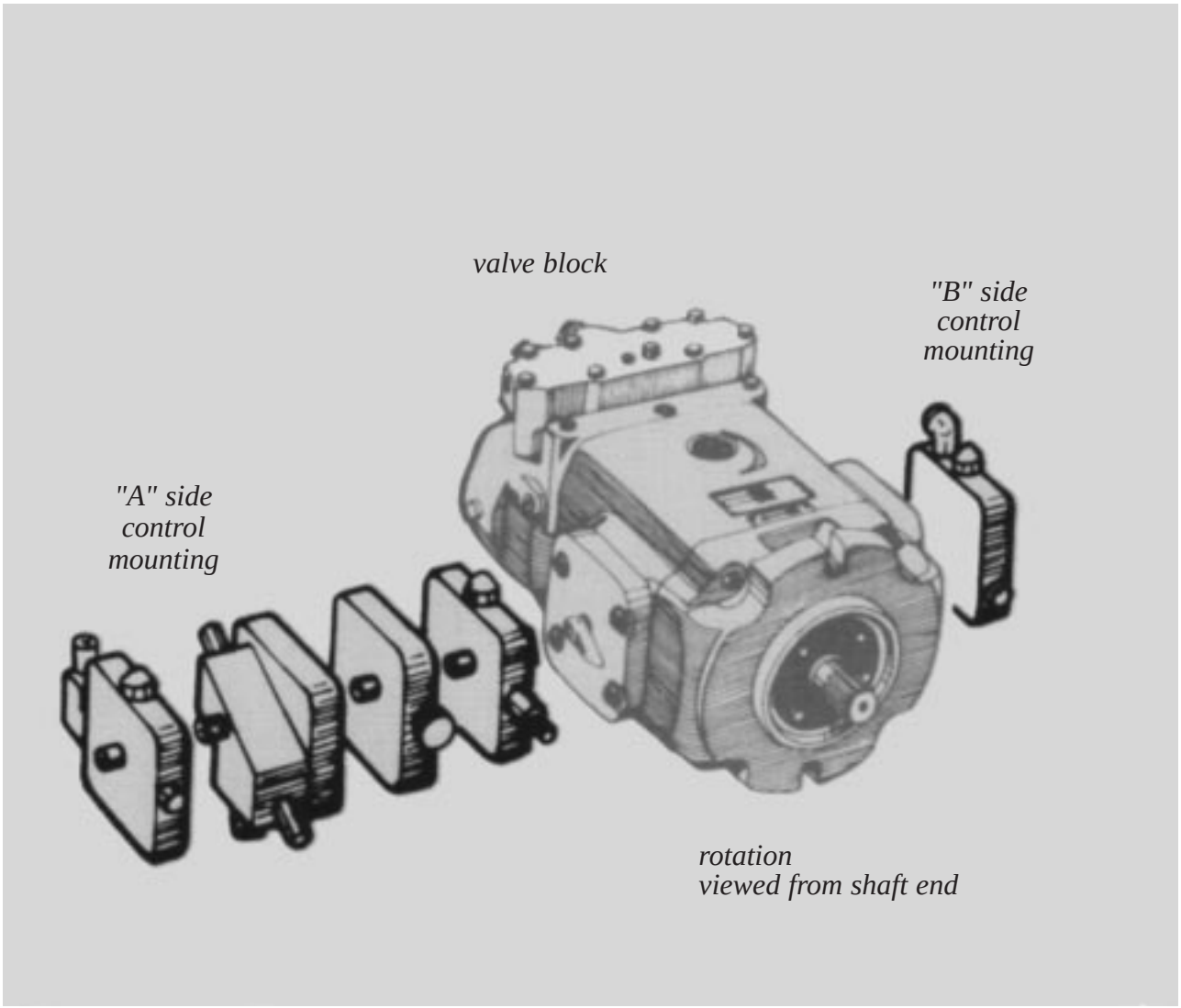
# DENISON HYDRAULICS
# controls for
# goldcup pumps & motors series 6. . .30

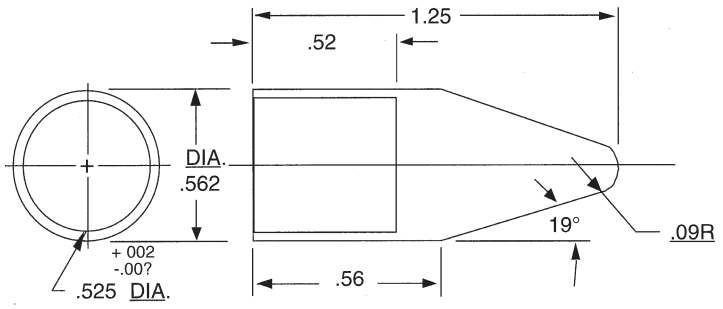
# service information




Publ. S1-AM030-A *replaces* S1-AM030 11-96

DENISON Hydraulics

Note: Metric terms are noted in parentheses with decimal point designated by a period, as (2.25 Nm) equals 2,25 Newton meters.




**T-1**
O-Ring installation tool

P 6 P -2 R 1 C **-4 A 2 -A -00** -B 1 -M-XXXXX

**Pump series**

**Primary Controls**
**1-**Screw Adjustment
**2-**Cylinder Control
**4-**Rotary Servo (spring centered w/trimmer)
**5-**Electrohydraulic Stroker
**6-**Hydraulic Stroker
**7-**Servovalve & Feedback Device
**8-**Proportional Hydraulic Stroker
**9-**Electrohydraulic Stroker
(All include rotary servo, pressure compensator override & displ. indicator)

**Primary Control Options**
**0-**None
**A-**Adjustable maximum volume stops
**B-**Automatic brake control
**C-**A & B above, together
**D-**10 GPM Servovalve w/feedback potentiometer
**E-**10 GPM Servovalve w/feedback RVDT
**F-**10 GPM Servovalve w/pot. & manual override w/4A2 Control
**G-**10 GPM Servovalve w/RVDT & manual override w/4A2 Control
**H-**3 pos (Spring centered w/trimmer)

**Secondary Controls**
**2-**Auxiliary Replenishment Port on Centerline
**4-**Torque Limiter and Auxiliary Replenishment Port

**Control Feature**
**500 Control**
**00-**with deadband
**01-**without deadband

**600 Control**
**00-**75-350 PSI (5-24 bar)
**01-**75-435 PSI (5-30 bar)
**02-**100-380 PSI (7-26 bar)
**03-**150-400 PSI (10.3-27.6 bar)

**700 Control**
**00-**w/o manual override shut-off
**01-**w/manual override shut-off

**800 Control**
**00-**75-350 PSI (5-24 bar)
**01-**75-435 PSI (5-30 bar)
**02-**100-380 PSI (7-26 bar)
**03-**150-400 PSI (10.3-27.6 bar)
**04-**75-250 PSI (5-17 bar)

**900 Control**
**00-**24 VDC
**01-**12 VDC
**ALL OTHER CONTROLS USE 00**

**Control Location**
**A-**Command on Port A side
**B-**Command on Port B side
(Displ. indicator on opposite side)

**Allowable Controls, P_P:**
102,104,2A2,2A4,2H2,2H4,402,404,4A2,4A4,4B2,4B4, 4C2,4C4,5A2,5A4,5C2,5C4,602,604,6B2,6B4,7D2, 7E2,7F2,7G2,8A2,8A4,8C2,8C4,9A2,9A4,9C2,9C4,

**Allowable Controls, P_V:***
102,104,2A2,2A4,4A2,4A4,4C2,4C4,5A2,5A4, 5C2,5C4,6A2,6A4,6C2,6C4,7D2,7E2,7F2,7G2, 8A2,8A4,8C2,8C4,9A2,9A4,9C2,9C4
*P_V not available on 24 & 30 Series

M 6 H -2 N 1 C **-2 A 0 -A -00** -M-XXXXX

**Motor series**

**Primary Controls**
**2-**Cylinder with adjustable maximum & minimum stops
**5-**Electrohydraulic Stroker
**6-**Hydraulic Stroker
**8-**Proportional Hydraulic Stroker
**9-**Electrohydraulic Stroker (without deadband)
(All include rotary servo stem and displacement indicator)

**Primary Control Options**
**0-**None
**A-**Adjustable maximum volume stops

**Secondary Control options**
**0-**None
**5-**Reverse compensator (not available on 24 & 30 series)

**Control Location**
**A-**Command on Port A side
**B-**Command on Port B side

**Control Feature**
**500 Control**
**1-**without deadband

**600 Control**
**0-**170-350 PSI (11.7-24.1 bar)
**1-**200-450 PSI (17.2-31 bar)
**2-**150-380 PSI (10.3-26.2 bar)
**3-**75-250 PSI (5-17 bar)

**800 Control**
**0-**75-250 PSI (5-17 bar)
**1-**250-450 PSI (17-31 bar)

**900 Control**
**0-**24 VDC
**0-**12 VDC

**Allowable Controls: M*V,M*H:** 2A0,2A5,5A0,5A5,6A0,6A5,8A0,8A5,9A0,9A5

**TABLE 1 TYPICAL CHARACTERISTICS**

| Specifications | Typ. Value |
|---|---|
| Control stop adjustment, 0 to full volume | |
| 1A, 2A, 4A, 4C | 6.72 Turns |
| 5A, 5C | 8.48 Turns |
| 6A, 6C | 6.06 Turns |
| 8A, 8C, 9A, 9C | 5.04 Turns |
| Servo response time, 0 to full volume | |
| P6, P7, P8 | .9 Seconds |
| P11, P14 | 1.5 Seconds |
| P24, P30 | 1.8 Seconds |
| Compensator off stroke response, full to 0 volume. | |
| P6, P7, P8 | .050 Seconds |
| P11, P14 | .070 Seconds |
| P24, P30 | .100 Seconds |
| Servo shaft rotation, 0 to full volume | 19 degrees |
| Fluid connections: | |
| Signal ports, 2A | 1/8 Dryseal NPTF |
| Signal ports, 2H, 60, 6A, 6B, 6C, 8A, 8C | SAE -4 St. Thd. O-ring seal |
| Brake port, 4B, 4C, 5C, 6B, 6C, 8C, 9C | SAE -6 St. Thd. O-ring seal |
| Bypass port to system pressure, 4B, 4C, 5C, 6B, 6C | SAE -4 St. Thd. O-ring seal |
| Bypass port to system pressure, 8C, 9C | SAE -6 St. Thd. O-ring seal |
| Bypass port to replenishing, 4B, 4C, 5C, 6B, 6C, 8C, 9C | SAE -6 St. Thd. O-ring seal |

***5A, 5C CONTROLS**

| Specifications | Typ. Value |
|---|---|
| Hysteresis | Less than 5% |
| Linearity | Within 5% |
| Response | 0.5 seconds, zero to full. (control response) |
| Temperature null shift | Less than 2% per 100° F (38°C) |
| Deadband | 0% or 10% |
| Input pressure | 400 psi (28 bar) nominal, range 200-1000 psi (14-70 bar) |
| Coil resistance | 24 to 30 Ohms |
| Electrical input | Full stroke .275 ma. typ., 400 ma. max., Max. current 600 ma. |
| Torque for manual operation | 20 in.-lb (2.25 Nm) with control pressure shut off. |

*Note: If the driver uses Pulse Width Modulation, (PWM) the frequency must be 2000 Hz. or higher to avoid erratic operation. Water Glycol, Phosphate Ester (including Skydrol), and Invert emulsions cannot be used with 5A and 5C controls.

**60, 6A, 6B, 6C PUMP CONTROLS**

| Feature | Control press. min. displacement | | Control press. max. displacement | | Max. hysteresis @ min. displacement | | Max. hysteresis @ max. displacement | |
|---|---|---|---|---|---|---|---|---|
| | psi | (bar) | psi | (bar) | psi | (bar) | psi | (bar) |
| 00 | 60-90 | (4.1-6.2) | 310-360 | (21.3-24.8) | 30 | (2.1) | 50 | (3.4) |
| 01 | 60-90 | (4.1-6.2) | 410-460 | (28.3-31.7) | 30 | (2.1) | 50 | (3.4) |
| 02 | 100-120 | (6.9-8.3) | 350-400 | (24.1-27.6) | 30 | (2.1) | 50 | (3.4) |
| 03 | 135-165 | (9.3-11.4) | 375-425 | (25.9-29.3) | 30 | (2.1) | 50 | (3.4) |

### 6A MOTOR CONTROLS

| Feature | Control press. max. displacement | | Control press. min. displacement | | Max. hysteresis @ max. displacement | | Max. hysteresis @ min. displacement | |
|---|---|---|---|---|---|---|---|---|
| | psi | (bar) | psi | (bar) | psi | (bar) | psi | (bar) |
| 0- | 155-185 | (10.7-12.7) | 310-360 | (21.3-24.8) | 30 | (2.1) | 50 | (3.4) |
| 1- | 185-215 | (12.8-14.8) | 410-460 | (28.3-31.7) | 30 | (2.1) | 50 | (3.4) |
| 2- | 135-165 | (9.3-11.3) | 350-400 | (24.1-27.6) | 30 | (2.1) | 50 | (3.4) |
| 3- | 60-90 | (4.1-6.2) | 225-275 | (15.5-19.0) | 30 | (2.1) | 50 | (3.4) |

### 700 FEEDBACK CONTROLS

| Specifications | Typ. Value |
|---|---|
| Input voltage | +/- 15 Volts |
| Input Amperes | |
| Potentiometer | 3 ma |
| D.C. RVDT | 30 ma |
| * Output Volts @ max displacement, 19° CW rotation facing control | |
| Potentiometer | +3.1 Volts |
| D.C. RVDT | -2.3 Volts |
| Output impedance | |
| Potentiometer | 2.5 K Ohms |
| D.C. RVDT | <1 Ohm |

*With connector terminal B at +15 Volts, terminal D at - 15 Volts. This polarity must be maintained for D.C. RVDT, Polarity is optional for potentiometer.

### 8A, 8C PUMP CONTROL

| Code | Control press. min. displacement | | Control press max. displacement | | Max. hysteresis @ min. displacement | | Max. hysteresis @ max. displacement | |
|---|---|---|---|---|---|---|---|---|
| | psi | (bar) | psi | (bar) | psi | (bar) | psi | (bar) |
| 00 | 60-90 | (4.1-6.2) | 310-360 | (21.3-24.8) | 30 | (2.1) | 50 | (3.4) |
| 01 | 60-90 | (4.1-6.2) | 410-460 | (28.3-31.7) | 30 | (2.1) | 50 | (3.4) |
| 02 | 100-120 | (6.9-8.3) | 350-400 | (24.1-27.6) | 30 | (2.1) | 50 | (3.4) |
| 03 | 135-165 | (9.3-11.4) | 375-425 | (25.9-29.3) | 30 | (2.1) | 50 | (3.4) |
| 04 | 60-90 | (4.1-6.2) | 225-275 | (15.5-19.0) | 30 | (2.1) | 50 | (3.4) |
| Torque for manual operation (no control pressure) begin stroke | | | | | | 7.5-20 in. lb. | (0.8-2.2 N·m) | |
| Torque for manual operation (no control pressure) end stroke | | | | | | 28-58 in. lb. | (3.2-6.5 N·m) | |

### 8A MOTOR CONTROL

| Code | Control press. min. displacement | | Control press max. displacement | | Max. hysteresis @ min. displacement | | Max. hysteresis @ max. displacement | |
|---|---|---|---|---|---|---|---|---|
| | psi | (bar) | psi | (bar) | psi | (bar) | psi | (bar) |
| 0* | 60-90 | (4.1-6.2) | 225-275 | (15.5-19.0) | 30 | (2.1) | 50 | (3.4) |
| 1* | 235-265 | (16.2-18.3) | 410-460 | (28.3-31.7) | 30 | (2.1) | 50 | (3.4) |
| Signal ports | | | | | | SAE - 4 | | |
| Torque for manual operation (no control pressure) begin stroke | | | | | | 7.5-20 in. lb. | (0.8-2.2 N·m) | |
| Torque for manual operation (no control pressure) end stroke | | | | | | 28-58 in. lb. | (3.2-6.5 N·m) | |

### 9A, 9C PUMP CONTROL

### 9A MOTOR CONTROL

| Code | mA @min. displacement | mA @max. displacement | Code | mA @max. displacement | mA @min. displacement | Coil voltage | Nom. resist. |
|---|---|---|---|---|---|---|---|
| 00 | 360 +/- 60 | 650 +/- 110 | 0* | 360 +/- 60 | 580 +/- 100 | 12 Volt | 10 Ohm |
| 01 | 180 +/- 30 | 325 +/- 55 | 1* | 180 +/- 30 | 290 +/- 50 | 24 Volt | 41 Ohm |
| * Hysteresis- percent of full displacement | | | | | | 5% typ. 8% max. | |
| * Linearity - percent of full displacement | | | | | | within 8% | |
| Manual override | | | | | | 3/16"(4.8 mm) internal hex | |
| Torque to override (no signal current) | | | | | | 30 in.-lb (3.4 N•m) typ. | |
| Mating connector (supplied) | | | | | | DIN 43650 type AF | |

*Specifications above are based on using a Jupiter 900 Driver with a 24 VDC supply and set at 120 Hz pulse width modulation. Performance will vary when other controls are used. 100 to 200 Hz pulse width modulation is recommended.

## CODE 1 - SCREW ADJUSTMENT CONTROL

*S23-12327*
*"A" Mounting CCW Rotation*
*"B" Mounting CW Rotation*

*S23-12328*
*"A" Mounting CW Rotation*
*"B" Mounting CCW Rotation*

### DESCRIPTION

The screw adjustment spring offsets the rotary servo to the maximum displacement as adjusted by the screw. The operator needs only to override the spring offset torque of approximately 20 lbs-in. (2.26 Nm) with the rotary servo stem to manually reduce displacement. The minimum displacement is set by the adjustable screw which determines the minimum rotary servo command. The pressure compensator override is independent of this control. A pump with this control acts as with a traditional pressure compensator. In the absence of an overriding rotary servo command the pump is held at the adjustable maximum displacement. The maximum screw is adjustable from approximately 100% to 0%. The minimum screw is nominally set at zero stroke but is adjustable from -50% to + 100% displacement.

### DISASSEMBLY

*See Figure 1*

1. Remove screws (2). Remove control from pump. Examine servo plate for excessive scratching. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two socket set screws from plate, then alternately loosening the two button head screws under the set screws.
2. Remove retaining ring (4) and press the shaft assembly through the valve body.
3. Examine shoes (8) and (25) for contamination in balance pads or excessive scratching on faces. Note: the two shoes are not identical and must be installed in the proper position on reassembly.
4. Remove the plug (17) with attached parts. Remove the spools (15) and spring (20). Examine spools and bores for free motion, wear or contamination

### REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |

### PREPARATION FOR ASSEMBLY

All parts are to be inspected and be free of material defects, dirt, scratches or any foreign material. All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air. After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

### ASSEMBLY

1. Apply pipe sealant and install plug (12) in body. Torque to 100 lbs-in. (11.3 Nm)
2. Press spring pins (23) into body, being careful not to mar the surface in the area of the shoe path.
3. Install O-ring (7) in groove of shear seal (8). Install shear seal with O-ring in the large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.

> Note: The shear seal will fit in one position only. Otherwise one side will be held up by the lip of the servo link. Shear seal (8) must be installed to face against the cover plate (10). This shear seal differs from shear seal (25) in that the face surface is machined with two .094" (2.4 mm) radius scallops.

4. Install thrust washers (9) over servo shaft and seat against the servo link.
5. Install O-ring (5) in the second groove from the end of the shaft, using assembly tool T-1.
6. Install the servo shaft assembly in the cover plate. (11).
7. Install retaining ring (4) into the groove of the servo shaft extending through the cover plate.
8. Install spools (15) into the bores in the body. Note: Reduced down diameters must

be to the outside, and spools must freely slip into the bores.
9. Install spring (20) over the spool extension on one side only. See chart for location relative to the 1/8" pipe plug.
10. Install plugs (17) with O-rings (16). Install remaining parts in plugs.

| Pump Shaft Rotation | Control mounting | Spring loc. to 1/8" plug |
|---|---|---|
| clockwise | A | same |
| clockwise | B | opposite |
| c/clockwise | A | opposite |
| c/clockwise | B | same |

11. Place two spring washers (24), nested with the bent sections matching each other, into the large hole in the servo link,
12. Place washer (19) against the spring washers.
13. Install O-ring into groove in the remaining shear seal (25). Note: This shear seal does not contain the two .094" (2.4 mm) radius scallops in the face. Place on top of washer (32). Position shear seal to match the lip on the servo link.
14. Install control on pump and torque bolts to 30 lbs-ft. (40.8 Nm).

**PARTS LIST**

*For Figure 1 - Screw adjustment control*

*S23-12327*
*CCW - "A" Mtg., CW - "B" Mtg.*

*S23-12328*
*CW - "A" Mtg., CCW - "B" Mtg.*

| ITEM | DESCRIPTION | PART NO. | QTY. |
|---|---|---|---|
| 1 | Servo shaft assy. | S13-48438 | 1 |
| 2 | Screw, hwhd. 3/8-16 x 1-1/4 | 353-25018 | 4 |
| 3 | NOT USED | | |
| 4 | Ring, WT 5100-50 | 356-65070 | 1 |
| 5 | O-ring, 70 S-1 ARP 013 | 671-00013 | 1 |
| 6 | Washer, Nyltite #37-3/8" | 631-45007 | 4 |
| 7 | O-ring, 70 S-1 ARP 017 | 671-00017 | 2 |
| 8 | Shear seal | 033-71371 | 1 |
| 9 | Thrust washer | 350-10103 | 3 |
| 10 | NOT USED | | |
| 11 | Control cover | 033-54647 | 1 |
| 12 | Hex flush plug, 1/8" pipe | 431-90204 | 1 |
| 13 | O-ring, 90 S-1 ARP 905 | 691-00905 | 3 |
| 14 | Plug, 5P5N-S | 488-35028 | 1 |
| 15 | Spool | 033-72180 | 2 |
| 16 | O-ring, 90 S-1 ARP 906 | 691-00906 | 2 |
| 17 | Plug | 033-91889 | 2 |
| 18 | Nut, cover | 033-91890 | 2 |
| 19 | Thrust washer | 350-10064 | 1 |
| 20 | Spring | 033-72198 | 1 |
| 21 | Soc. setscrew, 10-32 x 1 | 311-50002 | 2 |
| 22 | Nut | 333-67000 | 2 |
| 23 | Spring pin | 325-12120 | 2 |
| 24 | Finger spring | 350-10067 | 2 |
| 25 | Shear seal | 033-70525 | 1 |
| 26 | Control cover gasket | 033-91058 | 1 |

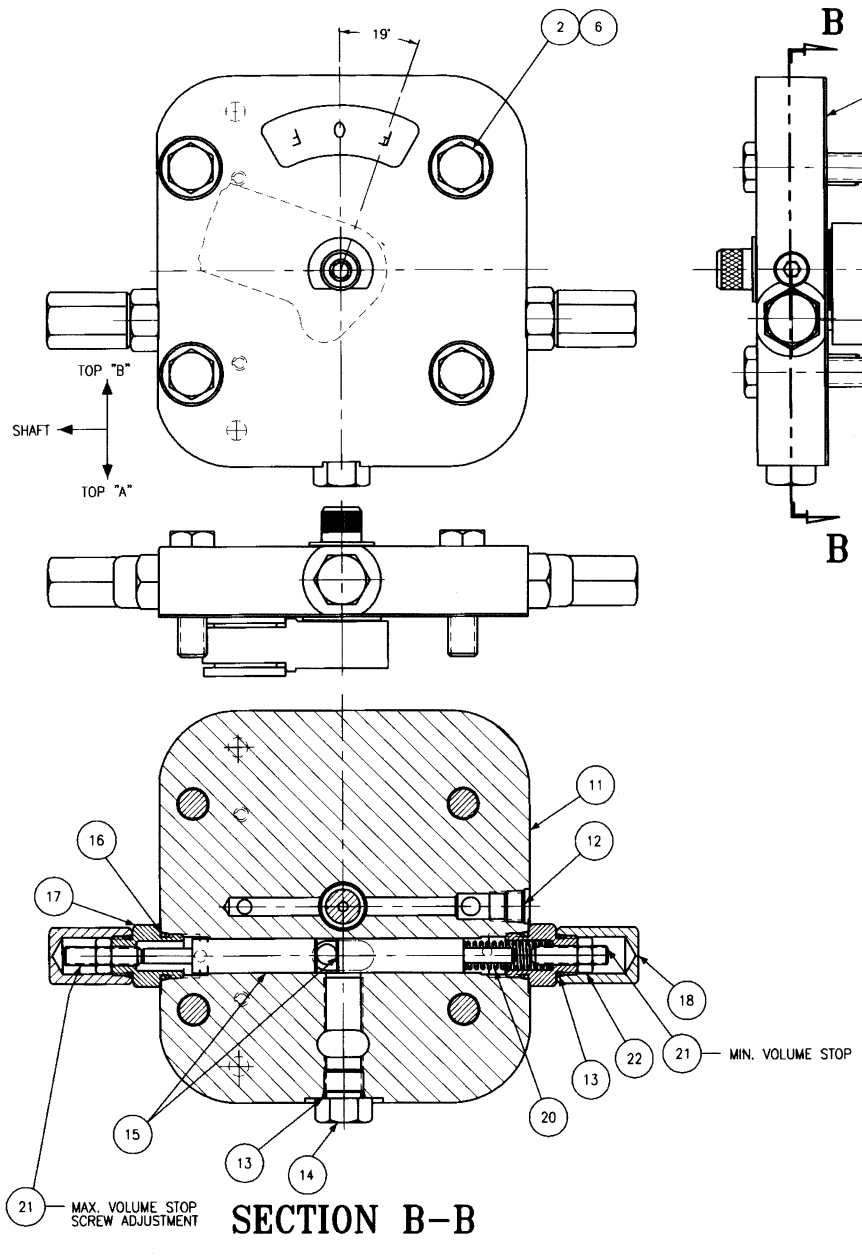



**FIGURE 1**
**SCREW ADJUSTMENT 1-SIDE OF CENTER, SPRING OFF SET TO FULL W/ADJ. MAX./MIN. VOLUME STOPS, CCW-B & CW-A**

**S23-12328**

## CODE 2A CYLINDER CONTROL

*S23-12338*
*"A" Mounting CCW Rotation pump*
*"B" Mounting CW Rotation pump*

*S23-12340*
*"A" Mounting CW Rotation pump*
*"B" Mounting CCW Rotation pump*

*S23-12326*
*"B" Mounting motor*

*S23-12329*
*"A" Mounting motor*

### DESCRIPTION

These controls provide the capability of hydraulically selecting pre-set displacements. On pump controls, the control is spring biased toward zero displacement. Maximum and minimum displacements are adjustable from zero to full. On motor controls, the control is spring offset toward full displacement. Maximum and minimum displacements are adjustable from 1/3 stroke to full. Stroking pistons engage a pin on the servo arm. When signal pressure is applied to the piston opposite to the spring, the piston moves, causing the control arm to move to the other position. With a lever attached to the input shaft, displacement may be manually controlled between these two limits when there is no control signal

### DISASSEMBLY

*See Figure 2A*

1. Remove screws (2). Remove control from pump. Examine servo plate for excessive scratching. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two socket set screws from plate, then alternately loosening the two button head screws under the set screws.
2. Remove retaining ring (4) and press the shaft assembly through the valve body.
3. Examine shoes (8) and (25) for contamination in balance pads or excessive scratching on faces. Note: the two shoes are not identical and must be installed in the proper position on reassembly.
4. Remove the plug (18) with attached parts. Remove the spools (15) and/or (22), and spring (16). Observe spools and bores for free motion, wear or contamination

### PREPARATION FOR ASSEMBLY

All parts are to be inspected and free of material defects, dirt, scratches or any foreign material. All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

### REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |

### ASSEMBLY

1. Apply pipe sealant and Install plug (12) in body. Torque to 100 lbs-in. (11.3 Nm)
2. Press spring pins (23) into body, being careful not to mar the surface in the area of the shoe path.
3. Install O-ring in groove of shear seal (8). Install shear seal with O-ring in the large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.

> Note: The shear seal will fit in one position only. Otherwise one side will be held up by the lip of the servo link. Shear seal (8) must be installed to face against the cover plate (10). This shear seal differs from shear seal (25) in that the face surface is machined with two .094" (2.4 mm) radius scallops.

4. Install needle bearing (9) over servo shaft and seat against the servo link. Install

thrust washer (6) over needle bearing.
5. Install O-ring (5) in the second groove from the end of the shaft., using installation tool T-1
6. Install the servo shaft assembly in the control cover (10).

Note: The dowel pin in the arm must be positioned in the rectangular slot beside the shaft hole. This will position the shear seal (8) face against the cover.

7. Install retaining ring (4) into the groove of the servo shaft extending through the control cover.
8. Install spools (15) and/or (22) into the bores in the body. Note: reduced down diameters must be to the outside, and spools must freely slip into the bores. Pump controls use two short spools (22). Motor controls use one long spool, (15) on the side with the spring, and one short spool (22), on the opposite side. See chart for spring location relative to item (12) figure 2A.

| **Pump Shaft Rotation** | **Control mounting** | **Spring loc. to 1/8" plug (12)** |
|---|---|---|
| clockwise | A | same |
| clockwise | B | opposite |
| c/clockwise | A | opposite |
| c/clockwise | B | same |

| **Motor control mtg**. | **Long spool and Spg. loc. to 1/8" plug (12)** |
|---|---|
| A | same |
| B | opposite |

9. Install spring (16) over the spool extension on indicated side.
10. Install plugs (17) with O-rings (16). Install remaining parts in plugs.
11. Place two spring washers (24), nested with the bent sections matching each other, into the large hole in the servo link.
12. Place washer (11) against the spring washers.
13. Install O-ring into groove in the remaining shear seal (25). Note: This shear seal does not contain the two .094" (2.4 mm) radius scallops in the face. Place on top of washer (32). Position shear seal to match the lip on the servo link.
14. Install control on pump control pad, over dowels, with gasket, (26). Place new Nyltite washers (3) on screws (2). Torque to 30 lbs-ft. (40.8 Nm).

**TEST**

1. Connect lever to input shaft. With unit running, manually stroke the shaft. Do not exceed 100 lbs-in. (11.3 Nm) torque. Pump or motor cam shall follow the motion of the input shaft.
Input shaft and cam shall return to the spring biased position when the lever is released.
2. Set the maximum stop screw for full displacement. Set the minimum stop position. For motor controls, minimum stroke shall be no less than 25% and no more than 33% of full stroke, with the lever at minimum stroke and the minimum stop screw backed away from contact with the piston. Caution! do not allow motor to exceed rated RPM. For pump controls, set the minimum stop screw for zero displacement. Lock in position.
3. Apply 300 to 600 psi servo supply to signal port. Control shaft shall rotate and pump or motor shall follow stroke of input shaft.

| **Pump shaft rotation** | **Control mounting** | **Signal port** | **Tank port** |
|---|---|---|---|
| clockwise | A | Y | X |
| clockwise | B | X | Y |
| c/clockwise | A | X | Y |
| c/clockwise | B | Y | X |

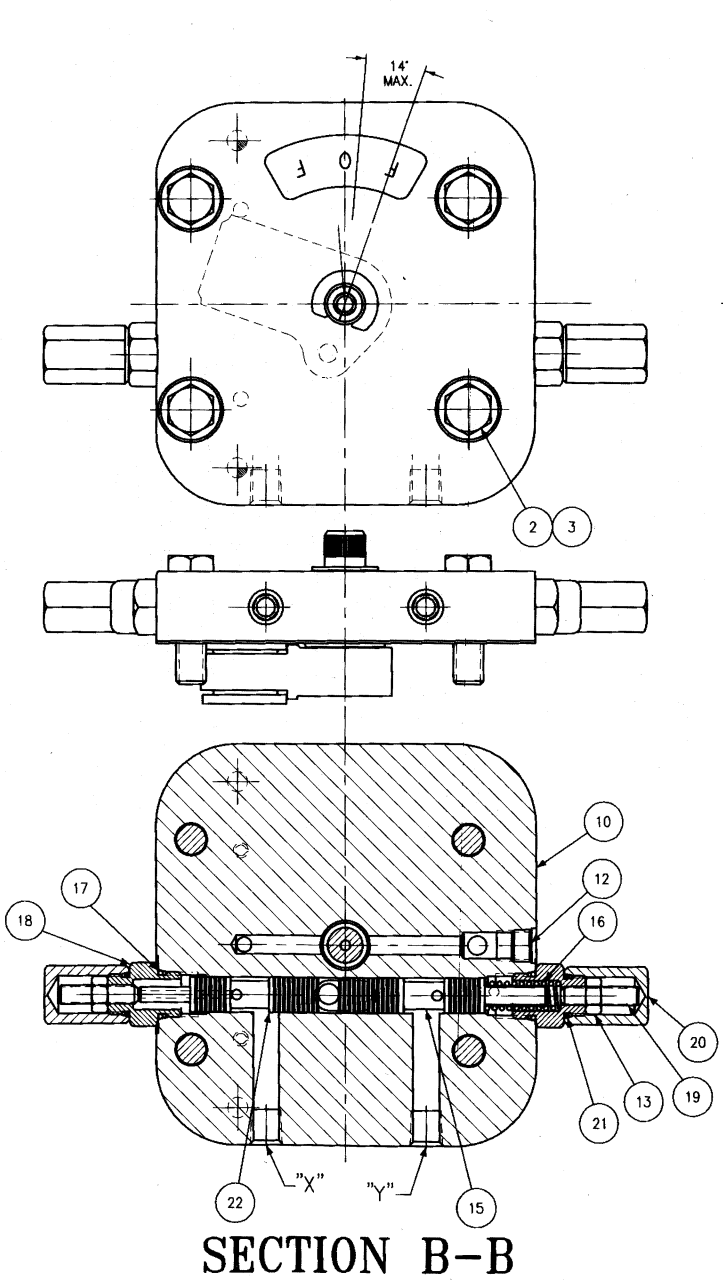
| **Motor control mounting** | **Signal port** | **Tank port** |
|---|---|---|
| A | X | Y |
| B | Y | X |

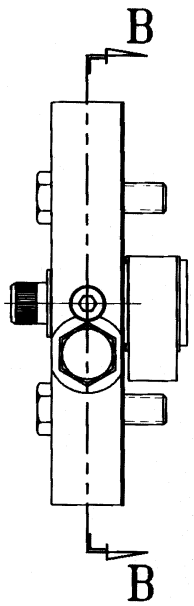
"Y" port is adjacent to 1/8" plug (12)

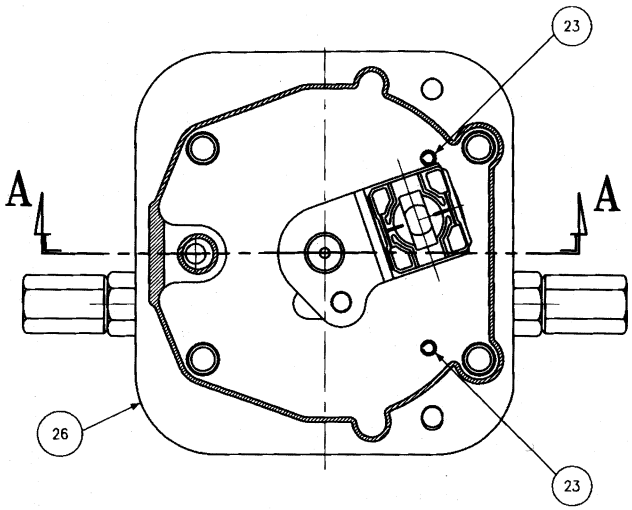
4. Drop signal pressure to minimum. Control shall return to the spring offset position, and pump or motor shall return to the initial displacement.

**PARTS LIST**
*For Figure 2A - Cylinder control*

| ITEM | DESCRIPTION | PART NO. | QTY. PUMP | QTY. MTR. |
|---|---|---|---|---|
| 1 | Servo shaft assy. | S13-48438 | 1 | 1 |
| 2 | Screw, hwhd. 3/8-16 x 1-1/4 | 353-25018 | 4 | 4 |
| 3 | Washer Nyltite #37 | 631-45007 | 4 | 4 |
| 4 | Ring, WT 5100-50 | 356-65070 | 1 | 1 |
| 5 | O-ring, 70 S-1 ARP 013 | 671-00013 | 1 | 1 |
| 6 | Washer, hardened | 350-10141 | 1 | 1 |
| 7 | O-ring, 70 S-1 ARP 017 | 671-00017 | 2 | 2 |
| 8 | Shear seal | 033-71371 | 1 | 1 |
| 9 | Needle bearing | 230-82141 | 1 | 1 |
| 10 | Control cover | 033-91154 | 1 | 1 |
| 11 | Thrust washer | 350-10064 | 1 | 1 |
| 12 | Hex flush plug 1/8” pipe | 431-90204 | 1 | 1 |
| 13 | Nut | 333-67000 | 2 | 2 |
| 14 | NOT USED | | | |
| 15 | Spool, 2.6” (66.0 mm) lg. | 033-70844 | - | 1 |
| 16 | Spring | 033-72181 | 1 | 1 |
| 17 | O-ring, 90 S-1 ARP 906 | 691-00906 | 2 | 2 |
| 18 | Plug | 033-91889 | 2 | 2 |
| 19 | Soc. setscrew. | 311-50002 | 2 | 2 |
| 20 | Nut, cover | 033-91890 | 2 | 2 |
| 21 | O-ring | 691-00905 | 2 | 2 |
| 22 | Spool, 2.26” (57.4 mm) lg. | 033-70845 | 2 | 1 |
| 23 | Spring pin | 325-12120 | 2 | 2 |
| 24 | Finger spring | 350-10067 | 2 | 2 |
| 25 | Shear seal | 033-70525 | 1 | 1 |
| 26 | Control cover gasket | 033-91058 | 1 | 1 |



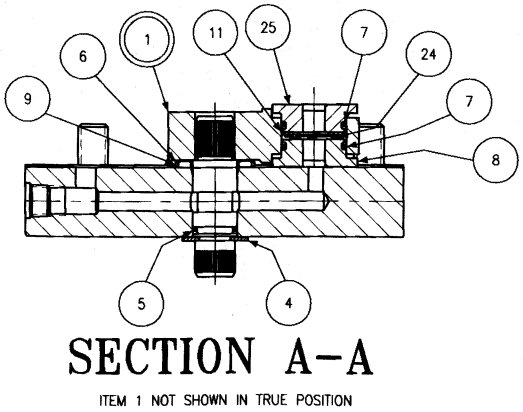




**FIGURE 2A**
**CYLINDER CONTROL**

**S23-12329**

## CODE 2H 3 POSITION CYLINDER CONTROL

*S23-12358*

### DESCRIPTION

Code 2H cross center pump controls are spring centered and can be piloted to full displacement either side of center by introducing a pilot pressure into the control ports. A trimmer adjustment provides for accurate setting of zero stroke position. Maximum displacements are adjustable from zero to full stroke.
When there is no control signal, displacement may be manually controlled between these two limits with a lever attached to the input shaft.

### DISASSEMBLY
*See Figure 2H*

1. Remove screws (17). Remove control from pump. Examine servo plate for excessive scratching. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two socket set screws from plate, then alternately loosening the two button head screws under the set screws.
2. Remove retaining ring (4) and press the shaft assembly through the valve body.
3. Examine shoes (8) and (25) for contamination in balance pads or excessive scratching on faces. Note: the two shoes are not identical and must be installed in the proper position on reassembly.
4. Remove the plug (29) with attached parts. Remove the spools (27).
5. Remove plugs (22). Remove springs (20) and spools (18). Examine spools and bores for free motion, wear or contamination.
6. If trimmer adjustment must be removed, carefully tap the spring pin (14) in till flush with O.D. of screw (13). Remove nut (15), and screw (14). Remove spring pin from screw.

### PREPARATION FOR ASSEMBLY

All parts are to be inspected and be free of material defects, dirt, scratches or any foreign material.
All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

### REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |

### ASSEMBLY

1. Apply pipe sealant and Install plug (10) in body. Torque to 100 lbs-in. (11.3 Nm)
2. Press rollpins (23) into body, being careful not to mar the surface in the area of the shoe path.
3. Press pin (12) into screw (13) to 0.38” (9.65 mm) extended length.
4. Install screw (13) into body Pin (12) should extend into spool bore approximately .090” (2.29 mm). The eccentric pin must be indexed so that it is offset towards the outside surface of the cover plate. The drilled hole for the spring pin (14) should be approximately centered in the slotted opening in the cover plate. Install spring pin (14) into trimmer assembly. Leave approximately one-half length of pin extending from screw. This will allow approximately plus or minus 45° rotation of the trimmer assembly. Install nut (15), O-ring (16), plug (32) and O-ring (31).
5. Install O-ring in groove of shear seal (8). Install shear seal with O-ring in the large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.

> Note: The shear seal will fit in one position only. Otherwise one side will be held up by the lip of the servo link. Shear seal (8) must be installed to face against the cover plate (11). This shear seal differs from shear seal (25) in that the face surface is machined with two .094” (2.4 mm) radius scallops.

6. Install thrust washers (9) over servo shaft and seat against the servo link.
7. Install O-ring (5) in the second groove from the end of the shaft, using installation tool T-1.

8. Install the servo shaft assembly in the control cover (11), engaging the pins in the slots, with the arm centered between the spring pins.
9. Install retaining ring (4) into the groove of the servo shaft extending through the control cover.
10. Install spools (18) into the bores in the body adjacent to the trimmer screw. Note that reduced down diameters must be to the outside, and spools must freely slip into the bores.
11. Install springs (20). Install O-rings (21) over plugs (22) and install plugs.
12. Install spools (27) in the remaining bores. Note that reduced down diameters must be to the outside, and spools must freely slip into the bores.
13. Install O-rings (21) on plugs (29). Install plugs in body.
14. Install adjusting screws (2), nuts (3) O-rings (30), plugs (34) and O-rings (33) into plugs (29).
15. Place two spring washers (24), nested with the bent sections matching each other, into the large hole in the servo link,
16. Place washer (11) against the spring washers.
17. Install O-ring into groove in the remaining shear seal (25). Note: This shear seal does not contain the two .094" (2.4 mm) radius scallops in the face. Place on top of washer (32). Position shear seal to match the lip on the servo link.
18. Install control over dowels, with gasket, (26), washers (6) and screws (17). Torque to 30 lbs-ft. (40.8 Nm).

**TEST**

1. Connect lever to input shaft. With unit running, manually stroke the shaft. Do not exceed 100 lbs-in. (11.3 Nm) torque on shaft. Pump shall follow the motion of the input shaft.
Input shaft and cam shall return to center when the lever is released.
2. Set the maximum stop screws for full displacement.
3. Remove plug from trimmer adjustment. Loosen locknut and adjust center position with a screwdriver. Lock on zero stroke position. Stroke pump and release handle, both sides of center. Pump shall return to zero consistently.
4. Apply 300 to 600 psi (20.5 to 41 bar) servo supply to one control port . The remaining control port shall be connected to tank. Control shaft shall rotate and pump shall follow stroke of input shaft.
5. Drop signal pressure to minimum. Control shall return to center.
6. Repeat procedure with signal applied to the other control port.

**PARTS LIST**

*For Figure 2H -3 Position cylinder control*

*S23-12358*

| ITEM | DESCRIPTION | PART NO. | QTY. |
|---|---|---|---|
| 1 | Servo shaft assy. | S23-12022 | 1 |
| 2 | Soc. setscrew | 311-50002 | 2 |
| 3 | Nut, cover | 033-91890 | 2 |
| 4 | Ring, WT 5100-50 | 356-65070 | 1 |
| 5 | O-ring, 70 S-1 ARP 013 | 671-00013 | 1 |
| 6 | Washer, Nyltite #37-3/8” | 631-45007 | 4 |
| 7 | O-ring, 70 S-1 ARP 017 | 671-00017 | 2 |
| 8 | Shear seal | 033-71371 | 1 |
| 9 | Thrust washer | 350-10103 | 3 |
| 10 | Hex flush plug, 1/8” pipe | 431-90204 | 1 |
| 11 | Control cover | 033-57807 | 1 |
| 12 | Pin | 033-71003 | 1 |
| 13 | Screw, center trim | 033-91042 | 1 |
| 14 | Spring pin 1/8 x 3/8 | 325-08060 | 1 |
| 15 | Nut | 033-91041 | 1 |
| 16 | O-ring, 70 S-1 ARP 015 | 671-00015 | 1 |
| 17 | Screw, hwhd. 3/8-16 x 1-1/4 | 353-25018 | 4 |
| 18 | Spool | 033-72180 | 2 |
| 19 | Thrust washer | 350-10064 | 1 |
| 20 | Spring | 033-72181 | 2 |
| 21 | O-ring, 90 S-1 ARP 906 | 691-00906 | 4 |
| 22 | Plug | 033-70840 | 2 |
| 23 | Spring pin, 3/16 x 3/4 | 325-12120 | 2 |
| 24 | Finger spring | 350-10067 | 2 |
| 25 | Shear seal | 033-70525 | 1 |
| 26 | Control cover gasket | 033-91058 | 1 |
| 27 | Spool | 033-70845 | 2 |
| 28 | Dust plug, 7/16-20 | 449-00506 | 2 |
| 29 | Plug | 033-91889 | 2 |
| 30 | Nut | 333-67000 | 2 |
| 31 | O-ring, 90 S-1 ARP 905 | 691-00905 | 3 |
| 32 | Plug, 5HP5N-S | 488-35020 | 1 |
| 33 | NOT USED | | |
| 34 | NOT USED | | |

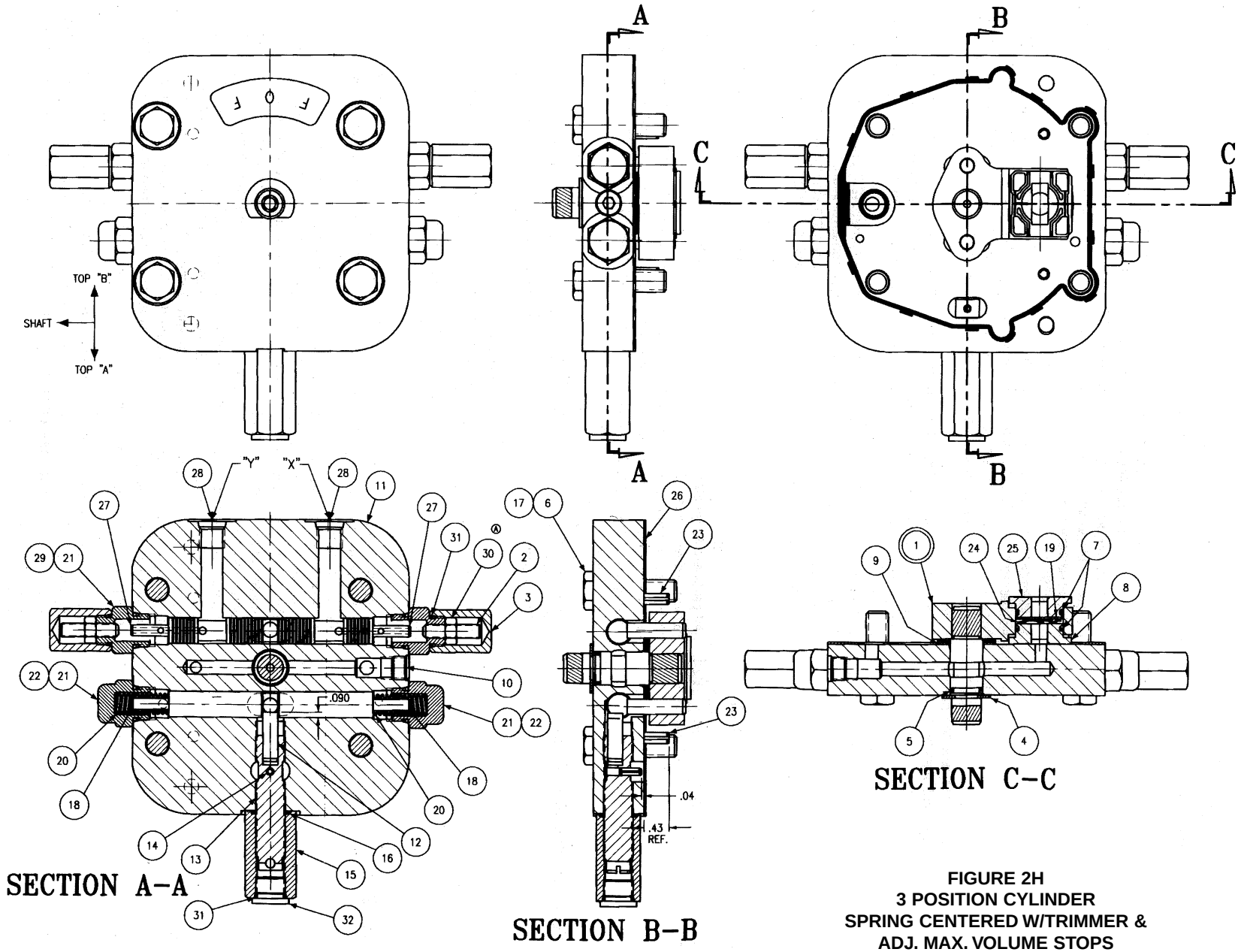



**FIGURE 2H**
**3 POSITION CYLINDER**
**SPRING CENTERED W/TRIMMER &**
**ADJ. MAX. VOLUME STOPS**

S23-12358

## CODE 4O*/4A* ROTARY SERVO SPRING CENTERED WITH TRIMMER

*S23-12344 - 4O (Less stops)*
*S23-12325 - 4A (With stops)*

### DESCRIPTION

Code 4O* and 4A* cross center pump controls are spring centered and can be manually stroked to full displacement either side of center with approximately 20 lbs-in. (2.26 Nm) torque. The spring centered position may be adjusted externally to approximately +/- 5% displacement. In the 4A control, maximum displacements are adjustable from zero to full stroke.

### DISASSEMBLY

*See Figure 4A*

1. Remove screws (2). Remove control from pump. Examine servo plate for excessive scratching. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two socket set screws from plate, then alternately loosening the two button head screws under the set screws.
2. Remove retaining ring (4) and press the shaft assembly through the valve body.
3. Examine shoes (8) and (28) for contamination in balance pads or excessive scratching on faces. Note: the two shoes are not identical and must be installed in the proper position on reassembly.
4. Remove plugs (22) with attached parts. Remove springs (20) and spools (18). Examine spools and bores for free motion, wear or contamination.
5. If trimmer adjustment must be removed, carefully tap the spring pin (14) in till flush with O.D. of screw (13). Remove nut (15), and screw (14). Remove spring pin from screw.

### PREPARATION FOR ASSEMBLY

All parts are to be inspected and be free of material defects, dirt, scratches or any foreign material.
All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

### REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |

### ASSEMBLY

1. Apply pipe sealant and install plug (10) in body. Torque to 100 lbs-in. (11.3 Nm)
2. Press spring pins (26) into body, being careful not to mar the surface in the area of the shoe path.
3. Press pin (12) into screw (13) to 0.38” (9.65 mm) extended length.
4. Install screw (13) into body Pin (12) should extend into spool bore approximately .090” (2.29 mm). The eccentric pin must be indexed so that it is offset towards the outside surface of the cover plate. The drilled hole for the spring pin (14) should be approximately centered in the slotted opening in the cover plate. Install spring pin (14) into trimmer assembly. Leave approximately one-half length of pin extending from screw. This will allow approximately plus or minus 45° rotation of the trimmer assembly. Install nut (15), O-ring (16), plug (3) and O-ring (17).
5. Install O-ring (7) in groove of shear seal (8). Install shear seal with O-ring in the large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.

> Note: The shear seal will fit in one position only. Otherwise one side will be held up by the lip of the servo link. Shear seal (8) must be installed to face against the cover plate (11). This shear seal differs from shear seal (28) in that the face surface is machined with two .094” (2.4 mm) radius scallops.

6. Install thrust washers (9) over servo shaft and seat against the servo link.
7. Install O-ring (5) in the second groove from the end of the shaft, using installation tool T-1.

8. Install the servo shaft assembly into the control cover (11), engaging the pin in the slot.
9. Install retaining ring (4) into the groove of the servo shaft extending through the control cover.
10. Install spools (18) into the bores in the body. Note that reduced down diameters must be to the outside, and spools must freely slip into the bores.
11. Install springs (20). Install O-rings (21) over plugs (22) and install plugs.
14. For the 4A control, install adjusting screws (23), nuts (24), O-rings (30), plugs (31) and O-rings (25) into plugs (22).
15. Place two spring washers (27), nested with the bent sections matching each other, into the large hole in the servo link.
16. Place washer (19) against the spring washers.
17. Install O-ring (7) into groove in the remaining shear seal (28). Note: This shear seal does not contain the two .094" (2.4 mm) radius scallops in the face. Place on top of washer (19). Position shear seal to match the lip on the servo link.
18. Install control over dowels, with gasket, (29), washers (6), and screws (2). Torque to 30 lbs-ft. (40.8 Nm).

**TEST**

1. Connect lever to input shaft. With unit running, manually stroke the shaft. Do not exceed 100 lbs-in. (11.3 Nm) torque on shaft. Pump shall follow the motion of the input shaft.
Input shaft and cam shall return to center when the lever is released.
2. For 4A controls, set maximum stop screws for full displacement.
3. Remove plug from trimmer adjustment. Loosen locknut and adjust center position with a screwdriver. Lock on zero stroke position. Stroke pump and release handle, both sides of center. Pump shall return to zero displacement consistently.

**PARTS LIST**

*For Figure 4A - Rotary servo spring centered w/trimmer*

*S23-12344 - 40* Fixed stops*

*S23-12325 - 4A* Adjustable max. volume stops*

| ITEM | DESCRIPTION | PART NO. | QTY 4O* | QTY 4A* |
|---|---|---|---|---|
| 1 | Servo shaft assembly | S13-48438 | 1 | 1 |
| 2 | Screw, 3/8-16 x 1.25 | 353-25018 | 4 | 4 |
| 3 | Plug, 5HP5N-S | 488-35020 | 1 | 1 |
| 4 | Ring, WT 5100-50 | 356-65070 | 1 | 1 |
| 5 | O-ring, 70 S-1 ARP 013 | 671-00013 | 1 | 1 |
| 6 | Washer Nyltite #37 | 631-45007 | 4 | 4 |
| 7 | O-ring, 70 S-1 ARP 017 | 671-00017 | 2 | 2 |
| 8 | Shear seal | 033-71371 | 1 | 1 |
| 9 | Washer, Thrust | 350-10103 | 3 | 3 |
| 10 | 1/8 Pipe plug | 431-90204 | 1 | 1 |
| 11 | Cover plate | 033-53576 | 1 | 1 |
| 12 | Pin | 033-71003 | 1 | 1 |
| 13 | Screw, center trim | 033-91042 | 1 | 1 |
| 14 | Spring pin, 1/8 x 3/8 | 325-08060 | 1 | 1 |
| 15 | Nut, hex | 033-91041 | 1 | 1 |
| 16 | O-ring, 70 S-1 ARP 015 | 671-00015 | 1 | 1 |
| 17 | O-ring, 90 S-1 ARP 905 | 691-00905 | 1 | 3 |
| 18 | Spool | 033-72180 | 2 | 2 |
| 19 | Thrust Washer | 350-10064 | 1 | 1 |
| 20 | Spring | 033-72181 | 2 | 2 |
| 21 | O-ring, 90 S-1 ARP 906 | 691-00906 | 2 | 2 |
| 22 | Plug | 033-70840 | 2 | - |
| | Plug | 033-91889 | - | 2 |
| 23 | Soc setscrew | 311-50002 | - | 2 |
| 24 | Nut, cover | 033-91890 | - | 2 |
| 25 | Nut | 333-67000 | - | 2 |
| 26 | Spring pin 3/16 x 3/4 | 325-12120 | 2 | 2 |
| 27 | Finger spring washer | 350-10067 | 2 | 2 |
| 28 | Shear seal | 033-70525 | 1 | 1 |
| 29 | Gasket | 033-91058 | 1 | 1 |
| 30 | NOT USED | | | |
| 31 | NOT USED | | | |

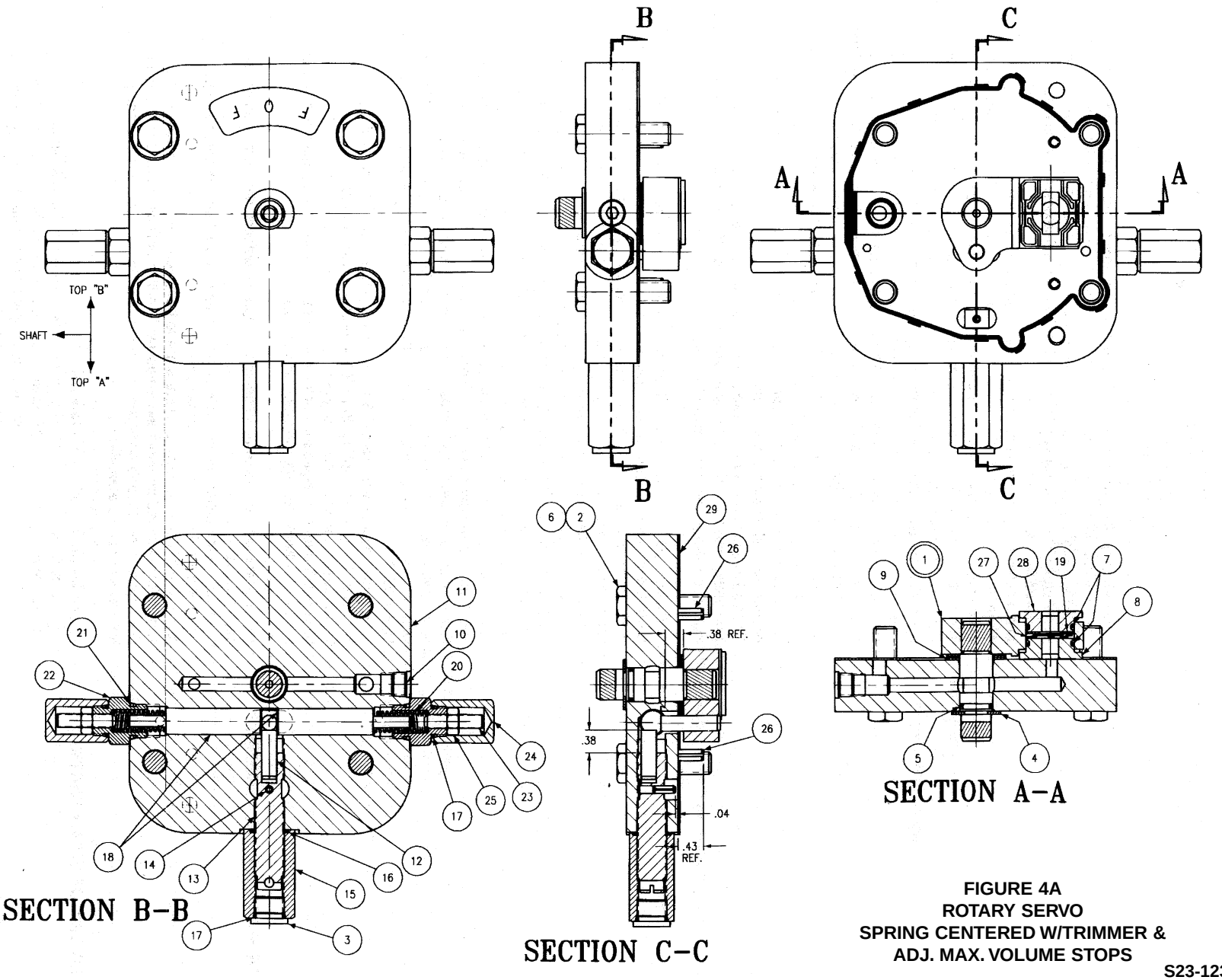



**FIGURE 4A**
**ROTARY SERVO**
**SPRING CENTERED W/TRIMMER &**
**ADJ. MAX. VOLUME STOPS**

**S23-12325**

## CODE 4B*/4C* ROTARY SERVO SPRING CENTERED WITH TRIMMER, BRAKE AND BYPASS VALVE

*S23-12343* *(4B*)*
*S23-12324* *(4C*)*

### DESCRIPTION

Code 4B* and 4C* cross center pump controls are spring and pressure centered and can be manually stroked to full displacement either side of center with approximately 20 lbs-in. (2.26 Nm) torque. The centered position may be adjusted externally to approximately +/- 5% displacement. In the 4C control, maximum stops may be adjusted from full to zero displacement.
In the same body is contained the brake and bypass valve option. A brake spool, when energized, connects the brake port to servo pressure. When de-energized, a spring shifts the spool, connecting the brake port to tank. Another port, located on the end of the brake valve, is closed by the energizing of the brake spool. When de-energized, this port dumps both pump system ports to the replenishing source, thus bypassing the small flow generated by slight errors on zero position.
The operation is controlled in this manner: A restricted servo flow is applied to shift the brake spool. This flow is dumped when a slot in the servo plate aligns with a passage connecting to this spool. This occurs when the pump is on zero stroke. Another restricted flow is applied to a spool adjacent to the brake spool. This flow is also connected to a passage in one centering piston, containing a ball and seat. When the control is off center, the ball seats, sealing the passage, to apply servo pressure to the spool. When the control is on center, a pin extending from the other centering piston pushes the ball off the seat, to dump the flow,
The brake spool is thus de-energized to set the brake when BOTH the pump cam is at zero stroke and the rotary servo is at zero command. If the pump is on stroke or the input is on stroke, the brake spool is energized, releasing the brake.

### DISASSEMBLY

*See Figure 4C*

1. Disconnect brake and bypass lines from control. Remove screws (2). Remove control from pump. Examine servo plate for excessive scratching. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two socket setscrews from plate, then alternately loosening the two button head screws under the set screws.
2. Remove retaining ring (4) and press the shaft assembly through the valve body.
3. Examine shoes (8) and (50) for contamination in balance pads or excessive scratching on faces. Note: the two shoes are not identical and must be installed in the proper position on reassembly.
4. Remove plugs (28) with attached parts. Remove springs (27), pistons (26), and spools (22), with attached parts. Do not disassemble unless parts are damaged. Examine spools, pistons and bores for free motion, wear or contamination.
5. If trimmer adjustment must be removed, carefully tap the spring pin (17) in till flush with O.D. of screw (16). Remove nut (18), and screw (16). Remove spring pin (17) from screw.
6. Remove bypass valve body (39) with fitting (41) piston (42) and spring (37). Remove plug (35) and spring (34). Remove spools (33) and (36).
7. Remove shoe (48), and spring (47).
8. Blow through passages to check two orifices (11) and orifice (10) in body for contamination. Check passages in body for free flow.

### PREPARATION FOR ASSEMBLY

All parts are to be inspected and be free of material defects, dirt, scratches or any foreign material.
All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

### REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover dings. | Stone or lap inside face to remove raised burrs & |
| Spool | Break sharp edges or dings. |

## ASSEMBLY

1. Install Lee Pluget in body using installation tool and gage.
2. Install orifices (10) and (11) in body. Torque to 25 lbs-in. (2.8 Nm). Make sure that the orifice (11) in the deeper bore extends past the wall of the valve bore and will not interfere with spool (33) or spool (22) action.
3. Apply pipe sealant and install plugs (14) in body. Torque to 100 lbs-in. (11.3 Nm)
4. Press rollpins (43) into body, being careful not to mar the surface in the area of the shoe path.
5. Install O-ring (7) in groove of shear seal (8). Install shear seal with O-ring in the large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.

Note: The shear seal will fit in one position only. Otherwise one side will be held up by the lip of the servo link. Shear seal (8) must be installed to face against the cover plate (12). This shear seal differs from shear seal (50) in that the face surface is machined with two .094" (2.4 mm) radius scallops.

6. Install needle bearing (9) over servo shaft and seat against the servo link. Install thrust washer (54) over needle bearing.
7. Install O-ring (5) in the second groove from the end of the shaft, using installation tool T-1.
8. Install the servo shaft assembly in the control cover (12), engaging the pin in the slot.
9. Install retaining ring (4) into the groove of the servo shaft extending through the control cover.
10. Press pin (15) into screw (16) to 0.38" (9.65 mm) extended length.
11. Install screw (16) into body. Pin (15) should extend into spool bore approximately .090" (2.29 mm). The eccentric pin must be indexed so that it is offset towards the outside surface of the cover plate. The drilled hole for the spring pin (17) should be approximately centered in the slotted opening in the cover plate. Install spring pin (17) into trimmer assembly. Leave approximately one-half length of pin extending from screw. This will allow approximately plus or minus 45° rotation of the trimmer assembly. Install nut (18) with O-ring (19), locking trimmer in position. Install O-ring (52) and plug (53).
12. Assemble seat insert (20) and threaded insert (21) into spools (22), using loctite #271 per instructions on bottle. Inserts must be assembled into the spool end nearest the 1/8" (3.18 mm) cross drilled holes.
13. When assembled spools (22) are installed in cover plate (12), they are held against the eccentric pin of the trimmer assembly by springs (27). In this position, adjusting screw (24) must have the ball (23) unseated by .012" (0.305 mm) to cause brake release at 5% of stroke. A special fixture permits adjustment to this setting per AP-01925. In the absence of this fixture, drop ball (23) into the spool containing the seat insert. Hold the ball against the seat by inserting piston (26) into the bore. Hold the two spools (22) with inserts together and set the adjusting screw (24) to where it just contacts the ball. Turn the adjusting screw in 8 3/8 turns past this point and lock with setscrew (25), being careful not to disturb the setting.
14. Retain ball (23) in spool bore by installing spring pin (17). Make sure that the ends of the spring pin do not extend beyond the O.D. of the spool.
15. Install pistons (26) into the spools (22). Install spool assemblies in the bore containing the trimmer adjustment. The spool containing the ball is to be on the side with the orifice (11).
16. Install springs (27) over pistons. Install plugs (28) and O-rings (29).
17. Install spools (33) and (36) into the other cross-bore in the cover (12). Spool (33) should be on the side with the orifice (11), and with the slotted side to the outside.
18. Install spring (34) and plug (35) with O-ring (29) on this side.
19. Install O-rings (40) on fitting (41). Install piston (42) in bore of body (39). Install fitting (41) on body (39) and install assembly in cover (12).
20. Install O-rings (44) and (45) on vent post (46). Install vent post in cover. Install spring (47) and shoe (48) on vent post.
21. Place two spring washers (49), nested with the bent sections matching each other, into the large hole in the servo link.
22. Place washer (55) against the spring washers.
23. Install O-ring (7) into groove in the remaining shear seal (50). Note: This shear seal does not contain the two .094" (2.4 mm) radius scallops in the face. Place on top of washer (55). Position shear seal to match the lip on the servo link.
24. For 4C controls, install adjusting screws (2), nuts (3) O-rings (30), plugs (34) and O-rings (33) into plugs (29).

25. Install control over dowels, with gasket, (51), washers (3) and screws (2). Torque to 30 lbs-ft. (40.8 Nm).
26. Install bypass tubing lines.

**TEST**

Install a needle valve on the bypass valve exhaust port, connected to tank. Close the valve.
Install a 1000 psi (70 bar) gage in the brake port.

1. Start prime mover and adjust compensator for 1000 psi (345 bar).
2. Turn centering trimmer screw to place input shaft on the zero stroke position. Stroke pump towards full and release, on both sides of center. Pump shall return to zero stroke within 200 psi (13.8 bar) max.
3. For 4C controls, unload pump, set maximum volume stops to full displacement.
4. Load pump. Stroke pump CW. The gage on the brake port should start to indicate servo pressure when the system pressure is between 2000 and 4500 psi (138 and 310 bar), with an increasing signal, and must return to case pressure before system pressure drops to 2000 psi (138 bar), on decreasing signal. Repeat by rotating input shaft CCW. If pressures are incorrect remove piston assembly containing the adjustment screw, to change ball gap setting. Extend adjustment to increase pressures, retract to reduce pressures. Standard setting is .012" (0.305 mm) gap, which is 3/8 turn of adjustment beyond closed position.
5. When finished adjusting, record both pressures for each rotation of the servo input shaft.
6. Open the needle valve on the neutral bypass port. Measure and record leakage from this port with the pump on center at minimum psi, and with the pump off center, at 5000 psi (345 bar).

**Maximum leakage with control on center:**
2.0 gpm (7.6 l/m)
**Minimum leakage with control on center:**
1.0 gpm (3.8 l/m)
**Maximum leakage with control off center:**
35 cu. in/min or .15 gpm (574 cm3/min. or 0.57 l/m)

7. Unload pump. Stroke pump above and below center. Control should operate smoothly. Brake pressure should drop to case pressure each time control is on center, and it should indicate servo pressure as soon as input shaft is rotated CW or CCW from center, per step 4 above.
8. Release control when pump is off center. Pump should return to center
9. Remove needle valve from bypass exhaust port and install exhaust line.

**PARTS LIST**

*For Figure 4C - Rotary servo with brake and bypass valve*

*S23-12343 - 4B* Fixed stops*

*S23-12324 - 4C* Adjustable max. stops*

| ITEM | DESCRIPTION | PART NO. | QTY. 4B* | QTY. 4C* |
|---|---|---|---|---|
| 1 | Servo shaft assembly | S13-48438 | 1 | 1 |
| 2 | Screw, hwhd. 3/8-16 x 1 1/4 | 353-25018 | 4 | 4 |
| 3 | Washer, Nyltite #37 | 631-45007 | 4 | 4 |
| 4 | Retaining ring, WT 5100-50 | 356-65070 | 1 | 1 |
| 5 | O-ring, 70 S-1 ARP 013 | 671-00013 | 1 | 1 |
| 6 | Plug 2HP5N-S | 488-35046 | - | 1 |
| 7 | O-ring, 70 S-1 ARP 017 | 671-00017 | 2 | 2 |
| 8 | Shear seal | 033-71371 | 1 | 1 |
| 9 | Needle bearing | 230-82141 | 1 | 1 |
| 10 | Orifice, .028" (.71 mm), 1/16 PT | 037-19104 | 1 | 1 |
| 11 | Orifice plug | 033-71437 | 2 | 2 |
| 12 | Control cover | 033-91110 | 1 | 1 |
| 13 | Lee Pluget | 447-00017 | 1 | 1 |
| 14 | 1/8" Hex flush plug | 431-90204 | 7 | 7 |
| 15 | Pin | 033-71003 | 1 | 1 |
| 16 | Center trim screw | 033-91042 | 1 | 1 |
| 17 | Spring pin 1/8 x 3/8 | 325-08060 | 2 | 2 |
| 18 | Hex nut | 033-91041 | 1 | 1 |
| 19 | O-ring, 70 S-1 ARP 015 | 671-00015 | 1 | 1 |
| 20 | Seat insert | 033-71001 | 1 | 1 |
| 21 | Threaded insert | 033-71000 | 1 | 1 |
| 22 | Spool | 033-70839 | 2 | 2 |
| 23 | Ball, 3/16" | 201-06001 | 1 | 1 |
| 24 | Adjustment screw | 033-71113 | 1 | 1 |
| 25 | Soc setscrew, 6-32 x 1/4 | 311-06042 | 1 | 1 |
| 26 | Piston | 033-70835 | 2 | 2 |
| 27 | Compression spring | 225-92040 | 2 | 2 |
| 28 | Plug | 033-70840 | 2 | - |
| | Plug, threaded | 033-70841 | - | 2 |
| 29 | O-ring, 90 S-1 ARP 906 | 691-00906 | 3 | 3 |
| 30 | Soc setscrew, 10-32 x 1" | 312-35040 | 2 | 2 |
| 31 | Cover nut, #10-32 | 033-91040 | 2 | 2 |
| 32 | O-ring, 70 S-1 ARP 010 | 671-00010 | - | 2 |
| 33 | Spool | 033-70999 | 1 | 1 |
| 34 | Spring | 033-71112 | 1 | 1 |
| 35 | Plug, 6P5ON-S | 488-35003 | 1 | 1 |
| 36 | Spool | 033-70997 | 1 | 1 |
| 37 | Spring | 033-70992 | 1 | 1 |
| 38 | Dowel pin, 1/8 x 1/2 | 324-20808 | 1 | 1 |
| 39 | Body | 033-91090 | 1 | 1 |
| 40 | O-ring, 90 S-1 ARP 016 | 691-00016 | 2 | 2 |
| 41 | Fitting | 033-70998 | 1 | 1 |
| 42 | Piston | 033-70993 | 1 | 1 |
| 43 | Spring pin, 3/16 x 3/4 | 325-12120 | 2 | 2 |
| 44 | O-ring, 90 S-1 ARP 902 | 691-00902 | 1 | 3 |
| 45 | O-ring, 70 S-1 ARP 006 | 671-00006 | 1 | 1 |
| 46 | Vent post | 033-70995 | 1 | 1 |
| 47 | Compression spring | 225-92044 | 1 | 1 |
| 48 | Shoe | 033-70996 | 1 | 1 |
| 49 | Finger spring washer | 350-10067 | 2 | 2 |
| 50 | Shear seal | 033-70525 | 1 | 1 |
| 51 | Control gasket | 033-91058 | 1 | 1 |
| 52 | O-ring, 90 S-1 ARP 905 | 691-00905 | 1 | 1 |
| 53 | Plug, 5HP5N-S | 488-35020 | 1 | 1 |
| 54 | Washer | 350-10141 | 1 | 1 |
| 55 | Thrust washer | 350-10064 | 1 | 1 |
| 56 | Plug, 2P5N-S | 488-35029 | - | 1 |

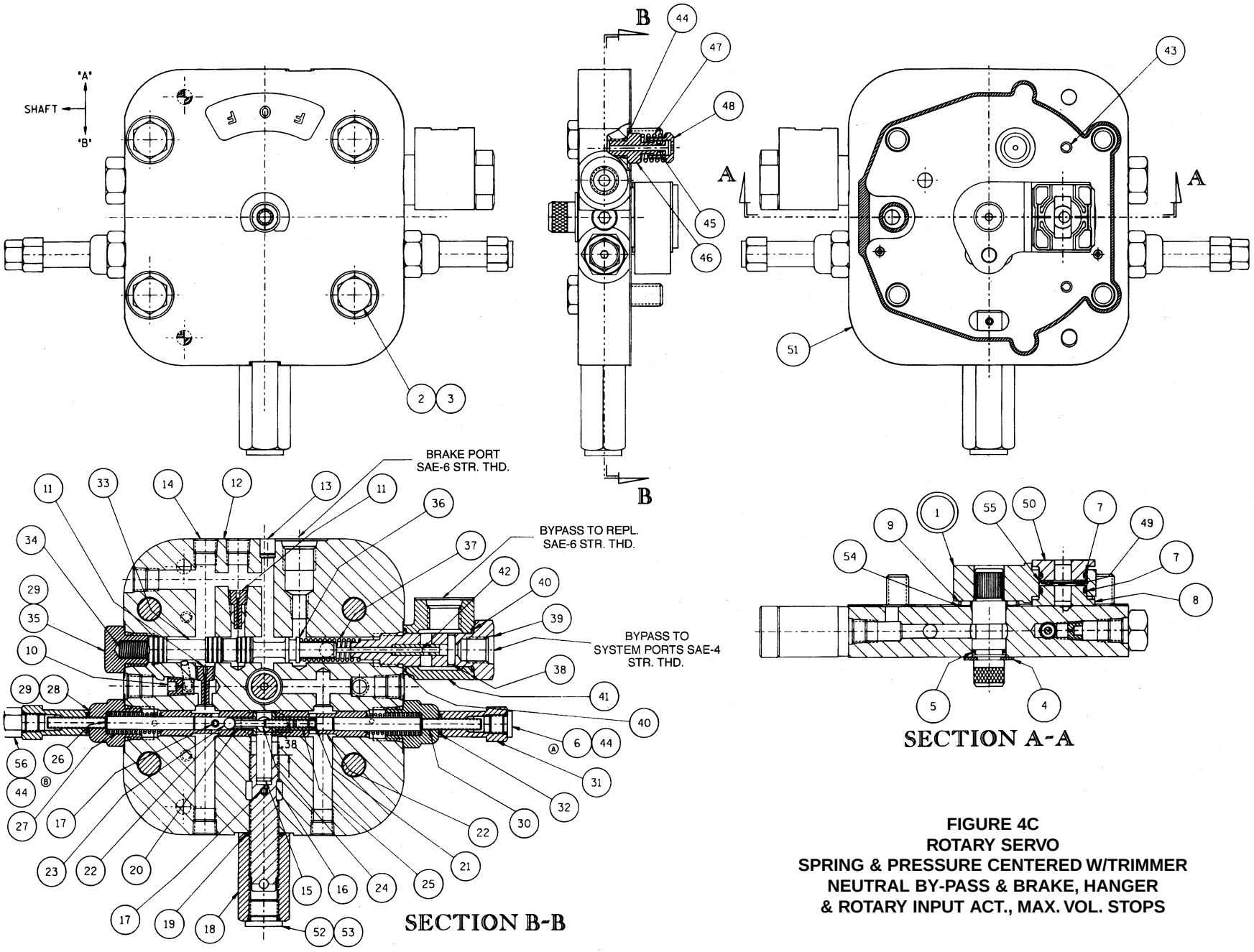



**FIGURE 4C**
**ROTARY SERVO**
**SPRING & PRESSURE CENTERED W/TRIMMER**
**NEUTRAL BY-PASS & BRAKE, HANGER**
**& ROTARY INPUT ACT., MAX. VOL. STOPS**

## CODE 5A - ELECTRIC STROKER

*S23-12413 - 5A* 00 (with deadband)*
*S23-12415 - 5A* 01 (no deadband)*
*S23-12419 - 5A* - A Mtg., Motor*
*S23-12418 - 5A* - B Mtg., Motor*

### DESCRIPTION

This control is used on both pumps and motors. The rotary servo input shaft is actuated by a hydraulic spool. A jet pipe is directed to two receiver orifices connecting to opposite ends of the hydraulic spool. The jet pipe is mechanically centered by a null adjust spring opposed by a feedback spring linked to spool position. A “voice coil” attached to the jet pipe creates an unbalance force in proportion to electrical current magnitude and direction. This causes the jet pipe to offset, increasing pressure on the one receiver and lowering pressure on the other receiver. The hydraulic spool responds causing the feedback spring to oppose the force, until the jet pipe is again centered at a new position of the servo.
When servo pressure to the jet pipe is blocked, the rotary servo spring centers and may be manually positioned.
Motor controls are configured to be offset to full stroke with zero signal, and 1/3 stroke with full signal. A spring in the rotary servo body biases the control to this position.
Cross center pump controls come in two versions. One version (feature 00) requires a small signal (deadband) prior to commencing stroke in either direction. The feature 01 control has no deadband.

**Note: This control is precision manufactured and requires training to properly assemble or disassemble. Unless repair parts and factory trained personnel are available, service should be limited to null adjustment.**

### NULL ADJUSTMENT:

If control functions over its full range, but pump remains on stroke when there is no electrical signal, adjustment of null position is indicated.
1. Load pump. Set compensator to 1000 psi (69 bar). Shut off external servo supply to control.
2. If system contains a shuttle valve, disable the shuttle valve as follows:. If shuttle is on the pump, turn the shuttle relief adjustment two turns in. If it is a Denison shuttle mounted on the motor, remove shuttle and plug the two threaded ports with 3/8-24 setscrews. Re-install the valve.
3. Adjust and lock the trimmer for minimum system pressure on both ports. Connect a handle to the .375” (9.52 mm) dia. shaft extension on the stroker. Stroke the pump both sides of center. Do not exceed 100 lbs-in. (11.3 Nm) torque. Observe pressures on system ports when handle is released. Continue adjustment till pressure on either side is less than 150 psi (10.3 bar) difference.
4. To set jet pipe null adjustment, disconnect electrical signal and open servo oil supply to stroker. (200 psi min., 1000 psi max.) (14 bar min., 69 bar max.). For pump controls with deadband, rotate the jet pipe null adjustment CCW and CW to develop 700 psi (48 bar) on each system port. **Caution: always begin adjustment by backing out (CCW) on the jet pipe null adjustment and observing control reaction. Overadjusting clockwise direction can damage the jet pipe or the trimmer spring.** Set and lock the screw midway between these two limits. Torque to 10 lbs-in. (1.1 Nm) max. Install O-ring and cover nut.
5. For pump controls with no deadband, set and lock the jet pipe null adjustment at the point of minimum system pressure on both ports with pump at operating temperature.
6. For motor controls, set and lock the jet pipe null adjustment to just before the control commences to destroke.
7. Connect electrical signal and zero the electrical driver “zero adjustment”.
8. Restore shuttle valve and system pressure settings to original operating conditions.

### PROCEDURE FOR CLEANING FILTER

*See Figure 5A*

A screen in the servo inlet line to the stroker prevents particles from getting into the jet pipe which might plug the jet pipe. In older models, this screen is behind the plug, (13). Field service is not recommended, as contaminants are on the outside, and could become dislodged in the servo body upon removal. In later models the screen is behind the fitting supplying servo oil to the stroker, and contaminants are lodged inside. With caution, it is possible to clean this filter as follows:
1. Disconnect servo tube line. Remove control from pump.
2. Remove plug (13).
3. Blow filtered air into the opening under the plug. Note if air escapes from the servo connection.
4. Force filtered oil or a compatable solvent through the opening to flush contaminants from the screen and out the servo inlet connection.

5. Carefully remove the filter without dislodging dirt into the opening. In recent controls, this filter is retained by a drilled hex plug. Backflush as before by forcing filtered oil into the port behind plug (13). Clean and install filter.
6. Examine surface of control cover for excess scratching. Examine shear seal for contamination in balance pads or deep scratches. Stone lightly to remove raised burrs and dings. Check that grooves supplying servo oil to balance pads are open.

*See Figure 5A-1 or Figure 5A-2*

7. Place two spring washers (1-6), nested with the bent sections matching each other, into the large hole in the servo link.
8. Place washer (1-10) against the spring washers.
9. Install O-ring (1-8) into groove in the shear seal (1-7). Install shear seal. Place on top of washer, (1-10). Position shear seal to match the lip on the servo link.
10. If control is to be tested on unit, install on control pad with new gasket and new Nyltite washers under screws. Torque to 30 lbs- ft. (40.8 Nm). Connect servo line and electrical connector to stroker.

**TEST, PUMP CONTROL**

1. With servo pressure applied, bleed air from force motor by loosening the screws holding the electrical connector to the cap. If force motor faces down, bleed air from the stroke limiting screws. Command stroker back and forth to assure that all air is purged from the stroke piston, and stroker is functioning properly.
2. Set compensator to 1000 psi (69 bar). Block pump outlet lines. Shut off external servo supply to control.
3. If system contains a shuttle valve, disable the shuttle valve as follows:. If shuttle is on the pump, turn the shuttle relief adjustment two turns in. If system contains a Denison shuttle mounted on the motor, remove shuttle and plug the two threaded ports with 3/8-24 setscrews. Re-install the valve.
4. Adjust and lock the mechanical trimmer for minimum system pressure on both ports. Connect a handle to the .375" (9.52 mm) dia. shaft extension on the stroker. Stroke the pump both sides of center. Do not exceed 100 lbs-in. (11.3 Nm) torque. Release handle and observe pressures on system ports. Continue adjustment till pressure is less than 150 psi (10.3 bar) difference on either side.
5. **For controls with deadband, (feature 00)**. To set jet pipe null adjustment, disconnect electrical signal and supply servo oil to stroker. (200 psi min, 1000 psi max.) (14 bar min., 69 bar max.). Rotate the jet pipe null adjustment CCW and CW to develop 700 psi (48 bar) on each system port. **Caution: always begin adjustment by backing out (CCW) on the jet pipe null adjustment and observing control reaction. Overadjusting clockwise direction can damage the jet pipe or the trimmer spring**. Set the screw midway between these two limits and lock. Torque to 10 lbs-in. (1.1 Nm) max. Install O-ring and cover nut.
6. Reconnect electrical signal and zero the electrical driver "zero adjustment" for minimum pressure.
7. Stroke to full displacement. Turn in maximum stroke stop till pump just commences reducing stroke. Lock in this position. Repeat with current of opposite polarity
8. Slowly apply current to the valve. Note the value of current at which pressure starts to build (e.g. +40MA). Back off current and slowly apply the opposite polarity current to the valve. Note the value of current at which pressure builds the opposite side of center (e.g. -50MA). The sum of the absolute values must be between 50 and 100 MA (e.g. 40 + 50=90MA), and the difference between the two absolute values must be less than 20MA. (e.g. 50 - 40=10MA). If not within specification, readjust jet pipe null.
9. **For controls with no deadband, (feature 01)**, disconnect the electrical connector, supply servo oil to the control. Set and lock the jet pipe null adjustment at the point of minimum system pressure on both ports with pump at operating temperature. Torque to 10 lbs-in. (1.1 Nm) max. **Caution: always begin adjustment by backing out (CCW) on the jet pipe null adjustment and observing control reaction. Overadjusting clockwise direction can damage the jet pipe or the trimmer spring**. Install O-ring and cover nut.
10. **For all controls**, apply 330MA to the control. The pump should go to full displacement. With the "A" terminal positive, control shaft should rotate CCW. Repeat for opposite side.
11. With pump at full displacement, block the servo supply to the stroker, The pump should spring center within 3 seconds.
12. Check for smooth change in displacement with gradual increase and decrease of control signal.
13. Restore shuttle valve and system pressure settings to original operating conditions.

**TEST, MOTOR CONTROL**

1. With servo pressure applied, bleed air from stroker force motor by loosening the screws holding the electrical connector to the cap. If force motor faces down, bleed air from the stroke limiting screws. Command stroker back and forth to assure that all air is purged from the stroke piston, and stroker is functioning properly.
2. With motor running at low speed and servo supply shut off, turn in maximum stop

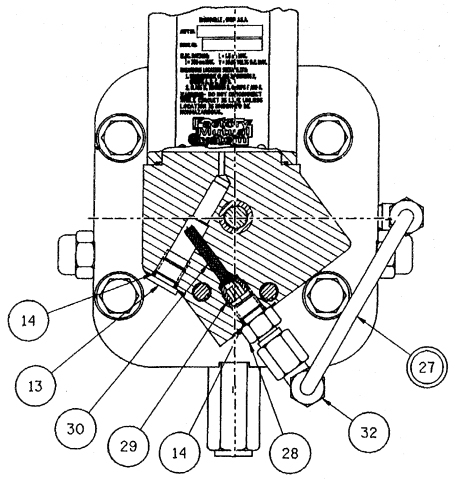
screw till motor just commences to reduce stroke (increase speed). Lock in this posi tion.
3. Open servo supply (200 psi min, 1000 psi max.) (14 bar min. 69 bar max.) and apply current (330 ma Max.), polarity to cause reduced stroke. Adjust minimum stroke screw for 1/3 stroke. (speed increased to three times initial speed) Lock in this posi-tion.
4. With motor at 1/3 stroke, shut off servo supply. Motor shall return to full stroke in 3 seconds max..
5. To set jet pipe null adjustment, disconnect electrical connector. Open servo supply. Rotate the jet pipe null adjustment CCW and CW. Set and lock at the point just before the stroker begins to reduce stroke (increase speed). Torque to 10 lbs-in. (1.1 Nm) max **Caution: always begin adjustment by backing out (CCW) on the jet pipe null adjustment and observing control reaction. Over-adjusting clockwise direction can damage the jet pipe or the trimmer spring.** Install O-ring and cover nut.
6. Re-connect electrical signal and zero the “zero adjustment”.
7. Apply 330MA to the control. The motor should go to 1/3 displacement. With the “A” terminal positive, control shaft should rotate CCW, and vice versa.
8. Check for smooth change in displacement with gradual increase and decrease of control signal.

**PARTS LIST**
*For Figure 5A Electric stroker*

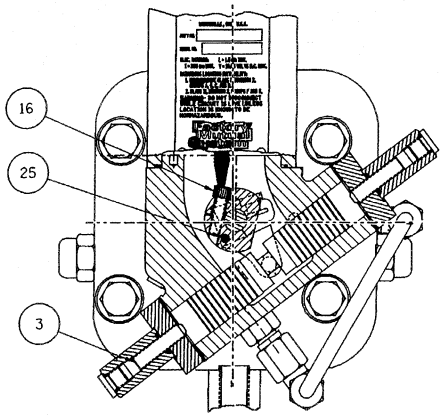
**PUMP CONTROLS**
*S23-12413 - 5A* 00 (With Deadband)*
*S23-12415 - 5A* 01 (No Deadband)*

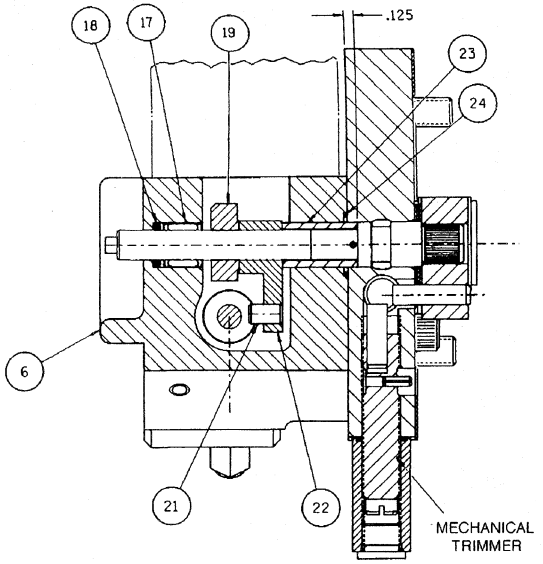
**MOTOR CONTROLS**
*S23-12419 - 5A* A Mtg.*
*S23-12418 - 5A* B Mtg.*

| | | Feature → | 00 Pump | 01 Pump | A Mtg. Motor | B Mtg. Motor |
|---|---|---|---|---|---|---|
| ITEM | DESCRIPTION | PART NO. | QTY. | QTY. | QTY. | QTY. |
| 1 | Rotary servo (Fig. 5A-1) | S23-12346 | 1 | 1 | - | - |
| | Rotary servo (Fig. 5A-2) | S23-12540 | - | - | 1 | - |
| | Rotary servo | S23-12539 | - | - | - | 1 |
| 2 | Cover nut 1/4-28 | 033-91038 | 2 | 2 | 2 | 2 |
| 3 | Screw. SHC 1/4-28 x1 | 312-11160 | 2 | 2 | 1 | 1 |
| 4 | O-ring, 70 S-5 ARP 011 | 675-00011 | 2 | 2 | 2 | 2 |
| 5 | Screw, SHC 1/4-20 x 3/4 | 358-12120 | 8 | 8 | 8 | 8 |
| 6 | Body-EH Stroker | 033-72117 | 1 | 1 | 1 | 1 |
| 7 | Spool | 033-53439 | 1 | 1 | 1 | 1 |
| 8 | Pluget, Lee | 447-00017 | 2 | 2 | 2 | 2 |
| 9 | Gasket | 033-72109 | 2 | 2 | 2 | 2 |
| 10 | Cover plate | 033-54538 | 2 | 2 | 2 | 2 |
| 11 | Screw, SHC 5/16-18 x 1 1/4 | 358-14180 | 2 | 2 | 2 | 2 |
| 12 | O-ring, 70 S-5 ARP 012 | 675-00012 | 2 | 2 | 2 | 2 |
| 13 | Plug, 4HP5N-S | 488-35061 | 1 | 1 | 1 | 1 |
| 14 | O-ring, 90 S-5 ARP 904 | 695-00904 | 1 | 1 | 1 | 1 |
| 15 | Plug, 2HP5N-S | 488-35046 | 2 | 2 | 2 | 2 |
| 16 | Screw, SHC, 10-24 x 5/8 | 358-10100 | 1 | - | - | - |
| | Screw, SHC, 10-24 x 1/2 | 358-10080 | - | 1 | 1 | 1 |
| 17 | Bearing, 3/8 x 9/16 x 1/2 | 230-82174 | 1 | - | - | - |
| | Bearing, 3/8 x 9/16 x 5/8 | 230-00610 | - | 1 | 1 | 1 |
| 18 | O-ring, 70 S-5 ARP 110 | 675-00110 | 1 | 1 | 1 | 1 |
| 19 | Clamp | 033-53688 | 1 | - | - | - |
| 20 | O-ring, 90 S-5 ARP 902 | 695-00902 | 2 | 2 | 2 | 2 |
| 21 | Pin | 033-53894 | 1 | 1 | 1 | 1 |
| 22 | Link, control | 033-53687 | 1 | - | - | - |
| | Clamp | 033-72111 | - | 1 | 1 | 1 |
| 23 | Bushing | 033-72112 | 1 | 1 | 1 | 1 |
| 24 | O-ring 70 S-5 ARP 017 | 675-00017 | 1 | 1 | 1 | 1 |
| 25 | Dowel pin, 1/8 x 1/2 | 324-20808 | 1 | - | - | - |
| 26 | Dowel pin, 3/16 x 1/2 | 324-21208 | 1 | 1 | 1 | 1 |
| 27 | Tubing, servo control | S23-12939 | 1 | 1 | 1 | 1 |
| 28 | Connector, 4-F5BX-S | 493-15027 | 1 | 1 | 1 | 1 |
| 29 | Screw | 033-91103 | 1 | 1 | 1 | 1 |
| 30 | Filter element | 033-91104 | 1 | 1 | 1 | 1 |
| 31 | Screw, SHC 1/4-28 x 1 1/2 | 312-11200 | - | - | 1 | 1 |
| 32 | Fitting, swivel nut elbow | 496-15009 | 1 | 1 | 1 | 1 |
| 33 | Force motor | S13-46096 | 1 | 1 | 1 | 1 |
| 34 | Nameplate | 033-91430 | 1 | 1 | 1 | 1 |
| 35 | Screw, HWHD 3/8-16 x 1 1/4 | 353-25018 | 4 | 4 | 4 | 4 |
| 36 | Washer, Nyltite #37 | 631-45007 | 4 | 4 | 4 | 4 |
| 37 | Drive screw,#2 x 3/16 | 320-10203 | 4 | 4 | 4 | 4 |

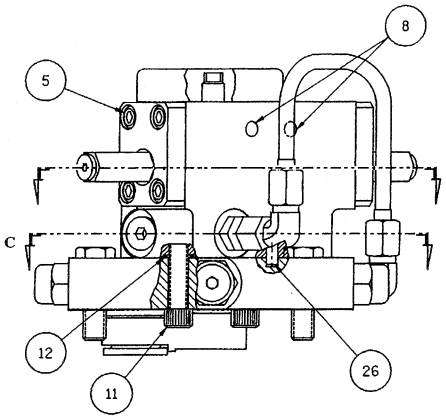


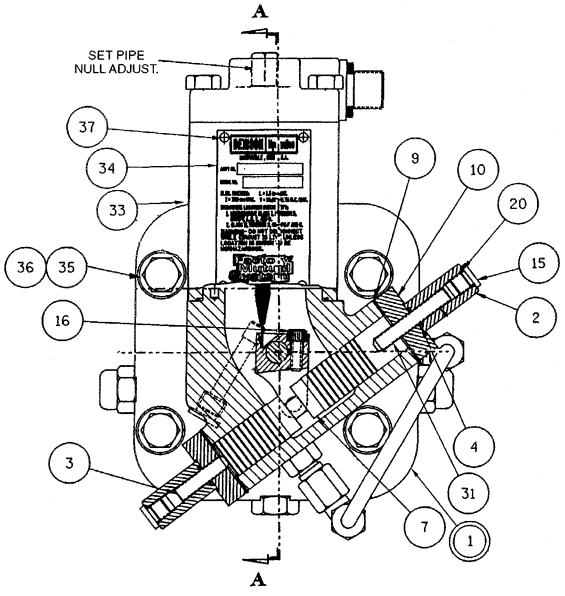

SECTION C-C




PUMP CONTROL W/DEADBAND




SECTION B-B

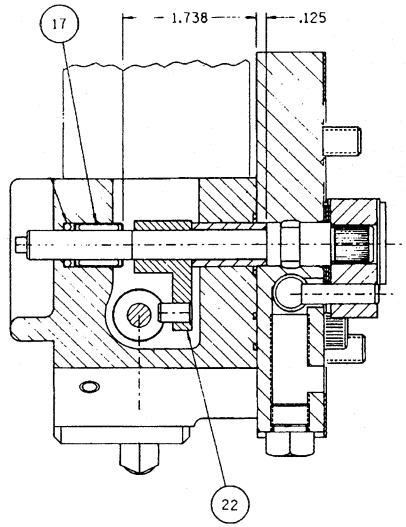



**FIGURE 5A**
**ELECTRIC STROKER**
**MOTOR CONTROL "O" DEAD BAND**
**"A" MTG. SHOWN**
**REVERSE ITEMS 3, 31 FOR "B" MTG.**

**PARTS LIST**

*For Figure 5A-1 - Servo for electric stroker - pump*

*S23-12346*
*Rotary servo for pump electric stroker*

| ITEM | DESCRIPTION | PART NO. | QTY. |
|---|---|---|---|
| 1 | Servo shaft, link & shear seal | S23-12497 | (1) |
| 1-1 | Servo shaft | 033-54841 | 1 |
| 1-2 | Pin | 033-71002 | 1 |
| 1-3 | Servo link | 033-70536 | 1 |
| 1-4 | Washer | 350-10141 | 1 |
| 1-5 | Shear seal, feed | 033-71371 | 1 |
| 1-6 | Washer, finger spring | 350-10067 | 2 |
| 1-7 | Shear seal | 033-70525 | 1 |
| 1-8 | O-ring, 70 S-5 ARP 017 | 675-00017 | 2 |
| 1-9 | Needle bearing | 230-82141 | 1 |
| 1-10 | Thrust washer | 350-10064 | 1 |
| 2 | O-ring, 90 S-5 ARP 905 | 695-00905 | 1 |
| 3 | Plug, 5-HP5N-S | 488-35020 | 1 |
| 7 | Gasket | 033-91058 | 1 |
| 9 | Cover plate | 033-72114 | 1 |
| 12 | Plug | 033-70840 | 2 |
| 13 | O-ring, 90 S-5 ARP 906 | 695-00906 | 2 |
| 14 | Spring | 033-72181 | 2 |
| 15 | Spool, short | 033-72180 | 2 |
| 16 | Fitting, male elbow | 473-15042 | 1 |
| 17 | O-ring, 70 S-5 ARP 015 | 675-00015 | 1 |
| 18 | Screw, center trim | 033-91042 | 1 |
| 19 | Nut | 033-91041 | 1 |
| 20 | Spring pin 1/8 x 3/8 | 325-08060 | 1 |
| 21 | Pin | 033-71003 | 1 |

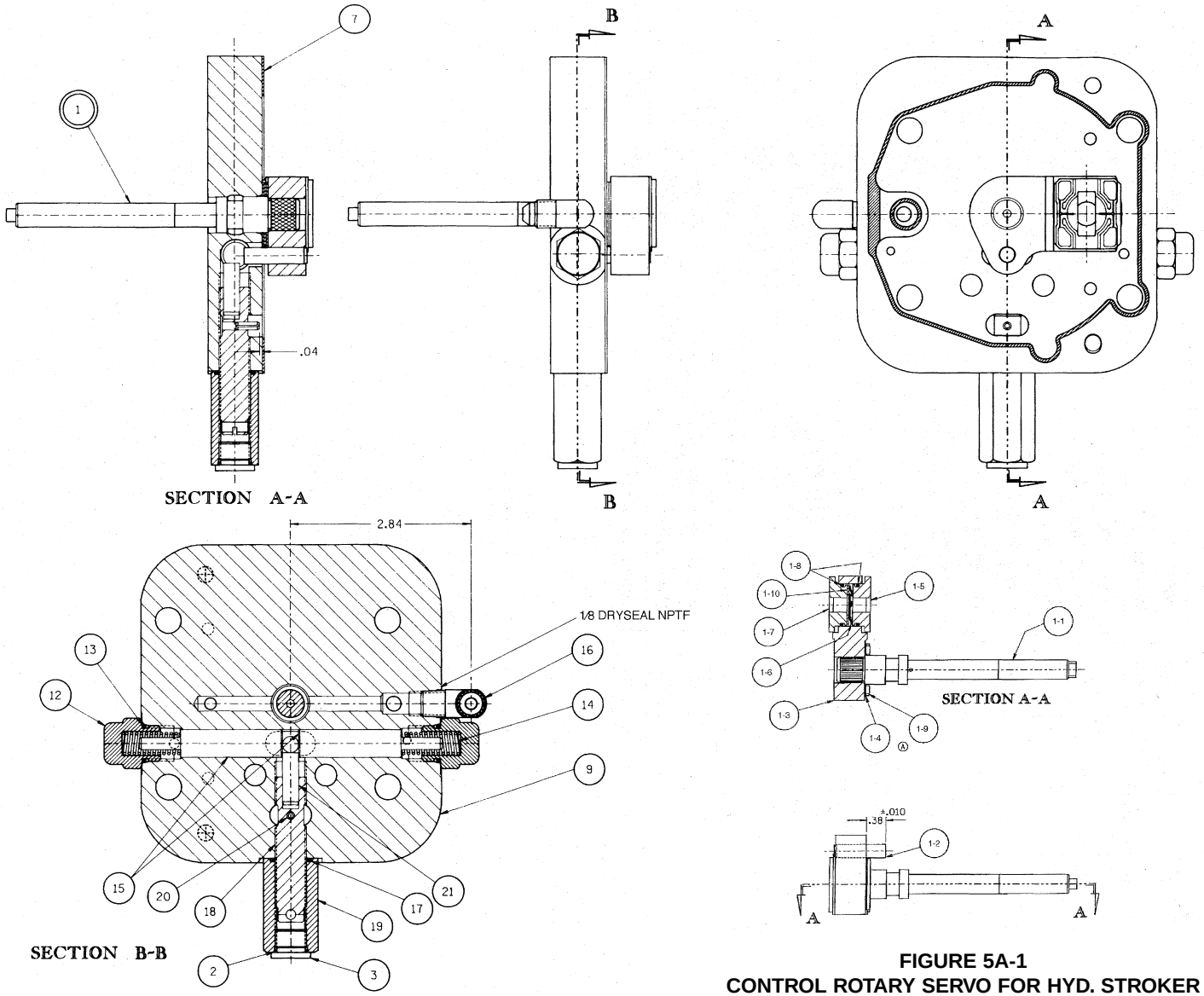



**FIGURE 5A-1**
**CONTROL ROTARY SERVO FOR HYD. STROKER**
**SPRING CENTERED WITH TRIMMER**

**S23-12346**

**PARTS LIST**

*For Figure 5A-2 - Servo for electric stroker- motor*

*S23-12540 - 5A* A Mtg.*
*23-12539 - 5A* B Mtg.*

*Rotary servo for motor electric stroker*

| ITEM | DESCRIPTION | PART NO. | QTY. |
|---|---|---|---|
| 1 | Servo shaft, link & shear seal | S23-12497 | (1) |
| 1-1 | Servo shaft | 033-54841 | 1 |
| 1-2 | Pin | 033-71002 | 1 |
| 1-3 | Servo link | 033-70536 | 1 |
| 1-4 | Washer | 350-10141 | 1 |
| 1-5 | Shear seal, feed | 033-71371 | 1 |
| 1-6 | Washer, finger spring | 350-10067 | 2 |
| 1-7 | Shear seal | 033-70525 | 1 |
| 1-8 | O-ring, 70 S-5 ARP 017 | 675-00017 | 2 |
| 1-9 | Needle bearing | 230-82141 | 1 |
| 1-10 | Thrust washer | 350-10064 | 1 |
| 2 | Gasket | 033-91058 | 1 |
| 3 | Cover plate | 033-72114 | 1 |
| 4 | Spool, short | 033-72180 | 1 |
| 5 | Plug | 033-70840 | 2 |
| 6 | O-ring, 90 S-5 ARP 906 | 695-00906 | 2 |
| 7 | Spring | 033-72181 | 1 |
| 8 | Spool, long | 033-70844 | 1 |
| 9 | Fitting, male elbow | 473-15042 | 1 |
| 10 | Plug, 5-P5N-S | 488-35028 | 1 |
| 11 | O-ring, 90 S-5 ARP 905 | 695-00905 | 1 |

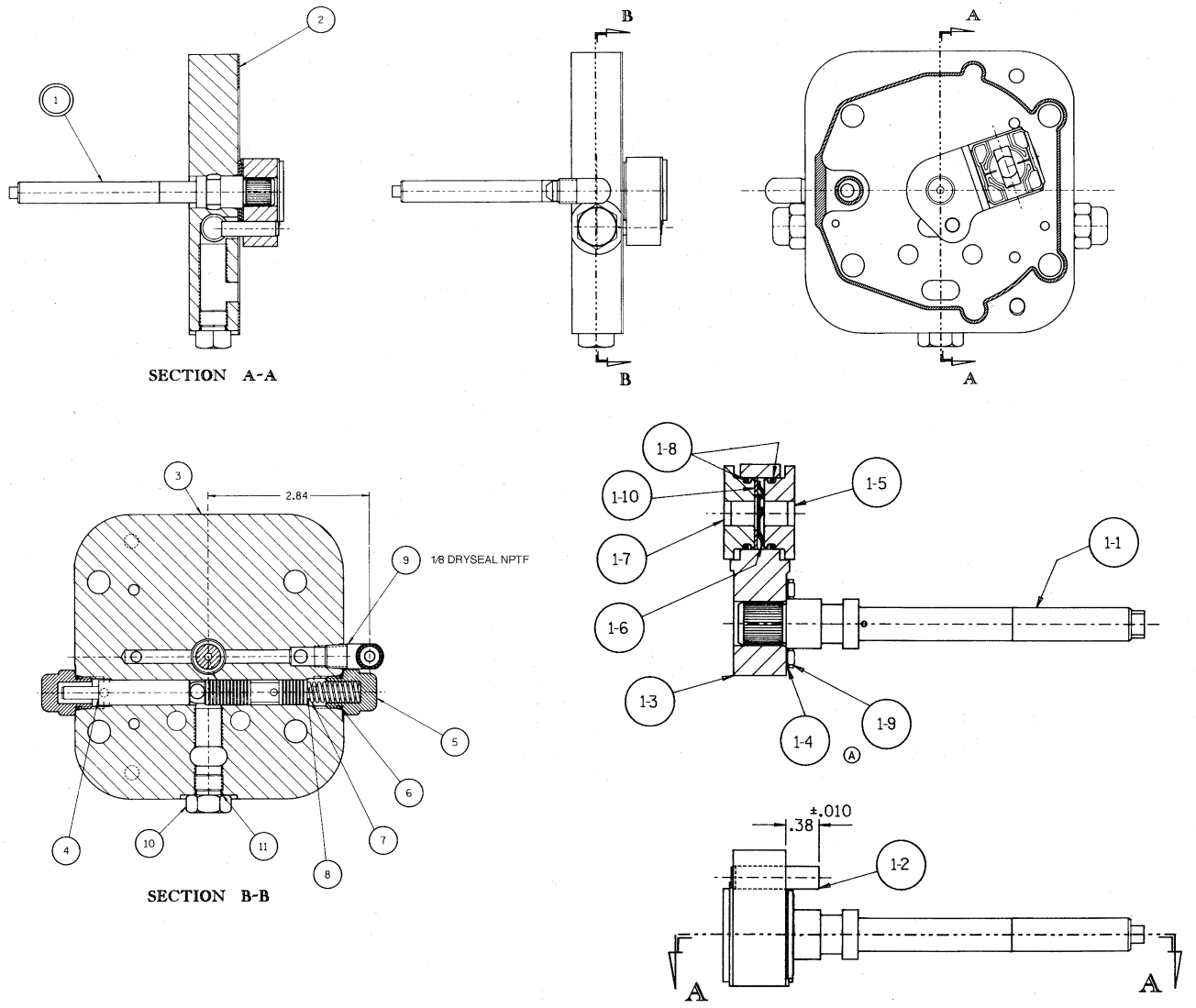



**FIGURE 5A-2**
**ASSEMBLY ROTARY SERVO,**
**SPRING OFF-SET, ELEC/HYD. CONTROL;**
**A SIDE INPUT, REVERSE ASSEMBLY OF**
**4, 7, 8 FOR B SIDE INPUT**

**S23-12540**

## CODE 5C - ELECTRIC STROKER WITH BRAKE AND BYPASS

*S23-12414 - 5C* 00 (With Deadband)*
*S23-12420 - 5C* 01 (No Deadband)*

### DESCRIPTION

This control is used on pumps. The rotary servo input shaft is actuated by a hydraulic spool. A jet pipe is directed to two receiver orifices connecting to opposite ends of the hydraulic spool. The jet pipe is mechanically centered by a null adjust spring opposed by a feedback spring linked to spool position. A “voice coil” attached to the jet pipe creates an unbalance force in proportion to electrical current magnitude and direction. This causes the jet pipe to offset, increasing pressure on the one receiver and lowering pressure on the other receiver. The hydraulic spool responds causing the feedback spring to oppose the force, until the jet pipe is again centered at a new position of the servo.

When servo pressure to the jet pipe is blocked, the rotary servo spring centers, and may be manually positioned.

One version of the cross center control requires a small signal (deadband) prior to commencing stroke in either direction. This control contains spring centering pistons and neutral trimmer adjustment for accurate centering. Another version, (no deadband) provides linear displacement with input command for accurate servo applications.

In the control cover is contained the brake and bypass valve option. A brake spool, when energized, connects the brake port to servo pressure. When de-energized, a spring shifts the spool, connecting the brake port to tank. Another port, located on the end of the brake valve, is closed by the energizing of the brake spool. When de-energized, this port dumps both pump system ports to the replenishing source, thus bypassing the small flow generated by slight errors on zero position.

The operation is controlled in this manner: A restricted servo flow is applied to shift the brake spool. This flow is dumped when a slot in the servo plate aligns with a passage connecting to this spool. This occurs when the pump is on zero stroke. Another restricted flow is applied to a spool adjacent to the brake spool. This flow is also connected to a passage in one centering piston, containing a ball and seat. When the control is off center, the ball seats, sealing the passage, to apply servo pressure to the spool. When the control is on center, a pin extending from the other centering piston pushes the ball off the seat, to dump the flow,

The brake spool is thus de-energized to set the brake when BOTH the pump cam is at zero stroke and the rotary servo is at zero command. If the pump is on stroke or the input is on stroke, the brake spool is energized, releasing the brake.

### DISASSEMBLY

*See Figure 5C*

**Note: This control is precision manufactured and requires training to properly assemble or disassemble. Unless repair parts and factory trained personnel are available, service should be limited to the brake and bypass portion, and null adjustment**

### NULL ADJUSTMENT:

If control functions over its full range, but pump remains on stroke when there is no electrical signal, adjustment of null position is indicated.

1. Load pump. Set compensator to 1000 psi (69 bar). Shut off external servo supply to control.
2. If system contains a shuttle valve, disable the shuttle valve as follows:. If shuttle is on the pump, turn the shuttle relief adjustment two turns in. If it is a Denison shuttle mounted on the motor, remove shuttle and plug the two threaded ports with 3/8-24 setscrews. Re-install the valve.
3. Adjust and lock the trimmer for minimum system pressure on both ports. Connect a handle to the .375” (9.52 mm) dia. shaft extension on the stroker. Stroke the pump both sides of center. Do not exceed 100 lbs-in. (11.3 Nm) torque. Observe pressures on system ports when handle is released. Continue adjustment till pressure on either side is less than 150 psi (10.3 bar) difference.
4. To set jet pipe null adjustment, disconnect electrical signal and open servo oil supply to stroker. (200 psi min, 1000 psi max.) (14 bar min. 69 bar max.). For pump controls with deadband, rotate the jet pipe null adjustment CCW and CW to develop 700 psi (48 bar) on each system port. **Caution: always begin adjustment by backing out (CCW) on the jet pipe null adjustment and observing control reaction. Overadjusting clockwise direction can damage the jet pipe or the trimmer spring.** Set and lock the screw midway between these two limits. Torque to 10 lbs-in. (1.1 Nm) max. Install O-ring and cover nut.
5. For pump controls with no deadband, set and lock the jet pipe null adjustment at the point of minimum system pressure on both ports with pump at operating temperature.

6. Connect electrical signal and zero the electrical driver “zero adjustment”.
7. Restore shuttle valve and system pressure settings to original operating conditions.

**PROCEDURE FOR CLEANING FILTER**

A screen in the servo inlet line to the stroker prevents particles from getting into the jet pipe which might plug the jet pipe. In older versions, this screen is behind the plug, (13). Field service is not recommended, as contaminants are on the outside, and could become dislodged in the servo body upon removal. In later versions the screen is behind the fitting supplying servo oil to the stroker, and contaminants are lodged inside. With caution, it is possible to clean this filter as follows:
1. Disconnect servo tube line. Remove control from pump.
2. Remove plug (13).
3. Blow filtered air into the opening under the plug. Observe for air from the servo connection.
4. Force filtered oil or a compatable solvent through the opening to flush contaminants from the screen and out the servo inlet connection.
5. Carefully remove the filter without dislodging dirt into the opening. In latest version, this filter is retained by a drilled hex plug. Backflush as before by forcing filtered oil into the port behind plug (13). Clean and install filter.
6. Examine surface of control cover for excess scratching. Examine shear seal for contamination in balance pads or deep scratches. Stone lightly to remove raised burrs and dings. Check that grooves supplying servo oil to balance pads are open.
7. Place two spring washers (31-6), nested with the bent sections matching each other, into the large hole in the servo link.
8. Place washer (31-10) against the spring washers.
9. Install O-ring (31-8) into groove in the shear seal (31-7). Install shear seal Place on top of washer, (31-10). Position shear seal to match the lip on the servo link.
10. If control is to be tested on unit, install on control pad with new gasket and new Nyltite washers under screws. Torque to 30 lbs- ft. (40.8 Nm). Connect bypass tubing lines. Connect servo line and electrical connector to stroker.

**DISASSEMBLY OF BRAKE AND BYPASS PORTION**
*See Figure 5C-1*

1. Remove plugs (28). Remove springs (27), pistons (26), and spools (22), with attached parts. Do not disassemble unless parts are damaged. Examine spools, pistons and bores for free motion, wear or contamination.
2. If trimmer adjustment must be removed, carefully tap the spring pin (17) in till flush with O.D. of screw (16). Remove nut (18), and screw (16). Remove spring pin (17) from screw.
3. Remove bypass valve body (36) with fitting (38) piston (39) and spring (34). Remove plug (32) and spring (31). Remove spools (30) and (33).
4. Remove shoe (45), and spring (44).
5. Blow through passages to check two orifices (11) and orifice (10) in body for contamination. Check passages in body for free flow.

**PREPARATION FOR ASSEMBLY**

All parts are to be inspected and be free of material defects, dirt, scratches or any foreign material.
All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

**REWORK OF WEAR PARTS**

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |
| Shoe | Stone to remove raised burrs or dings. |

**ASSEMBLY**
*See Figure 5C-1*

1. Install orifices (10) and (11) in body. Torque to 25 lbs-in. (2.8 Nm). Make sure that the orifice (11) in the deeper bore extends past the wall of the valve bore and will not interfere with spool (33) or spool (22) action.
2. Apply pipe sealant and install plugs (14) in body. Torque to 100 lbs-in. (11.3 Nm)
3. Press pin (15) into screw (16) to 0.38” (9.65 mm) extended length.
4. Install screw (16) into body. Pin (15) should extend into spool bore approximately .090” (2.29 mm). The eccentric pin must be indexed so that it is offset towards the outside surface of the cover plate. The drilled hole for the spring pin (17) should be approximately centered in the slotted opening in the cover plate. Install spring pin (17) into trimmer assembly. Leave approximately one-half length of pin extending from

screw. This will allow approximately plus or minus 45° rotation of the trimmer assembly. Install nut (18) with O-ring (19), locking trimmer in position. Install O-ring (52) and plug (53).
5. Assemble seat insert (20) and threaded insert (21) into spools (22), using loctite #271 per instructions on bottle. Inserts must be assembled into the spool end nearest the 1/8" (3.18 mm) cross drilled holes.
6. When assembled spools (22) are installed in cover plate (12), they are held against the eccentric pin of the trimmer assembly by springs (27). In this position, adjusting screw (24) must have the ball (23) unseated by .012" (.305 mm) to cause brake release at 5% of stroke. A special fixture permits adjustment to this setting per AP-01925. In the absence of this fixture, drop ball (23) into the spool containing the seat insert. Hold the ball against the seat by inserting piston (26) into the bore. Hold the two spools (22) with inserts together and set the adjusting screw (24) to where it just contacts the ball. Turn the adjusting screw in 8 3/8 turns past this point and lock with setscrew (25), being careful not to disturb the setting.
7. Retain ball (23) in spool bore by installing spring pin (17). Make sure that the ends of the spring pin do not extend beyond the O.D. of the spool.
8. Install pistons (26) into the spools (22). Install spool assemblies in the bore containing the trimmer adjustment. The spool containing the ball is to be on the side with the orifice (11).
9. Install springs (27) over pistons. Install plugs (28) and O-rings (29).
10. Install spools (30) and (33) into the other cross-bore in the cover (12). Spool (30) should be on the side with the orifice (11), and with the slotted side to the outside.
11. Install spring (31) and plug (32) with O-ring (29) on this side.
12. Install O-rings (37) on fitting (38). Install piston (39) in bore of body (36). Install fitting (38) on body (36) and install assembly in cover (12).
13. Install O-rings (41) and (42) on vent post (43). Install vent post in cover. Install spring (44) and shoe (45) on vent post.

*See Figure 5-C*

14. Place two spring washers (31-6), nested with the bent sections matching each other, into the large hole in the servo link.
15. Place washer (31-4) against the spring washers.
16. Install O-ring (31-8) into groove in the remaining shear seal (31-7). Place on top of washer (31-4). Position shear seal to match the lip on the servo link.
17. Install control on pump over dowels, with gasket, washers (36) and screws (35). Torque to 30 lbs-ft. (40.8 Nm).
18. Install bypass tubing lines.

**TEST**

Install a needle valve on the bypass valve exhaust port, connected to tank. Close the valve. Install a 1000 psi (70 bar) gage in the brake port.
1. With servo pressure applied, bleed air from force motor by loosening the screws holding the electrical connector to the cap. If force motor faces down, bleed air from the stroke limiting screws. Command stroker back and forth to assure that all air is purged from the stroke piston, and stroker is functioning properly.
2. Load pump. Set compensator to 1000 psi. Shut off external servo supply to control.
3. If system contains a shuttle valve, disable the shuttle valve as follows:. If shuttle is on the pump, turn the shuttle relief adjustment two turns in. If it is a Denison shuttle mounted on the motor, remove shuttle and plug the two threaded ports with 3/8-24 setscrews. Re-install the valve.
4. Adjust and lock the trimmer for minimum system pressure on both ports. Connect a handle to the .375" (9.52 mm) dia. shaft extension on the stroker. Stroke the pump both sides of center. Do not exceed 100 lbs-in. (11.3 Nm) torque. Observe pressures on system ports. Continue adjustment till pressure on either side is less than 150 psi difference.
5. Disconnect electrical signal and open servo oil supply to stroker. (200 psi min, 1000 psi max.) (14 bar min. 69 bar max.).
6. **For controls with deadband (Feature 00)**, rotate the jet pipe null adjustment CCW and CW to develop 700 psi (48 bar) on each system port. **Caution: always begin adjustment by backing out (CCW) on the jet pipe null adjustment and observing control reaction. Overadjusting clockwise direction can damage the jet pipe or the trimmer spring**. Set the screw midway between these two limits and lock. Torque to 10 lbs-in. (1.1 Nm) max. Install O-ring and cover nut.
7. **For controls with no deadband**, set and lock the jet pipe null adjustment at the point of minimum system pressure on both ports with pump at operating temperature.
8. Reconnect electrical signal and zero the electrical driver "zero adjustment" for minimum pressure.
9. Unload pump. Stroke to full displacement. Turn in maximum stroke stop till pump just commences reducing stroke. Lock in this position. Repeat with current of opposite polarity
10. For controls with the 00 feature (deadband): Slowly apply current to the valve. Note the value of current at which pressure starts to build (e.g. +40MA). Back off cur

rent and slowly apply the opposite polarity current to the valve. Note the value of current at which pressure builds the opposite side of center (e.g. -50MA). The sum of the absolute values must be between 50 and 100 MA (e.g. 40 + 50=90MA), and the difference between the two absolute values must be less than 20MA. (e.g. 50 - 40=10MA). If not within specification, readjust jet pipe null.
For controls with the 01 feature (no deadband), there should be minimal hesitation as the control signal passes through zero.
11. Apply 330MA to the control. The pump should go to full displacement. Repeat for opposite side. With the “A” terminal positive, control shaft should rotate CCW.
12. With pump at full displacement, block the servo supply to the stroker. The pump should spring center within 3 seconds.
13. Check for smooth change in displacement with gradual increase and decrease of control signal.
14. Load pump. Stroke input shaft CW. The gage on the brake port should start to indicate servo pressure when the system pressure is between 2000 and 4500 psi (138 and 310 bar), with an increasing signal, and must return to case pressure before system pressure drops to 2000 psi (138 bar), on decreasing signal. Repeat by rotating input shaft CCW. If pressures are incorrect remove piston assembly containing the adjustment screw, to change ball gap setting. Extend adjustment to increase pressures, retract to reduce pressures. Standard setting is .012” (0.305 mm) gap, which is 3/8 turn of adjustment beyond closed position.
15. When finished adjusting, record both pressures for each rotation of the servo input shaft.
16. Open the needle valve on the neutral bypass port. Measure and record leakage from this port with the pump on center at minimum psi, and with the pump off center, at 5000 psi

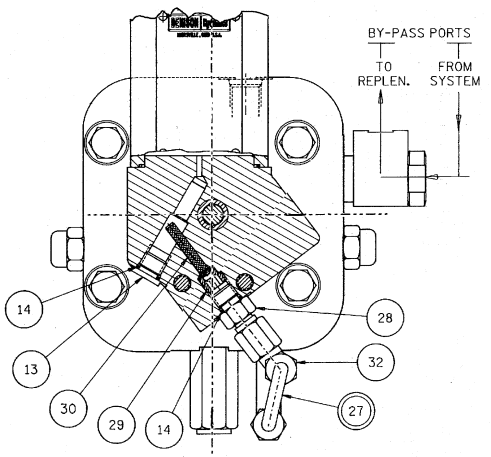
**Maximum leakage with control on center:**
2.0 gpm (7.6 l/m)
**Minimum leakage with control on center:**
1.0 gpm (3.8 l/m)
**Maximum leakage with control off center:**
35 cu. in/min or .15 gpm (574 $cm^3$/min. or 0.57 l/m)

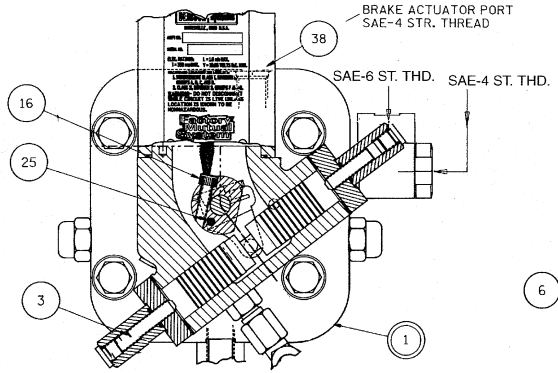
17. Unload pump. Stroke pump above and below center. Control should operate smoothly. Brake pressure should drop to case pressure each time control is on center, and it should indicate servo pressure as soon as input shaft is rotated CW or CCW from center, per step 4 above.
18. Release control when pump is off center. Pump should return to center. Repeat several times in each direction and at different pressures from 200 to 5000 psi (13.8 to 345 bar).
19. Remove needle valve from bypass exhaust port and install exhaust line.
20. Restore shuttle valve and system pressure settings to original operating conditions.

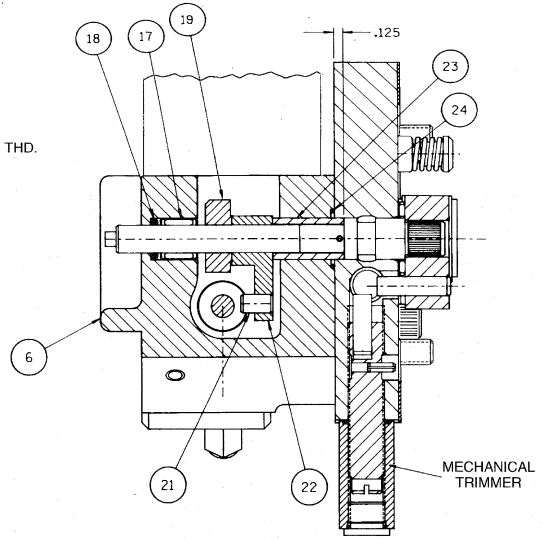
**PARTS LIST**
*For Figure 5C Electric stroker*

*S23-12414 - 5C* 00 (With Deadband)*
*S23-12420 - 5C* 01 (No Deadband)*

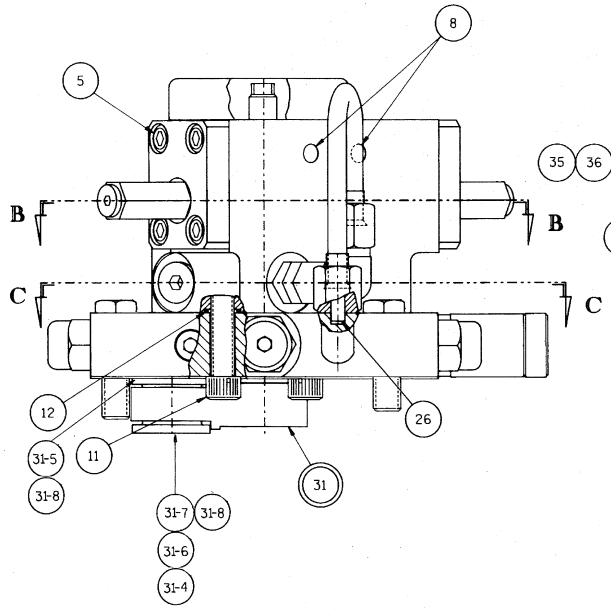
| | | Feature → | 00 | 01 |
|---|---|---|---|---|
| ITEM | DESCRIPTION | PART NO. | QTY. | QTY. |
| 1 | Rotary servo (Fig. 5C-1) | S23-12347 | 1 | 1 |
| 2 | Cover nut 1/4-28 | 033-91038 | 2 | 2 |
| 3 | Screw. SHC 1/4-28 x1 | 312-11160 | 2 | 2 |
| 4 | O-ring, 70 S-5 ARP 011 | 675-00011 | 2 | 2 |
| 5 | Screw, SHC 1/4-20 x 3/4 | 358-12120 | 8 | 8 |
| 6 | Body-EH Stroker | 033-72117 | 1 | 1 |
| 7 | Spool | 033-53439 | 1 | 1 |
| 8 | Pluget, Lee | 447-00017 | 2 | 2 |
| 9 | Gasket | 033-72109 | 2 | 2 |
| 10 | Cover plate | 033-54538 | 2 | 2 |
| 11 | Screw, SHC 5/16-18 x 1 1/4 | 358-14180 | 2 | 2 |
| 12 | O-ring, 70 S-5 ARP 012 | 675-00012 | 2 | 2 |
| 13 | Plug, 4HP5N-S | 488-35061 | 1 | 1 |
| 14 | O-ring, 90 S-5 ARP 904 | 695-00904 | 1 | 1 |
| 15 | Plug, 2HP5N-S | 488-35046 | 2 | 2 |
| 16 | Screw, SHC, 10-24 x 5/8 | 358-10100 | 1 | - |
| | Screw, SHC, 10-24 x 1/2 | 358-10080 | - | 1 |
| 17 | Bearing, 3/8 x 9/16 x 1/2 | 230-82174 | 1 | - |
| | Bearing, 3/8 x 9/16 x 5/8 | 230-00610 | - | 1 |
| 18 | O-ring, 70 S-5 ARP 110 | 675-00110 | 1 | 1 |
| 19 | Clamp | 033-53688 | 1 | - |
| 20 | O-ring, 90 S-5 ARP 902 | 695-00902 | 2 | 2 |
| 21 | Pin | 033-53894 | 1 | 1 |
| 22 | Link, control | 033-53687 | 1 | - |
| | Clamp | 033-72111 | - | 1 |
| 23 | Bushing | 033-72112 | 1 | 1 |
| 24 | O-ring 70 S-5 ARP 017 | 675-00017 | 1 | 1 |
| 25 | Dowel pin, 1/8 x 1/2 | 324-20808 | 1 | - |
| 26 | Dowel pin, 3/16 x 1/2 | 324-21208 | 1 | 1 |
| 27 | Tubing, servo control | S23-12938 | 1 | 1 |
| 28 | Connector, 4-F5BX-S | 493-15027 | 1 | 1 |
| 29 | Screw | 033-91103 | 1 | 1 |
| 30 | Filter element | 033-91104 | 1 | 1 |
| 31 | Servo shaft, link & shear seal | S23-12497 | (1) | (1) |
| 31-1 | Servo shaft | 033-54841 | 1 | 1 |
| 31-2 | Pin | 033-71002 | 1 | 1 |
| 31-3 | Servo link | 033-70536 | 1 | 1 |
| 31-4 | Washer | 350-10141 | 1 | 1 |
| 31-5 | Shear seal, feed | 033-71371 | 1 | 1 |
| 31-6 | Washer, finger spring | 350-10067 | 2 | 2 |
| 31-7 | Shear seal | 033-70525 | 1 | 1 |
| 31-8 | O-ring, 70 S-5 ARP 017 | 675-00017 | 2 | 2 |
| 31-9 | Needle bearing | 230-82141 | 1 | 1 |
| 31-10 | Thrust washer | 350-10064 | 1 | 1 |
| 32 | Fitting, swivel nut elbow | 496-15009 | 1 | 1 |
| 33 | Force motor | S13-46096 | 1 | 1 |
| 34 | Nameplate | 033-91430 | 1 | 1 |
| 35 | Screw, HWHD 3/8-16 x 1 1/4 | 353-25018 | 4 | 4 |
| 36 | Washer, Nyltite #37 | 631-45007 | 4 | 4 |
| 37 | Drive screw, #2 x 3/16 | 320-10203 | 4 | 4 |
| 38 | Plug | 449-00510 | 1 | 1 |

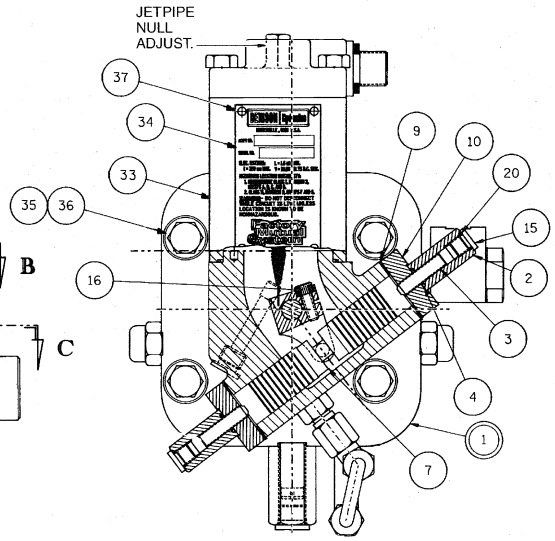


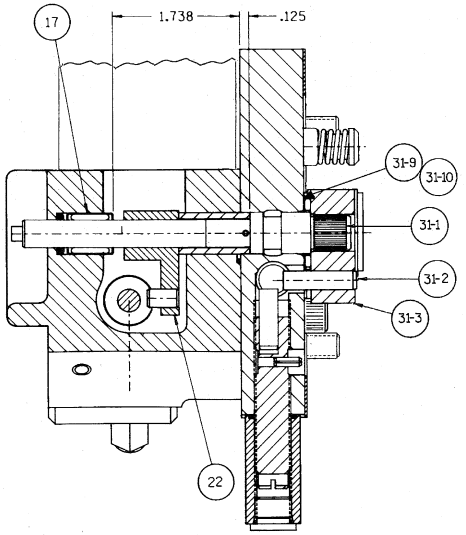




CONTROL WITH DEADBAND




CONTROL WITH "O" DEADBAND

**FIGURE 5C**

**ELECTRIC STROCKER W/ BRAKE AND BYPASS**

**PARTS LIST**

*For Figure 5C-1 Brake and bypass valve for 5C control*

*S23-12347*

| ITEM | DESCRIPTION | PART NO. | QTY. |
|---|---|---|---|
| 6 | Gasket, control cover | 033-91058 | 1 |
| 10 | Orifice, .028” (0.71 mm), 1/16 PT | 037-19104 | 1 |
| 11 | Orifice plug | 033-71437 | 2 |
| 12 | Cover | 033-91156 | 1 |
| 13 | Lee Pluget | 447-00017 | 1 |
| 14 | 1/8” Hex flush plug | 431-90204 | 6 |
| 15 | Pin | 033-71003 | 1 |
| 16 | Screw, center trim | 033-91042 | 1 |
| 17 | Spring pin, 1/8 x 3/8 | 325-08060 | 2 |
| 18 | Nut | 033-91041 | 1 |
| 19 | O-ring, 70 S-5 ARP 015 | 675-00015 | 1 |
| 20 | Seat - insert | 033-71001 | 1 |
| 21 | Insert - threaded | 033-71000 | 1 |
| 22 | Spool | 033-70839 | 2 |
| 23 | Ball, 3/16 DIA | 201-06001 | 1 |
| 24 | Screw, adjustment | 033-71113 | 1 |
| 25 | Soc. setscrew, 6-32 x 1/4 | 311-06042 | 1 |
| 26 | Piston | 033-70835 | 2 |
| 27 | Spring | 225-92040 | 2 |
| 28 | Plug | 033-70840 | 2 |
| 29 | O-ring, 90 S-5 ARP 906 | 695-00906 | 3 |
| 30 | Spool | 033-70999 | 1 |
| 31 | Spring | 033-71112 | 1 |
| 32 | Plug, 6P5ON-S | 488-35003 | 1 |
| 33 | Spool | 033-70997 | 1 |
| 34 | Spring | 033-70992 | 1 |
| 35 | Dowel pin, 1/8 x 1/2 | 324-20808 | 1 |
| 36 | Body | 033-91090 | 1 |
| 37 | O-ring, 90 S-5 ARP 016 | 695-00016 | 2 |
| 38 | Fitting | 033-70998 | 1 |
| 39 | Piston | 033-70993 | 1 |
| 41 | O-ring, 90 S-5 ARP 902 | 695-00902 | 1 |
| 42 | O-ring, 70 S-5 ARP 006 | 675-00006 | 1 |
| 43 | Vent post | 033-70995 | 1 |
| 44 | Compression spring | 225-92044 | 1 |
| 45 | Shoe | 033-70996 | 1 |
| 52 | O-ring, 90 S-5 ARP 905 | 695-00905 | 1 |
| 53 | Plug, 5-P5N-S | 488-35020 | 1 |
| 54 | Fitting, XLG male elbow 37° | 473-15043 | 1 |

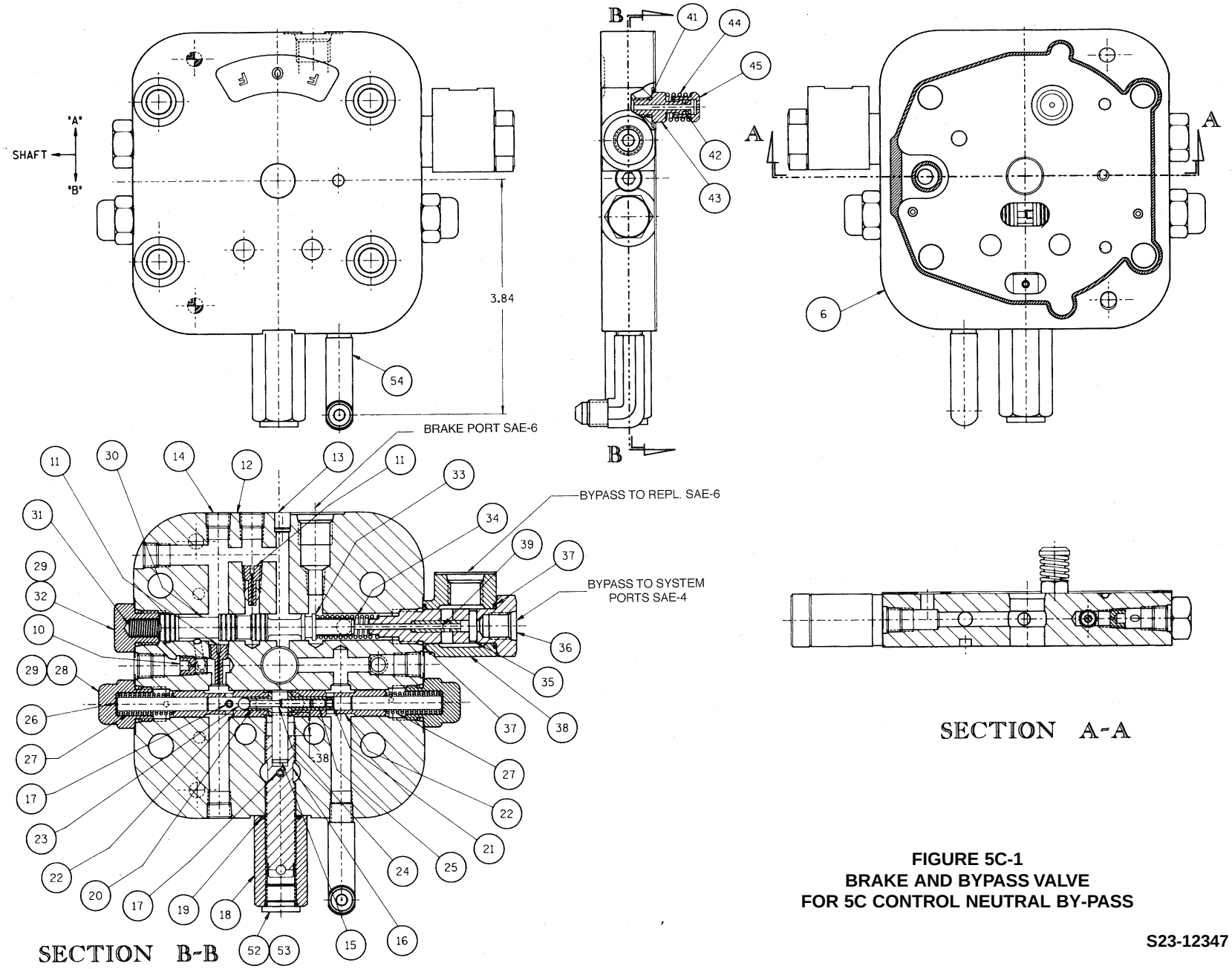



**FIGURE 5C-1**
**BRAKE AND BYPASS VALVE**
**FOR 5C CONTROL NEUTRAL BY-PASS**

**S23-12347**

## CODE 60 - HYDRAULIC STROKER

*S13-48944 Feature 00 (75 - 350 PSI)*
*S23-00402 Feature 01 (75 - 435 PSI)*
*S23-04305 Feature 02 (100 - 380 PSI)*

### DESCRIPTION

This cross-center control actuates the rotary input shaft by means of a hydraulic piston. The piston is trapped between two caged springs, which are set to provide zero displacement. Pilot pressure applied to either end of the piston causes it to move either side of center in proportion to the pilot pressure, thus positioning the rotary servo in proportion to pilot pressure.

### DISASSEMBLY

*See Figure 60*

1. Remove screws (10). Remove control from pump. Examine servo plate for excessive scratching. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two socket setscrews from plate, then alternately loosening the two button head screws under the set screws.
2. Remove screws (24) and remove cover (23). Loosen screw (4).
3. Remove servo shaft assembly and clamp (8).
4. Remove screws (26) and remove the centering adjusting group intact. Note: signal pressure setting is determined by the spring preload. Do not disassemble or change unless parts are damaged or setting is incorrect.
5. Remove spool (13). Do not remove stroker body from valve cover unless damaged, or seals need replaced.

*See Figure 60-1*

6. Examine shoes (1-5) and (1-7) for contamination in balance pads or excessive scratching on faces. Note: the two shoes are not identical and must be installed in the proper position on reassembly.

### ASSEMBLY

All parts are to be inspected and be free of material defects, dirt, scratches or any foreign material.
All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

### REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |
| Shoe | Stone to remove raised burrs or dings. |

*See Figure 60*

1. If stroker housing was removed from control cover, install O-ring (25A) in housing and O-rings (5) and (7) on interface between parts. Slip servo shaft through the bore, and install screws (6). Torque to 25 lbs-ft. (33.9 Nm). Check for free motion of shaft. Remove shaft.

*See Figure 60-1*

2. Apply pipe sealant to the 1/8" pipe plug (12) and install in the cover plate. Torque to 100 lbs-in.. (11.3 Nm)
3. Install O-ring (1-8) in groove of shear seal (1-5). Install shear seal with O-ring in the large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.
4. Install thrust washers (1-9) over servo shaft and seat against the servo link.
5. Place two spring washers (1-6), nested with the bent sections matching each other, into the large hole in the servo link (1-3).
6. Place washer (1-10) against the spring washers.

Note: The shear seal will fit in one position only. Otherwise one side will be held up by the lip of the servo link. Shear seal (1-5) must be installed to face against the cover plate. This shear seal differs from shear seal (1-7) in that the face surface is machined with two .094" (2.4 mm) radius scallops.

7. Install O-ring (1-8) into groove in the remaining shear seal (1-7). Note: This shear seal does not contain the two .094 radius scallops in the face. Place on top of washer, (1-10). Position shear seal to match the lip on the servo link (1-3).

*See Figure 60*

8. Install spool (13) in stroker body. Press dowel (9) into clamp (8) to .500" (12.7mm) dimension shown. Install screw (4) in clamp. Slip clamp into body to engage groove in spool (13). Slip servo shaft assembly through the body and through the clamp.
9. Tighten the clamp only enough to hold the clamp snugly against the bushing, while permitting the shaft to turn in the clamp with light force.
10. Holding a flat plate against the ends of the spool bore, rotate the shaft clockwise and counterclockwise, causing spool (13) to travel from flush one side to flush the other side. Observe the position of the shear seal relative to the two 3/16 dowel holes in the cover. Position such that the overlap is equal on each side. Eliminate end play and torque screw (4) to 72 lbs-in. (8 Nm), locking the clamp to the shaft
11. Place washers (17) into end connection (2) Place spring (16) on washer. Insert screw (21) into spring guide (14) and thread into end connection. Thread screw until spring guide (14) extends .308" (7.82 mm). beyond mating surface of end conn. (2). Thread nut (18) hand tight.
12. Place washer (15) and O-ring (22) in position as shown.
13. Using screws (26) bolt end connection (2) onto body (25). Torque to 14 lbs-ft. (19 Nm).
14. Install O-ring (19) on plug (20) and insert into end connection.
15. Repeat steps 11 thru 14 on other end.
16. Install cover (23) with cover screws (24) and O-ring (27). Torque screws to 14 lbs-ft. (19 Nm).
17. If control is to be tested on pump, install on pump control pad with gasket (7), ref Fig. 60-1, Nyltite washers (12), and screws (10). Torque to 30 lb. ft. (40.8 Nm).

## TEST

Connect servo source, adjustable to 450 psi (31 bar), to control ports on hydraulic stroker through a 4-way valve. Center position must dump both ports to tank at min. pressure.
1. To set pump centering, remove plugs from ends of centering groups. Alternately adjust screws by backing out on one slightly and turning in on the opposite screw the same amount, (till it just contacts the spool), observing pump flow and pressure till minimum flow and pressure are obtained and there is no backlash. Stroke pump to full and release, on both sides of center. Pump shall return to zero stroke within 200 psi (13.8 bar) max.
2. Apply servo pressure to one port of stroker. Adjust pressure from minimum to maximum. Note the pressure at which pump just starts to stroke, and the pressure at which the pump reaches full stroke These pressures must be within the following values:

## PUMP CONTROL PRESSURE

If pressures are incorrect, control may be disassembled and washers added or deleted in the spring box on the opposite end. Each washer (17) added (or removed) increases (or decreases) control pressure approximately 10 psi for 00 and 02 control features, and 12 psi for the 01 control feature.
3. With minimum signal, pump shall return to zero stroke within 200 psi (13.8 bar) max.

| Control Feature | Pressure Start | Pressure Full |
|---|---|---|
| 00 | 75± 15 psi (5.2± 1 bar) | 335± 25 psi (23.1±1.7 bar) |
| 01 | 75± 15 psi (5.2± 1 bar) | 435± 25 psi (30± 1.7 bar) |
| 02 | 100± 15 psi (6.9± 1 bar) | 375± 25 psi (25.9± 1.7 bar) |

4. Repeat test on opposite side of center.
5. Increase and decrease control pressure between 0 and 450 psi (31 bar) several times . Pump stroke should follow control pressure smoothly and proportionally. Full to zero or zero to full stroke should be achieved in no more than two seconds. Adjust control pressure up to 50% stroke from zero stroke, then adjust down from full stroke to the same value. The control pressure at the two settings shall not vary more than 50 psi (3.4 bar) from each other.

**PARTS LIST**
*For Figure 60 Hydraulic stroker*

| ITEM | DESCRIPTION | Feature → PART NO. | 00 QTY. | 01 QTY. | 02 QTY. |
|---|---|---|---|---|---|
| 1 | Rotary servo (Fig. 6O-1) | S13-47528 | 1 | 1 | 1 |
| 2 | End connection | 033-53590 | 2 | - | 2 |
| | End connection | 033-53783 | - | 2 | - |
| 4 | Screw, SHC, 10-24 x 1/2 | 358-10080 | 1 | 1 | 1 |
| 5 | O-ring, 70 S-1 ARP 017 | 671-00017 | 1 | 1 | 1 |
| 6 | Screw, SHC, 5/16-18 x 1-1/4 | 358-14180 | 2 | 2 | 2 |
| 7 | O-ring, 70 S-1 ARP 012 | 671-00012 | 2 | 2 | 2 |
| 8 | Clamp | 033-72111 | 1 | 1 | 1 |
| 9 | Pin | 033-53894 | 1 | 1 | 1 |
| 10 | Screw, HWHD 3/8-16 x 1 1/4 | 353-25018 | 4 | 4 | 4 |
| 12 | Washer, Nyltite #37 | 631-45007 | 4 | 4 | 4 |
| 13 | Spool | 033-53439 | 1 | 1 | 1 |
| 14 | Spring guide | 033-53420 | 2 | - | 2 |
| | Spring guide | 033-57489 | - | 2 | - |
| 15 | Thrust washer | 031-53421 | 2 | 2 | 2 |
| 16 | Spring | 033-53627 | 2 | - | 2 |
| | Spring | 033-53782 | - | 2 | - |
| 17 | Washer | 035-53452 | 2 | 2 | 8 |
| 18 | Nut | 333-12614 | 2 | 2 | 2 |
| 19 | O-ring, 90 S-1 ARP 908 | 691-00908 | 2 | 2 | 2 |
| 20 | Plug, 8-P5N-S | 488-35002 | 2 | 2 | 2 |
| 21 | Screw | 033-53419 | 2 | 2 | 2 |
| 22 | O-ring, 70 S-1 ARP 022 | 671-00022 | 2 | 2 | 2 |
| 23 | Cover | 031-53148 | 1 | 1 | 1 |
| 24 | Screw, SHC 1/4-20 x 5/8 | 358-12100 | 4 | 4 | 4 |
| 25 | Body sub assy. | S13-48902 | 1 | 1 | 1 |
| 25A | O-ring, 70 S-5 ARP 110 | 675-00110 | 1 | 1 | 1 |
| 26 | Screw, SHC 1/4-20 x 3/4 | 358-12120 | 8 | 8 | 8 |
| 27 | O-ring, 70 S-1 ARP 133 | 671-00133 | 1 | 1 | 1 |
| 28 | Tag | 036-24496 | - | 1 | 1 |
| 29 | Screw, RDHD drive #2 x 3/16 SS | 320-10203 | - | 2 | 2 |

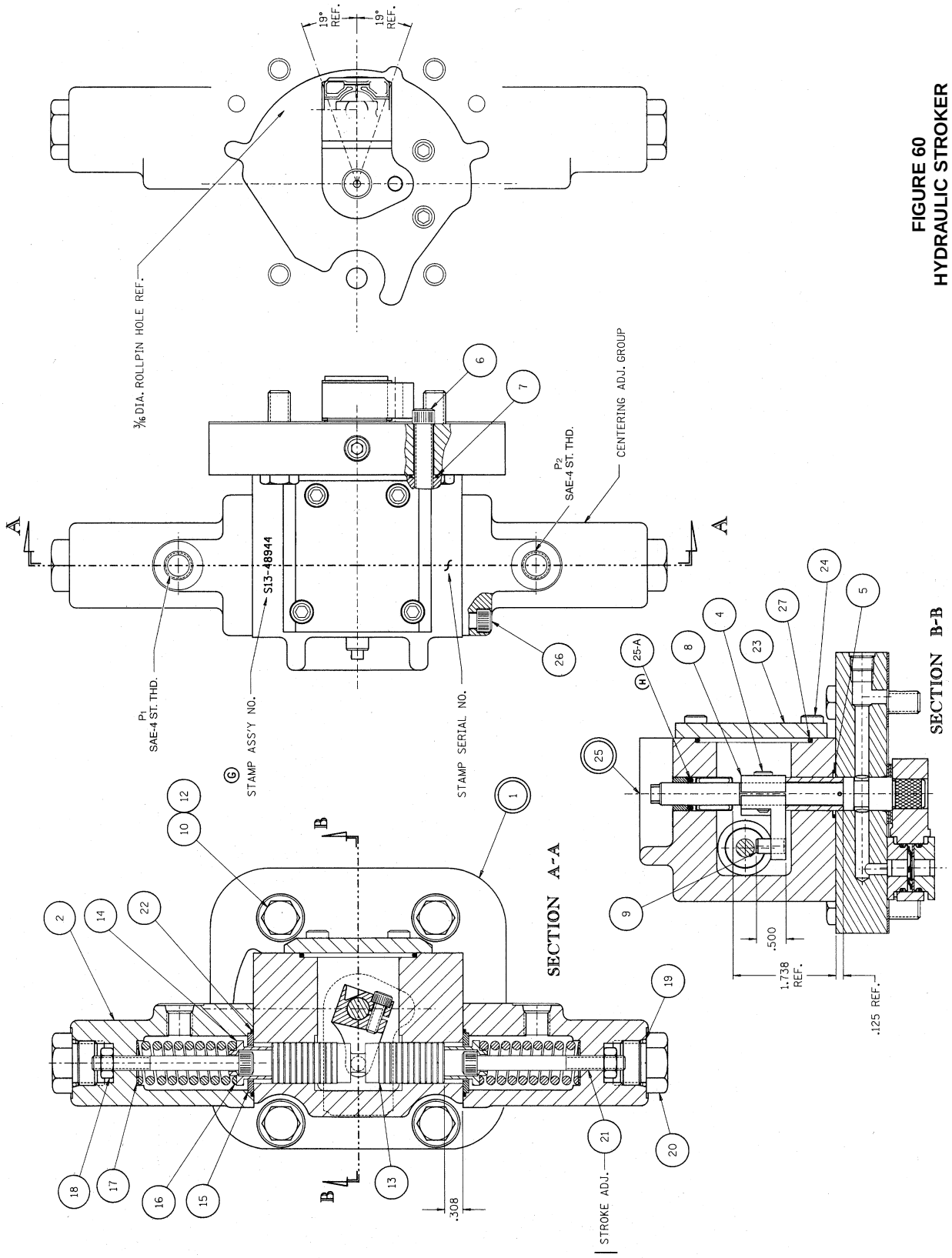



FIGURE 60
HYDRAULIC STROKER

**PARTS LIST**
*For Figure 60-1 - Servo for hydraulic stroker*

*S13-47528*

| ITEM | DESCRIPTION | PART NO. | QTY. |
|---|---|---|---|
| 1 | Servo shaft assembly | S23-00620 | (1) |
| 1-1 | Servo shaft | 033-54841 | 1 |
| 1-3 | Servo link | 033-70536 | 1 |
| 1-5 | Shear seal, feed | 033-71371 | 1 |
| 1-6 | Washer, finger spring | 350-10067 | 2 |
| 1-7 | Shear seal | 033-70525 | 1 |
| 1-8 | O-ring, 70 S-5 ARP 017 | 675-00017 | 2 |
| 1-9 | Thrust washer | 350-10103 | 3 |
| 1-10 | Thrust washer | 350-10064 | 1 |
| 7 | Gasket | 033-91058 | 1 |
| 9 | Cover plate | 033-72535 | 1 |
| 12 | Plug, 1/8 NPTF flush | 431-90204 | 1 |

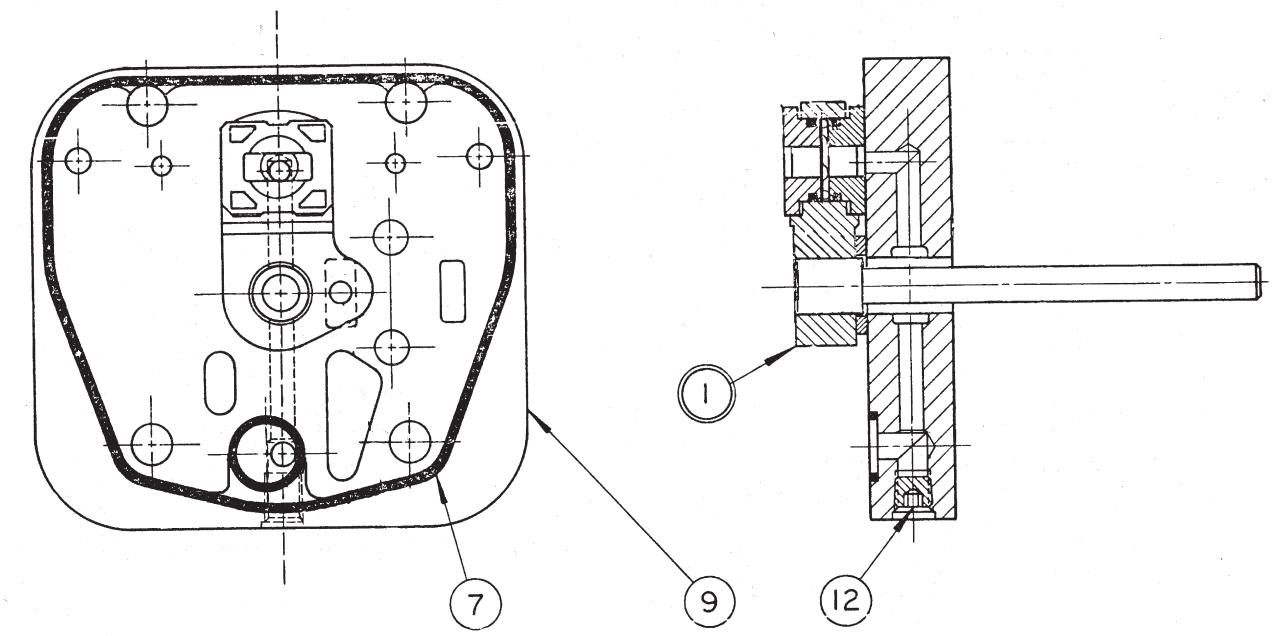



**FIGURE 60-1**
**SERVO FOR HYDRAULIC STROKER**

## CODE 6A - HYDRAULIC STROKER/ADJUSTABLE STOPS PUMP

*S23-12289*
*Feature 00, CW -A Mtg, CCW - B Mtg.*

*S23-12290*
*Feature 00, CW -B Mtg, CCW - A Mtg.*

*S23-12291*
*Feature 01, CW -A Mtg, CCW -B Mtg.*

*S23-12292*
*Feature 01, CW -B Mtg, CCW -A Mtg.*

**MOTOR**
*S23-12304 Feature 0*, B Mtg*
*S23-12305 Feature 1*, A Mtg*
*S23-12293 Feature 1*, B Mtg.*
*S23-12306 Feature 2*, A Mtg.*
*S23-12295 Feature 3*, A Mtg.*

### DESCRIPTION

This one side of center control is used on both pumps and motors. It contains a spring biased spool in the control cover that is operated by the signal port. This positions the rotary servo proportionally to pilot or control pressure. With no external control pressure and the centering spring properly adjusted, the stroking piston will position the rotary servo at the zero stroke position for pumps, and for motors at the full stroke position. With full signal, the stroking piston will position the rotary servo at full position for pumps, and for motors at 1/3 stroke position. Minimum and maximum stops are fully adjustable.

### DISASSEMBLY

*See Figure 6A*

1. Remove screws (10). Remove control from unit. Examine servo plate for excessive scratching. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two socket set screws from plate, then alternately loosening the two button head screws under the set screws.
2. Remove screws (24) and remove the centering adjusting group intact. Do not disassemble or change unless parts are damaged or setting is incorrect.
3. Remove screws (29) and cover (28) with assembled parts.
4. Remove screws (22) and remove cover (21). Loosen screw (4).
5. Remove servo shaft assembly. Remove clamp (8).
6. Examine shoes on servo shaft assembly for contamination in balance pads or excessive scratching on faces. Note: the two shoes are not identical and must be installed in the proper position on reassembly.
7. Remove spool (12). Do not remove stroker body from valve cover unless seals need replaced.

### ASSEMBLY

*See Figure 6A-1*

After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

### REWORK OF WEAR PARTS

| Part Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |

1. Apply pipe sealant to the 1/8" pipe plug (12) and install in the cover plate (9). Torque to 100 lbs-in. (11.3 Nm).
2. Install O-ring (1-8) in groove of shear seal (1-5). Install shear seal with O-ring in the large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.

Note: The shear seal will fit in one position only. Otherwise one side will be held up by the lip of the servo link. Shear seal (1-5) must be installed to face against the cover plate. This shear seal differs from shear seal (1-7) in that the face surface is machined with two .094" (2.4 mm) radius scallops.

3. Install thrust washers (1-9) over servo shaft and seat against the servo link.

*See Figure 6A*

4. Install O-ring (23-A) in housing (23).
5. Install O-rings (5) and (7) on interface between stroker housing (23) and cover (1). Slip servo shaft assembly through the bore, and install screws (6). Torque to 25 lbs-ft. (33.9 Nm). Check for free motion of shaft assembly. Remove shaft.
6. Install spool (12) into stroker body. Press dowel (9) into clamp (8) to .500" (12.7mm) dimension shown. Install screw (4) in clamp. Slip clamp into body to engage groove in spool (12). Slip shaft through the body and through the clamp.
7. Tighten the clamp only enough to hold the clamp snugly against the bushing, while permitting the shaft to turn in the clamp with light force.
8. Install setscrew (30) in cover (28). For pump controls, set to .308" (7.82mm) inside extension. For motor controls, set to 410" (10.4mm) inside extension and install two nuts (31) locked together to maintain this dimension. Install nut (31), O-ring (32), plug (27) and O-ring (26) on external extension.
9. Install O-ring (20) in cover (28) and mount on housing on opposite side from centering assembly, (see chart below) with screws (29). Torque screws to 14 lbs-ft. (19 Nm).
10. For pump controls, hold a flat plate against the centering group end of the spool bore. Position clamp such that the spool is flush with the edge of the bore when the servo shoe is tangent to the corresponding dowel hole in the control face. Eliminate end play and torque screw (4) to 72 in.-lb. (8 Nm), locking the clamp to the shaft. Check for free motion.
For motor controls, hold spool (12) against the stop screw, (30) and tighten screw (4), locating the servo shoe adjacent to the corresponding dowel hole in the control face. Torque to 72 in.-lb. (8 Nm), locking the clamp to the shaft. Check for free motion.
11. Install spring guide (13) and spring (14) over screw (19). Install screw into adjustment screw (18). Adjust to 2" compressed length on spring (14). Install 1/4-20 nut (17).
12. Insert spring assembly in body (2). Adjust for correct extension of spring guide beyond surface. (See below). Install O-ring (20) in locknut, and install acorn nut (16) on screw (18).
13. Install O-ring (20) in body and place assembly on stroker body, according to chart below:

**PUMP**
*Spring Guide Extension .308" (7.82MM)*

| Rotation & cont. mtg | Centering group location |
|---|---|
| CW -- A | See Fig. 6-A |
| CW - B | Opposite to Fig. 6-A |
| CCW - A | Opposite to Fig. 6-A |
| CCW - B | See Fig. 6-A |

**MOTOR**
*Spring Guide Extension .206" (5.23MM)*

| Control mounting | Centering group location |
|---|---|
| B | See Fig. 6-A |
| A | Opposite to Fig. 6-A |

14. Using screws (24) bolt end connection (2) onto body (23). Torque screws to 14 lbs-ft. (19 Nm).
15. Install O-ring (25), cover (21), and cover screws (22). Torque screws to 14 lbs-ft. (19 Nm).
16. Place two spring washers (1-6), nested with the bent sections matching each other, into the large hole in the servo link.
17. Place washer (1-10) against the spring washers.
18. Install O-ring (1-8) into groove in the remaining shear seal (1-7). Note: This shear seal does not contain the two .094" radius scallops in the face. Place on top of washer, (1-10). Position shear seal to match the lip on the servo link.
19. If control is to be tested on unit, install on control pad with gasket, nyltite washers (12), and screws (10). Torque to 30 lb. ft. (40.8 Nm).

**TEST**

Connect servo source, adjustable to 450 psi (31 bar), to control port on hydraulic stroker.

1. Set pump (motor) to zero (full) stroke by adjusting minimum (maximum) stop screw (30).
2. Apply servo pressure to signal port of stroker. Adjust pressure from minimum to maximum. Note the pressure at which unit just starts to stroke, and the pressure at which the unit reaches the final stroke These pressures must be within the following values:

**PUMP CONTROL PRESSURE**

| CONTROL FEATURE | PRESSURE START | PRESSURE FULL |
|---|---|---|
| 00 | 75± 15 psi (5.2± 1 bar) | 335± 25 psi (23.1±1.7 bar) |
| 01 | 75± 15 psi (5.2± 1 bar) | 435± 25 psi (30± 1.7 bar) |
| 02 | 100± 15 psi (6.9± 1 bar) | 375± 25 psi (25.9± 1.7 bar) |
| 03 | 150±15 psi (10.3±1 bar) | 400± 25 psi (27.6± 1.7 bar) |

**MOTOR CONTROL PRESSURE**

| CONTROL FEATURE | PRESSURE FULL | PRESSURE 1/3 STROKE |
|---|---|---|
| 0* | 170± 15 psi (11.7± 1 bar) | 335± 25 psi (23.1±1.7 bar) |
| 1* | 200± 15 psi (13.8± 1 bar) | 435± 25 psi (30± 1.7 bar) |
| 2* | 150± 15 psi (10.3± 1 bar) | 375± 25 psi (25.9± 1.7 bar) |
| 3* | 75±15 psi (5.17±1 bar) | 250± 25 psi (17.2± 1.7 bar) |

If pressures are incorrect, use adjusting screw (18) to obtain correct pressure.
3. With minimum signal, unit shall return to starting stroke, pumps to zero, and motors to full displacement.
4. With full control signal pressure on control port, set screw (19) for final stroke, Pumps at full, and motors at 1/3 stroke. Lock adjustments and install acorn nut (16).
5. Increase and decrease control pressure between 0 and 450 psi (31 bar) several times . Stroke should follow control pressure smoothly and proportionally. Full to minimum or minimum to full stroke should be achieved in no more than two seconds. Adjust control pressure up to 50% stroke from initial stroke, then adjust down from final stroke to the same value. The control pressure at the two settings shall not vary more than 50 psi (3.4 bar) from each other.

**PARTS LIST**
*For figure 6A hydraulic stroker/adjustable stops*

**PUMP CONTROLS**
*S23-12289*
*Feature 00, CW - A, CCW - B Mtg.*

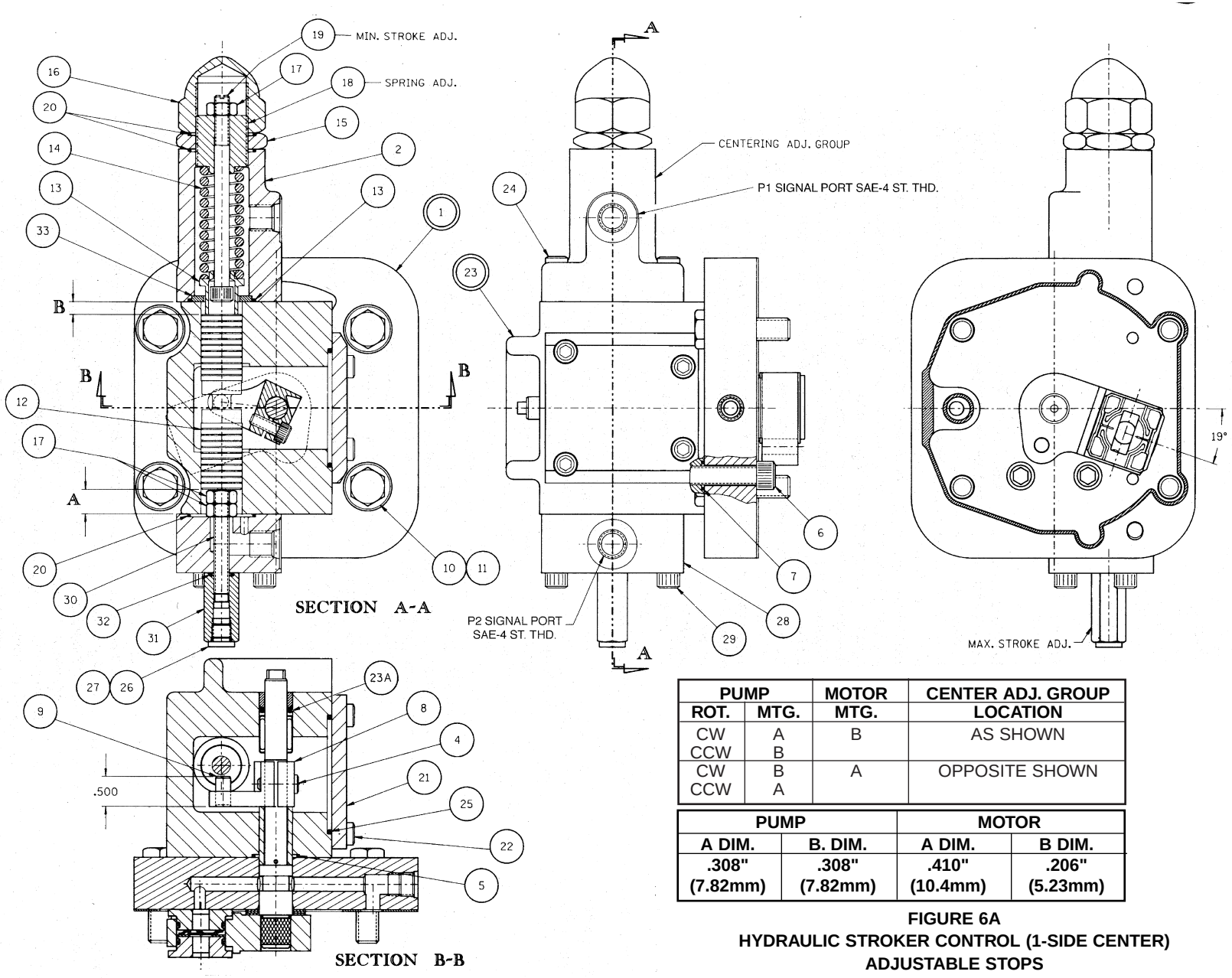
*S23-12290*
*Feature 00, CW - B, CCW - A Mtg.*

*S23-12291*
*Feature 01, CW - B, CCW - A Mtg.*

*S23-12292*
*Feature 01, CW - B, CCW - A Mtg.*

**MOTOR CONTROLS**
*S23-12304 Feature 0*, B Mtg.*
*S23-12305 Feature 1*, A Mtg.*
*S23-12293 Feature 1*, B Mtg.*
*S23-12306 Feature 2*, A Mtg.*
*S23-12295 Feature 3*, A Mtg.*

| | | Feature → | 00,02,03 Pump | 01 Pump | 1*, 2* Motor | 0*, 3* Motor |
|---|---|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **PART NO.** | **QTY.** | **QTY.** | **QTY.** | **QTY.** |
| 1 | Rotary servo (Fig. 6O-1) | S13-47528 | 1 | 1 | 1 | 1 |
| 2 | End connection | 033-53880 | 1 | 1 | 1 | 1 |
| 4 | Screw, SHC, 10-24 x 1/2 | 358-10080 | 1 | 1 | 1 | 1 |
| 5 | O-ring 70 S-1 ARP 017 | 671-00017 | 1 | 1 | 1 | 1 |
| 6 | Screw, SHC 5/16-18 x 1 1/4 | 358-14180 | 2 | 2 | 2 | 2 |
| 7 | O-ring, 70 S-1 ARP 012 | 671-00012 | 2 | 2 | 2 | 2 |
| 8 | Clamp | 033-72111 | 1 | 1 | 1 | 1 |
| 9 | Pin | 033-53894 | 1 | 1 | 1 | 1 |
| 10 | Screw, HWHD 3/8-16 x 1 1/4 | 353-25018 | 4 | 4 | 4 | 4 |
| 11 | Washer, Nyltite #37 | 631-45007 | 4 | 4 | 4 | 4 |
| 12 | Spool | 033-53439 | 1 | 1 | 1 | 1 |
| 13 | Spring guide | 033-53420 | 1 | 1 | 1 | 1 |
| 14 | Spring | 033-54269 | 1 | | | 1 |
| | Spring | 033-57486 | | 1 | 1 | |
| 15 | Locknut | 033-53877 | 1 | 1 | 1 | 1 |
| 16 | Acorn nut, 7/8-14 | 327-25007 | 1 | 1 | 1 | 1 |
| 17 | Hex nut | 333-12614 | 1 | 1 | 3 | 3 |
| 18 | Adjustment screw | 033-53876 | 1 | 1 | 1 | 1 |
| 19 | Slotted screw | 033-53878 | 1 | 1 | 1 | 1 |
| 20 | O-ring, 70 S-1 ARP 022 | 671-00022 | 4 | 4 | 4 | 4 |
| 21 | Cover | 031-53148 | 1 | 1 | 1 | 1 |
| 22 | Screw, SHC 1/4-20 x 5/8 | 358-12100 | 4 | 4 | 4 | 4 |
| 23 | Body-sub assembly | S13-48902 | 1 | 1 | 1 | 1 |
| 23-A | O-ring, 70 S-5 ARP 110 | 675-00110 | 1 | 1 | 1 | 1 |
| 24 | Screw. SHC 1/4-20 x 1 | 358-12160 | 4 | 4 | 4 | 4 |
| 25 | O-ring, 70 S-1 ARP 133 | 671-00133 | 1 | 1 | 1 | 1 |
| 26 | O-ring, 90 S-1 ARP 902 | 691-00902 | 1 | 1 | 1 | 1 |
| 27 | Plug, 2HP5N-S | 488-35046 | 1 | 1 | 1 | 1 |
| 28 | Cover | 033-53879 | 1 | 1 | 1 | 1 |
| 29 | Screw, SHC 1/4-20 x 1 1/2 | 358-12200 | 4 | 4 | 4 | 4 |
| 30 | Setscrew, 1/4-20 x 1 3/4 | 311-12220 | 1 | 1 | 1 | 1 |
| 31 | Cover nut 1/4-20 | 033-91039 | 1 | 1 | 1 | 1 |
| 32 | O-ring, 70 S-1 ARP 011 | 671-00011 | 1 | 1 | 1 | 1 |
| 33 | Thrust washer | 031-53421 | 1 | 1 | 1 | 1 |




| PUMP | | MOTOR | CENTER ADJ. GROUP |
|---|---|---|---|
| ROT. | MTG. | MTG. | LOCATION |
| CW<br>CCW | A<br>B | B | AS SHOWN |
| CW<br>CCW | B<br>A | A | OPPOSITE SHOWN |

| PUMP | | MOTOR | |
|---|---|---|---|
| A DIM. | B. DIM. | A DIM. | B DIM. |
| .308"<br>(7.82mm) | .308"<br>(7.82mm) | .410"<br>(10.4mm) | .206"<br>(5.23mm) |

**FIGURE 6A**
**HYDRAULIC STROKER CONTROL (1-SIDE CENTER)**
**ADJUSTABLE STOPS**

**S23-12293**

## CODE 6B - HYDRAULIC STROKER WITH BRAKE AND BYPASS

*S23-12424 Feature 00 (75 - 350 PSI)*

*S23-12423 Feature 01 (75 - 435 PSI)*

*S23-12422 Feature 02 (100 - 380 PSI)*

*23-12544 Feature 03 (150 - 400 PSI)*

### DESCRIPTION

This cross-center control actuates the rotary input shaft by means of a hydraulic piston. The piston is trapped between two caged springs, which are set to provide zero displacement. Pilot pressure applied to either end of the piston causes it to move either side of center in proportion to the pilot pressure, thus positioning the rotary servo in proportion to pilot pressure.
In the rotary servo body is contained the brake and bypass valve option. A brake spool, when energized, connects the brake port to servo pressure. When de-energized, a spring shifts the spool, connecting the brake port to tank. Another port, located on the end of the brake valve, is closed by the energizing of the brake spool. When de-energized, this port dumps both pump system ports to the replenishing source, thus bypassing the small flow generated by slight errors on zero position.
The operation is controlled in this manner: A restricted servo flow is applied to shift the brake spool. This flow is dumped when a slot in the servo plate aligns with a passage connecting to this spool. This occurs when the pump is on zero stroke. Another restricted flow is applied to a spool adjacent to the brake spool. This metered signal is connected to a port controlled by the input command spool. This port is set to open to tank when the input command is at zero stroke.
The brake spool is thus de-energized to set the brake when BOTH the pump cam is at zero stroke and the rotary servo is at zero command. If the pump is on stroke or the input is on stroke, the brake spool is energized, releasing the brake.

### DISASSEMBLY

*See Figure 6B*

1. Disconnect brake and bypass lines from control. Remove screws (10). Remove control from pump. Examine servo plate for excessive scratching. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two socket setscrews from plate, then alternately loosening the two button head screws under the set screws.
2. Remove screws (24) and remove cover (23). loosen screw (4).
3. Remove servo shaft assembly (25) and clamp (8).
4. Examine shoes (25-5) and (25-7) for contamination in balance pads or excessive scratching on faces. Note: the two shoes are not identical and must be installed in the proper position on reassembly.
5. Remove screws (26) and remove the centering adjusting group intact. Note: signal pressure setting is determined by the spring preload. Do not disassemble or change unless parts are damaged or setting is incorrect.
6. Remove spool (13). Do not remove stroker body from valve cover unless damaged, or seals need replaced.

*See Figure 6B-1*

7. Remove plug (30). Remove plug (28) with attached parts. Remove spool (25).
8. Remove bypass valve body (39) with fitting (41) and piston (42). Remove plug (35) and spring (34). Remove spools (33) and (36).
9. Remove shoe (48), and spring (47).
10. Examine two orifices (11) and orifice (10) in body for contamination. Examine passages in body for free flow.
11. Clean and examine all parts for breakage or evidence of abnormal wear.

### ASSEMBLY

All parts are to be inspected and be free of material defects, dirt, scratches or any foreign material.
All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit.
During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

## REWORK OF WEAR PARTS

| Part Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |
| Shoe | Stone to remove raised burrs or dings. |

*See Figure 6B-1*

1. Install Lee Pluget (13) using installation tool and gage.
2. Install orifices (10) and (11) in body. Make sure that the orifice (11) in the deeper bore extends past the wall of the valve bore and will not interfere with spools (25) or (33) action.
3. Install 1/16 pipe plug (27) into cover (12). Plug must extend below bore, so it will not interfere with spool (25).
4. Apply pipe sealant to the 1/8" pipe plugs (14) and install in the cover plate. Torque to 100 in.-lbs. (11.3 Nm)
5. If stroker housing was removed from control cover, install O-ring (12-1A) in housing and O-rings (12-3) and (12-5) on interface between parts. Slip servo shaft through the bore, and install screws (12-4). Torque to 25 lbs-ft. (33.9 Nm). Check for free motion of shaft. Remove shaft. Slip spools (25), (33) and (36) into their respective bores and check for free travel. If tight, it may be necessary to carefully hone the bore, till spools are free in bores. Position spool (25) in the bore with the slot, with the elongated hole centered over the slot and the grooved end toward the orifice (33).
6. Install O-ring (29) on nut (28) and the neutral bypass trimmer assembly into nut (28). Install nut (28) into cover. Adjust trimmer assembly until the land on end of assembly is centered in groove in spool (25), with elongated hole in spool centered on slot in cover. Hold in place and install nut (31), O-ring (32), plug (6) and O-ring (44).
7. Install O-ring (29) on plug (30) and install on other end of this bore.
8. Install spools (33) and (36) into the other cross-bore in the cover (12). The slotted end of spool (33) should be to the outside.
9. Install O-ring (29) on plug (35). Install spring (34) in plug and install plug in cover as shown.
10. Install O-rings (40) on fitting (41). Install piston (42) in bore of body (39). Install fitting (41) on body and install assembly in cover (12).
11. Install O-rings (44) and (45) on vent post (46). Install vent post in cover.
12. Install spring (47) and shoe (48) over vent post.
13. Install O-ring (19) on plug (18) and install in body (12).

*See Figure 6B*

14. Install O-ring (25-8) in groove of shear seal (25-5). Install shear seal with O-ring in the large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.
15. Install needle bearing (25-9) over servo shaft and seat against the servo link. Install thrust washer (25-4) over needle bearing.

> Note: The shear seal will fit in one position only. Otherwise one side will be held up by the lip of the servo link. Shear seal (25-5) must be installed to face against the cover plate. This shear seal differs from shear seal (25-7) in that the face surface is machined with two .094" (2.4 mm) radius scallops.

16. Install spool (13) in stroker body. Press dowel (9) into clamp (8) to .500" (12.7mm) dimension shown. Install screw (4) in clamp. Slip clamp into body to engage groove in spool (13). Slip servo shaft assembly (25) through the body and through the clamp, simultaneously engaging the pin on the servo arm with the slot in the spool, (25) ref. Fig. 6B-1.
17. Tighten the clamp only enough to hold the clamp snugly against the bushing, while permitting the shaft to turn in the clamp with light force.
18. Holding a flat plate against the ends of the spool bore, rotate the shaft clockwise and counterclockwise, causing spool (13) to travel from flush one side to flush the other side. Observe the position of the shear seal relative to the two 3/16 dowel holes in the cover. Position such that the overlap is equal on each side. Eliminate end play and torque screw (4) to 72 lbs-in. (8 Nm), locking the clamp to the shaft
19. Place washer or washers (17) as required into end connection (2) Place spring (16) on washer. Insert screw (21) into spring guide (14) and thread into end connection. Thread screw until spring guide (14) extends .308" (7.82 mm) beyond mating surface of end conn. (2). Thread nut (18) hand tight.
20. Place washer (15) and O-ring (22) in position as shown.
21. Using screws (26) bolt end connection (2) onto body (25). Torque to 14 lbs-ft. (19 Nm).
22. Install O-ring (19) on plug (20) and insert into end connection.

23. Repeat steps 19 thru 22 on other end.
24. Install cover (23) with cover screws (24) and O-ring (27). Torque screws to 14 lbs-ft. (19 Nm).
25. Place two spring washers (25-6), nested with the bent sections matching each other, into the large hole in the servo link (25-3).
26. Place washer (25-10) against the spring washers.
27. Install O-ring (25-8) into groove in the remaining shear seal (25-7). Note: This shear seal does not contain the two .094 radius scallops in the face. Place on top of washer, (25-10). Position shear seal to match the lip on the servo link.
28. If control is to be tested on pump, install on pump control pad with gasket (51), ref Fig. 6B-1, Nyltite washers (12), and screws (10). Torque to 30 lb. ft. (40.8 Nm). Install bypass check valves, fittings, and lines.

## TEST

Connect servo source, adjustable to 450 psi (31 bar), to control ports on hydraulic stroker through a 4-way valve. Center position must dump both ports to tank at min. pressure.
Install a needle valve on the bypass valve exhaust port, connected to tank. Close the valve.
1. To set pump centering, remove plugs from ends of centering groups. Alternately adjust screws by backing out on one slightly and turning in on the opposite screw the same amount, (till it just contacts the spool), observing pump flow and pressure till minimum flow and pressure are obtained and there is no backlash. Stroke pump to full and release, on both sides of center. Pump shall return to zero stroke within 200 psi (13.8 bar) max.
2. Apply servo pressure to one port of stroker. Adjust pressure from minimum to maximum. Note the pressure at which pump just starts to stroke, and the pressure at which the pump reaches full stroke These pressures must be within the following values:

## PUMP CONTROL PRESSURE

| CONTROL FEATURE | PRESSURE START | PRESSURE FULL |
|---|---|---|
| 00 | 75± 15 psi (5.2± 1 bar) | 335± 25 psi (23.1±1.7 bar) |
| 01 | 75± 15 psi (5.2± 1 bar) | 435± 25 psi (30± 1.7 bar) |
| 02 | 100± 15 psi (6.9± 1 bar) | 375± 25 psi (25.9± 1.7 bar) |
| 03 | 150±15 psi (10.3±1 bar) | 400± 25 psi (27.6± 1.7 bar) |

If pressures are incorrect, control may be disassembled and washers added or deleted in the spring box on the opposite end. Each washer (17) added (or removed) increases (or decreases) control pressure approximately 10 psi for 00, 02 and 03 control features, and 12 psi for the 01 control feature.
3. With minimum signal, pump shall return to zero stroke within 200 psi (13.8 bar) max.
4. Repeat test on opposite side of center.
5. Increase and decrease control pressure between 0 and 450 psi (31 bar) several times . Pump stroke should follow control pressure smoothly and proportionally. Full to zero or zero to full stroke should be achieved in no more than two seconds. Adjust control pressure up to 50% stroke from zero stroke, then adjust down from full stroke to the same value. The control pressure at the two settings shall not vary more than 50 psi (3.4 bar) from each other.
6. With pump on zero stroke, turn brake trimmer screw CW and CCW while observing gage on brake port. Note the positions where the gage reading changes from case pressure to servo pressure to case pressure. Set and lock the adjustment midway between these two positions.
7. Load the pump. Stroke pump CW. The gage on the brake port should start to indicate servo pressure when the system pressure is between 2000 and 4500 psi (138 and 310 bar), with an increasing signal, and must return to case pressure before system pressure drops to 2000 psi (138 bar), on decreasing signal. Repeat by rotating input shaft CCW. Record both pressures for each rotation of the servo input shaft.
8. Open the needle valve on the neutral bypass port. Measure and record leakage from this port with the pump on center at minimum psi, and with the pump off center, at 5000 psi.

**Maximum leakage with control on center:**
2.0 gpm (7.6 l/m)
**Minimum leakage with control on center:**
1.0 gpm (3.8 l/m)
**Maximum leakage with control off center:**
35 cu. in/min or .15 gpm (574 cm3/min. or 0.57 l/m)

9. Unload the pump. Stroke pump above and below center. Control should operate smoothly. Brake pressure should drop to case pressure each time control is on center, and it should indicate servo pressure as soon as input shaft is rotated CW or CCW from center, per step 7.
10. Release control when pump is off center. Pump should return to center. Repeat several times in each direction and at different pressures from 200 to 5000 psi (13.8 to 345 bar)
11. Remove needle valve from bypass exhaust port and install exhaust line.

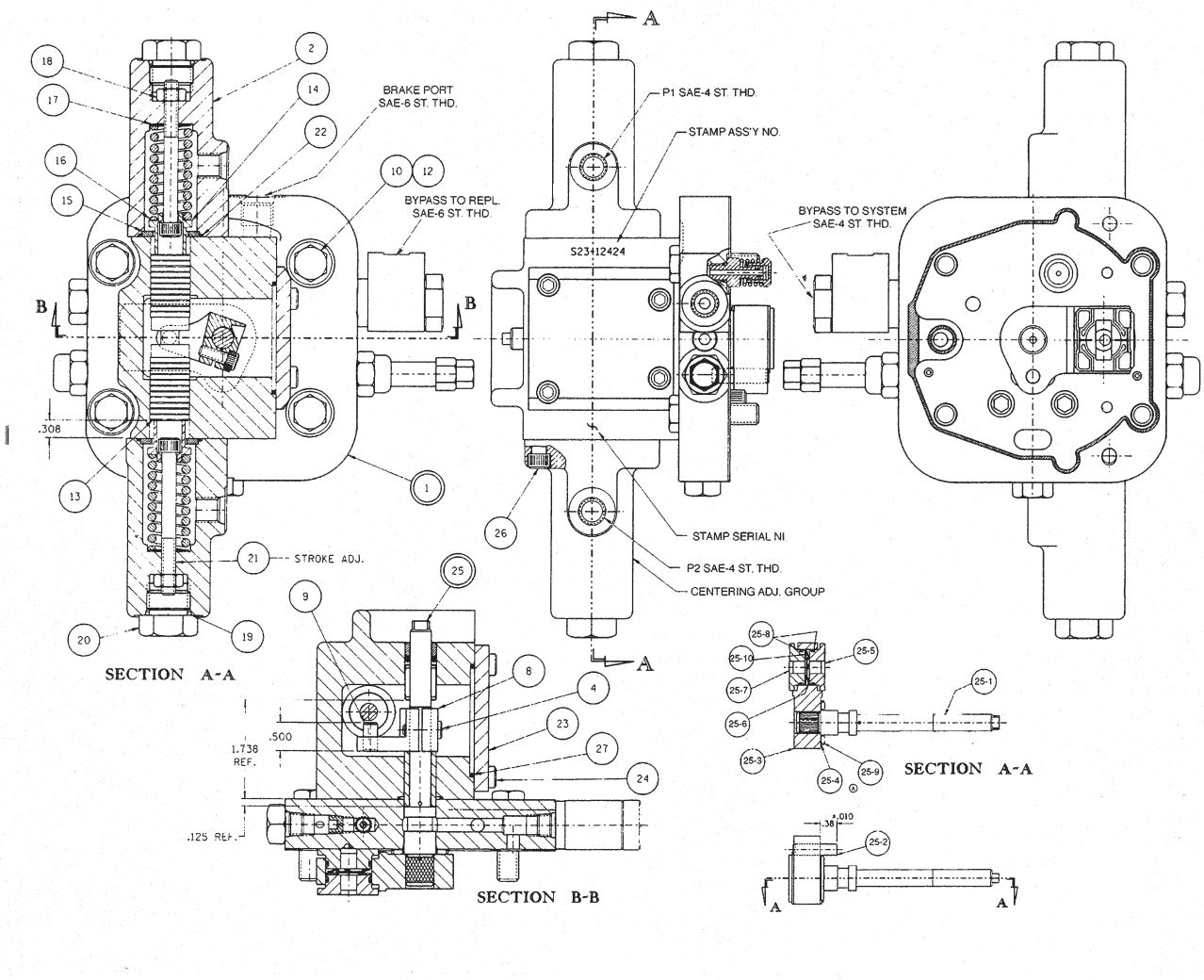



**FIGURE 6B**
**HYDRAULIC STROKER**
**WITH BRAKE AND BYPASS VALVE**

**PARTS LIST**

*For Figure 6B Hydraulic stroker with brake and bypass valve*

*S23-12424* *Feature 00*

*S23-12423* *Feature 01*

*S23-12422* *Feature 02*

*S23-12544* *Feature 03*

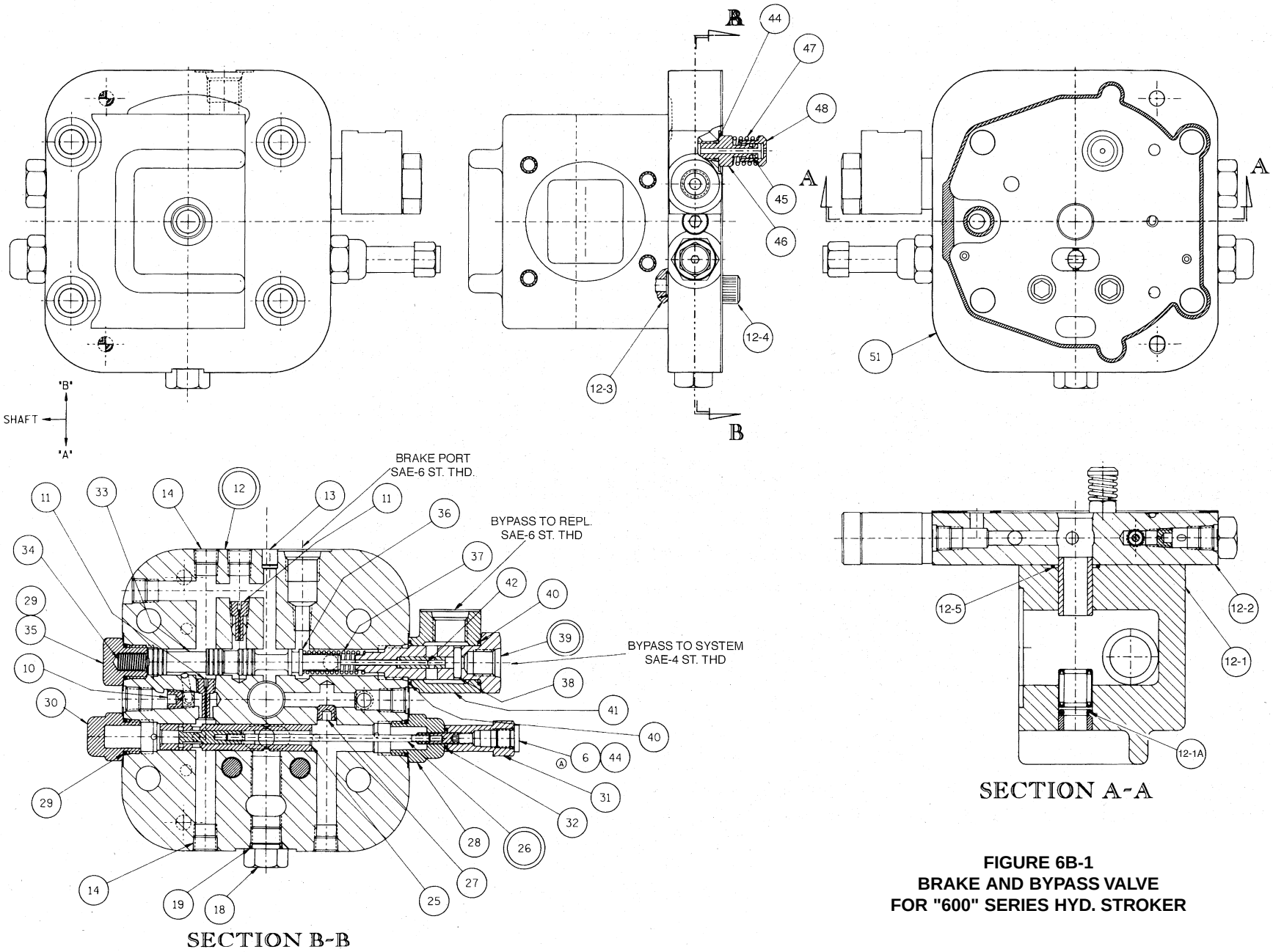
| | | Feature → | 00 | 01 | 02 | 03 |
|---|---|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **PART NO.** | **QTY.** | **QTY.** | **QTY.** | **QTY.** |
| 1 | Neutral bypass/brake subassy.(Fig. 6B-1) | S23-12335 | 1 | 1 | 1 | 1 |
| 2 | End connection | 033-53590 | 2 | - | 2 | 2 |
| | End connection | 033-53783 | - | 2 | - | - |
| 4 | Screw, SHC, 10-24 x 1/2 | 358-10080 | 1 | 1 | 1 | 1 |
| 8 | Clamp | 033-72111 | 1 | 1 | 1 | 1 |
| 9 | Pin | 033-53894 | 1 | 1 | 1 | 1 |
| 10 | Screw, HWHD 3/8-16 x 1 1/4 | 353-25018 | 4 | 4 | 4 | 4 |
| 12 | Washer, Nyltite #37 | 631-45007 | 4 | 4 | 4 | 4 |
| 13 | Spool | 033-53439 | 1 | 1 | 1 | 1 |
| 14 | Spring guide | 033-53420 | 2 | 2 | 2 | 2 |
| 15 | Thrust washer | 031-53421 | 2 | 2 | 2 | 2 |
| 16 | Spring | 033-53627 | 2 | - | 2 | - |
| | Spring | 033-53782 | - | 2 | - | - |
| | Spring | 225-92092 | - | - | - | 2 |
| 17 | Washer | 035-53452 | 2 | 2 | 8 | 4 |
| 18 | Nut | 333-12614 | 2 | 2 | 2 | 2 |
| 19 | O-ring, 90 S-1 ARP 908 | 691-00908 | 2 | 2 | 2 | 2 |
| 20 | Plug, 8-P5N-S | 488-35002 | 2 | 2 | 2 | 2 |
| 21 | Screw | 033-53419 | 2 | 2 | 2 | 2 |
| 22 | O-ring, 70 S-1 ARP 022 | 671-00022 | 2 | 2 | 2 | 2 |
| 23 | Cover | 031-53148 | 1 | 1 | 1 | 1 |
| 24 | Screw, SHC 1/4-20 x 5/8 | 358-12100 | 4 | 4 | 4 | 4 |
| 25 | Servo shaft assembly | S23-12497 | (1) | (1) | (1) | (1) |
| 25-1 | Shaft | 033-54841 | 1 | 1 | 1 | 1 |
| 25-2 | Pin | 033-71002 | 1 | 1 | 1 | 1 |
| 25-3 | Link | 033-70536 | 1 | 1 | 1 | 1 |
| 25-4 | Washer | 350-10141 | 1 | 1 | 1 | 1 |
| 25-5 | Shear seal | 033-71371 | 1 | 1 | 1 | 1 |
| 25-6 | Washer, finger spring | 350-10067 | 2 | 2 | 2 | 2 |
| 25-7 | Shear seal | 033-70525 | 1 | 1 | 1 | 1 |
| 25-8 | O-ring 70 S-5 ARP 017 | 675-00017 | 2 | 2 | 2 | 2 |
| 25-9 | Needle bearing | 230-82141 | 1 | 1 | 1 | 1 |
| 25-10 | Thrust washer | 350-10064 | 1 | 1 | 1 | 1 |
| 26 | Screw, SHC 1/4-20 x 3/4 | 358-12120 | 8 | 8 | 8 | 8 |
| 27 | O-ring, 70 S-1 ARP 133 | 671-00133 | 1 | 1 | 1 | 1 |

**PARTS LIST**

*For Figure 6B-1 - Brake and bypass valve for 600 series*

*S23-12335*

| ITEM | DESCRIPTION | PART NO. | QTY. |
|---|---|---|---|
| 6 | Plug 2HP5N-S | 488-35046 | 1 |
| 10 | Orifice, .028" (.71 mm), 1/16 PT | 037-19104 | 1 |
| 11 | Orifice plug | 033-71437 | 2 |
| 12 | Body and cover | P23-12496 | (1) |
| 12-1 | Body | S13-48902 | 1 |
| 12-1A | O-ring, 70 S-5 ARP 110 | 675-00110 | 1 |
| 12-2 | Cover | 033-91157 | 1 |
| 12-3 | O-ring, 70 S-1 ARP 012 | 671-00012 | 2 |
| 12-4 | Screw, SHC, 5/16-18 x 1 1/4 | 358-14180 | 2 |
| 12-5 | O-ring, 70 S-1 ARP 017 | 671-00017 | 1 |
| 13 | Lee Pluget | 447-00017 | 1 |
| 14 | 1/8" Hex flush plug | 431-90204 | 7 |
| 18 | Plug, 5P5N-S | 488-35028 | 1 |
| 19 | O-ring, 70 S-1 ARP 905 | 671-00905 | 1 |
| 25 | Spool | 035-71026 | 1 |
| 26 | Neutral bypass trimmer | S13-40908 | 1 |
| 27 | Plug, flush 1/16 PT | 431-90104 | 1 |
| 28 | Plug | 033-70841 | 1 |
| 29 | O-ring, 90 S-1 ARP 906 | 691-00906 | 3 |
| 30 | Plug | 033-70840 | 1 |
| 30 | Soc setscrew, 10-32 x 1" | 312-35040 | 2 |
| 31 | Cover nut, #10-32 | 033-91040 | 1 |
| 32 | O-ring, 70 S-1 ARP 010 | 671-00010 | 1 |
| 33 | Spool | 033-70999 | 1 |
| 34 | Spring | 033-71112 | 1 |
| 35 | Plug, 6P5ON-S | 488-35003 | 1 |
| 36 | Spool | 033-70997 | 1 |
| 37 | Spring | 033-70992 | 1 |
| 38 | Dowel pin, 1/8 x 1/2 | 324-20808 | 1 |
| 39 | Body | 033-91090 | 1 |
| 40 | O-ring, 90 S-1 ARP 016 | 691-00016 | 2 |
| 41 | Fitting | 033-70998 | 1 |
| 42 | Piston | 033-70993 | 1 |
| 44 | O-ring, 90 S-1 ARP 902 | 691-00902 | 2 |
| 45 | O-ring, 70 S-1 ARP 006 | 671-00006 | 1 |
| 46 | Vent post | 033-70995 | 1 |
| 47 | Compression spring | 225-92044 | 1 |
| 48 | Shoe | 033-70996 | 1 |
| 51 | Control gasket | 033-91058 | 1 |




SECTION B-B

SECTION A-A

**FIGURE 6B-1**
**BRAKE AND BYPASS VALVE**
**FOR "600" SERIES HYD. STROKER**

## CODE 6C - HYDRAULIC STROKER WITH BRAKE AND BYPASS VALVE/ADJ. STOPS

*S23-12296 Feature 00, CW -A Mtg, CCW - B Mtg.*

*S23-12297 Feature 00, CW -B Mtg, CCW - A Mtg.*

### DESCRIPTION

This one side of center control actuates the rotary input shaft by means of a hydraulic piston. The piston is spring loaded to zero stroke. Pilot pressure applied to the end opposite the spring causes the piston to move in proportion to the pilot pressure, thus positioning the rotary servo in proportion to pilot pressure. Maximum and minimum displacements are adjustable from zero to full.

Within the rotary servo body is contained the brake and bypass valve option. A brake spool, when energized, connects the brake port to servo pressure. When de-energized, a spring shifts the spool, connecting the brake port to tank. Another port, located on the end of the brake valve, is closed by the energizing of the brake spool. When de-energized, this port dumps both pump system ports to the replenishing source, thus bypassing the small flow generated by slight errors on zero position.

The operation is controlled in this manner: A restricted servo flow is applied to shift the brake spool. This flow is dumped when a slot in the servo plate aligns with a passage connecting to this spool. This occurs when the pump is on zero stroke. Another restricted flow is applied to a spool adjacent to the brake spool. This metered signal is connected to a port controlled by the input command spool. This port is set to open to tank when the input command is at zero stroke.

The brake spool is thus de-energized to set the brake when BOTH the pump cam is at zero stroke and the rotary servo is at zero command. If the pump is on stroke or the input is on stroke, the brake spool is energized, releasing the brake.

### DISASSEMBLY

*See Figure 6C*

1. Disconnect brake and bypass lines from control. Remove screws (10). Remove control from pump. Examine servo plate for excessive scratching. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two socket set screws from plate, then alternately loosening the two button head screws under the set screws.
2. Remove screws (22) and remove cover (21). Loosen screw (4).
3. Remove servo shaft assembly (23) and clamp (8).
4. Examine shoes (23-5) and (23-7) for contamination in balance pads or excessive scratching on faces. Note: the two shoes are not identical and must be installed in the proper position on reassembly.
5. Remove screws (24) and remove the centering adjusting group intact. Note: signal pressure setting is determined by the spring preload. Do not disassemble or change unless parts are damaged or setting is incorrect.
6. Remove screws (29) and cover (28) with assembled parts.
7. Remove spool (12). Do not remove stroker body from valve cover unless damaged, or seals need replaced.

*See Figure 6B-1*

8. Remove plug (30). Remove plug (28) with attached parts. Remove spool (25).
9. Remove bypass valve body (39) with fitting (41) and piston (42). Remove plug (35) and spring (34). Remove spools (33) and (36).
10. Remove shoe (48), and spring (47).
11. Examine two orifices (11) and orifice (10) in body for contamination. Examine passages in body for free flow.
12. Clean and examine all parts for breakage or evidence of abnormal wear.

### ASSEMBLY

All parts are to be inspected and be free of material defects, dirt, scratches or any foreign material.

All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.

After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

## REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |
| Shoe | Stone to remove raised burrs or dings. |

*See Figure 6B-1*

1. Install Lee Pluget (13) using installation tool and gage.
2. Install orifices (10) and (11) in body. Make sure that the orifice (10) in the deeper bore extends past the wall of the valve bore and will not interfere with spools (25) or (33) action.
3. Install 1/16 pipe plug (27) into cover (12). Plug must extend below bore, so it will not interfere with spool (25).
4. Apply pipe sealant to the 1/8" pipe plugs (14) and install in the cover plate. Torque to 100 in.-lbs. (11.3 Nm)
5. If stroker housing was removed from control cover, install O-ring (12-1A) in housing and O-rings (12-3) and (12-5) on interface between parts. Slip servo shaft assembly through the bore, and install screws (12-4). Torque to 25 lbs-ft. (33.9 Nm). Check for free motion of shaft assembly. Remove shaft. Slip spools into their respective bores and check for free travel. If tight, it may be necessary to carefully hone the bore, till spools are free in bores. Position spool (25) in the bore with the slot, align the elongated hole centered over the slot and the grooved end toward the orifice (33).
6. Install O-ring (29) on nut (28) and the neutral bypass trimmer assembly into nut (28). Install nut (28) into cover. Adjust trimmer assembly until the land on end of assembly is centered in groove in spool (25), with elongated hole in spool centered on slot in cover. Hold in place and install nut (31), O-ring (32), plug (6) and O-ring (44).
7. Install O-ring (29) on plug (30) and install on other end of this bore.
8. Install spools (33) and (36) into the other cross-bore in the cover (12). The slotted end of spool (33) should be to the outside.
9. Install O-ring (29) on plug (35). Install spring (34) in plug and install plug in cover as shown.
10. Install O-rings (40) on fitting (41). Install piston (42) in bore of body (39). Install fitting (41) on body and install assembly in cover (12).
11. Install O-rings (44) and (45) on vent post (46). Install vent post in cover.
12. Install spring (47) and shoe (48) over vent post.
13. Install O-ring (19) on plug (18) and install in body (12).

*See Figure 6C*

14. Install O-ring (23-8) in groove of shear seal (23-5). Install shear seal with O-ring in the large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.
15. Install needle bearing (23-9) over servo shaft and seat against the servo link. Install thrust washer (23-4) over needle bearing.

> Note: The shear seal will fit in one position only. Otherwise one side will be held up by the lip of the servo link. Shear seal (23-5) must be installed to face against the cover plate. This shear seal differs from shear seal (23-7) in that the face surface is machined with two .094" (2.4 mm) radius scallops.

16. Install spool (12) in stroker body. Press dowel (9) into clamp (8) to .500" (12.7mm) dimension shown. Install screw (4) in clamp. Slip clamp into body to engage groove in spool (12). Slip servo shaft assembly (23) through the body and through the clamp, simultaneously engaging the pin on the servo arm with the slot in the spool, (25) ref. 6B-1.
17. Tighten the clamp only enough to hold the clamp snugly against the bushing, while permitting the shaft to turn in the clamp with light force.
18. Holding a flat plate against the ends of the spool bore, rotate the shaft clockwise and counterclockwise, causing spool (12) to travel from flush one side to flush the other side. Observe the position of the shear seal relative to the two 3/16 dowel holes in the cover. Position such that the overlap is equal on each side. Eliminate end play and torque screw (4) to 72 lbs-in, (8 Nm), locking the clamp to the shaft
19. Install spring guide (13) and spring (14) over screw (19). Install screw into screw (18). Adjust to 2" compressed length on spring (14). Install 1/4-20 nut (17) and tighten.
20. Insert spring assembly in body (2). Adjust for .308" ((7.82 mm) extension of spring guide beyond surface. Install O-ring (20) in body and locknut (15). Install locknut and l acorn nut (16) on screw (18).
18. Install O-ring (20) in body and place assembly on stroker body, according to chart:
19. Using screws (24) bolt end connection (2) onto body (23).

20.. Install O-ring (20) in cover (28) and mount on housing on opposite side from centering assembly, with screws (29). Torque screws to 14 lbs-ft. (19 Nm).

| Pump rot. & cont. mtg | Centering group location |
|---|---|
| CW — A | See Fig. 6C |
| CW - B | Opposite to Fig. 6C |
| CCW - A | Opposite to Fig. 6C |
| CCW - B | See Fig. 6C |

21 Install setscrew (30) in cover (28) till it contacts spool (12). Install nut (31), O-ring (32), plug (27) and O-ring (26) on setscrew and lock.
22. Install cover (21), cover screws (22) and O-ring (25). Torque screws to 14 lbs-ft. (19 Nm).
23. Place two spring washers (23-6), nested with the bent sections matching each other, into the large hole in the servo link,
24. Place washer (23-10) against the spring washers.
25. Install O-ring (23-8) into groove in the remaining shear seal (23-7). Note: This shear seal does not contain the two .094 radius scallops in the face. Place on top of washer, (23-10). Position shear seal to match the lip on the servo link.
26. If control is to be tested on pump, install on pump control pad with gasket (ref Fig. 6B-1 item 51), nyltite washers (12), and screws (10). Torque to 30 lb. ft. (40.8 Nm). Install bypass check valves fittings, and lines.

**TEST**

Connect servo source, adjustable to 450 psi (31 bar), to control port on hydraulic stroker.
Install a needle valve on the bypass valve exhaust port, connected to tank. Close the valve.
1. Set pump to zero stroke by adjusting minimum stop screw (30).
2. Apply servo pressure to signal port of stroker. Adjust pressure from minimum to maximum. Note the pressure at which pump just starts to stroke, and the pressure at which the pump reaches full stroke These pressures must be within the following values:

| Control Feature | Pressure Start | Pressure Full |
|---|---|---|
| 00 | 75± 15 psi (5.2± 1 bar) | 335± 25 psi (23.1±1.7 bar) |
| 01 | 75± 15 psi (5.2± 1 bar) | 435± 25 psi (30± 1.7 bar) |
| 02 | 100± 15 psi (6.9± 1 bar) | 375± 25 psi (25.9± 1.7 bar) |
| 03 | 150±15 psi (10.3±1 bar) | 400± 25 psi (27.6± 1.7 bar) |

If pressures are incorrect, turn adjusting screw (18) to obtain correct pressure.
3. With minimum signal, pump shall return to zero stroke within 200 psi (13.8 bar) max. system pressure.
4. With full control signal pressure on control port, set screw (19) for full stroke, Lock adjustments and install acorn nut (16).
5. Increase and decrease control pressure between 0 and 450 psi (31 bar) several times . Pump stroke should follow control pressure smoothly and proportionally. Full to zero or zero to full stroke should be achieved in no more than two seconds. Adjust control pressure up to 90% stroke from zero stroke, then adjust down from full stroke to the same value. The control pressure at the two settings shall not vary more than 50 psi (3.4 bar) from each other.
6. With pump on zero stroke, turn brake trimmer screw CW and CCW while observing gage on brake port. Note the positions where the gage reading changes from case pressure to servo pressure to case pressure. Set and lock the adjustment midway between these two positions.
7. Place load on pump and stroke pump. The gage on the brake port should start to indicate servo pressure when the system pressure is between 2000 and 4500 psi (138 and 310 bar), with an increasing signal, and must return to case pressure before system pressure drops to 2000 psi (138 bar), on decreasing signal. Record both pressures.
8. Open the needle valve on the neutral bypass port. Measure and record leakage from this port with the pump on center at minimum psi, and with the pump off center, at 5000 psi.
**Maximum leakage with control on center:**

2.0 gpm (7.6 l/m)

**Minimum leakage with control on center:**

1.0 gpm (3.8 l/m)

**Maximum leakage with control off center:**

35 cu. in/min or .15 gpm (574 cm3/min. or 0.57 l/m)

9. Unload and stroke pump. Control should operate smoothly. Brake pressure should drop to case pressure each time control is on center, and it should indicate servo pressure as soon as input shaft is rotated on stroke.
10. Release control signal when pump is off center. Pump should return to center. Repeat several times at different pressures from 200 to 5000 psi (13.8 to 345 bar)
11. Remove needle valve from bypass exhaust port and install exhaust line.

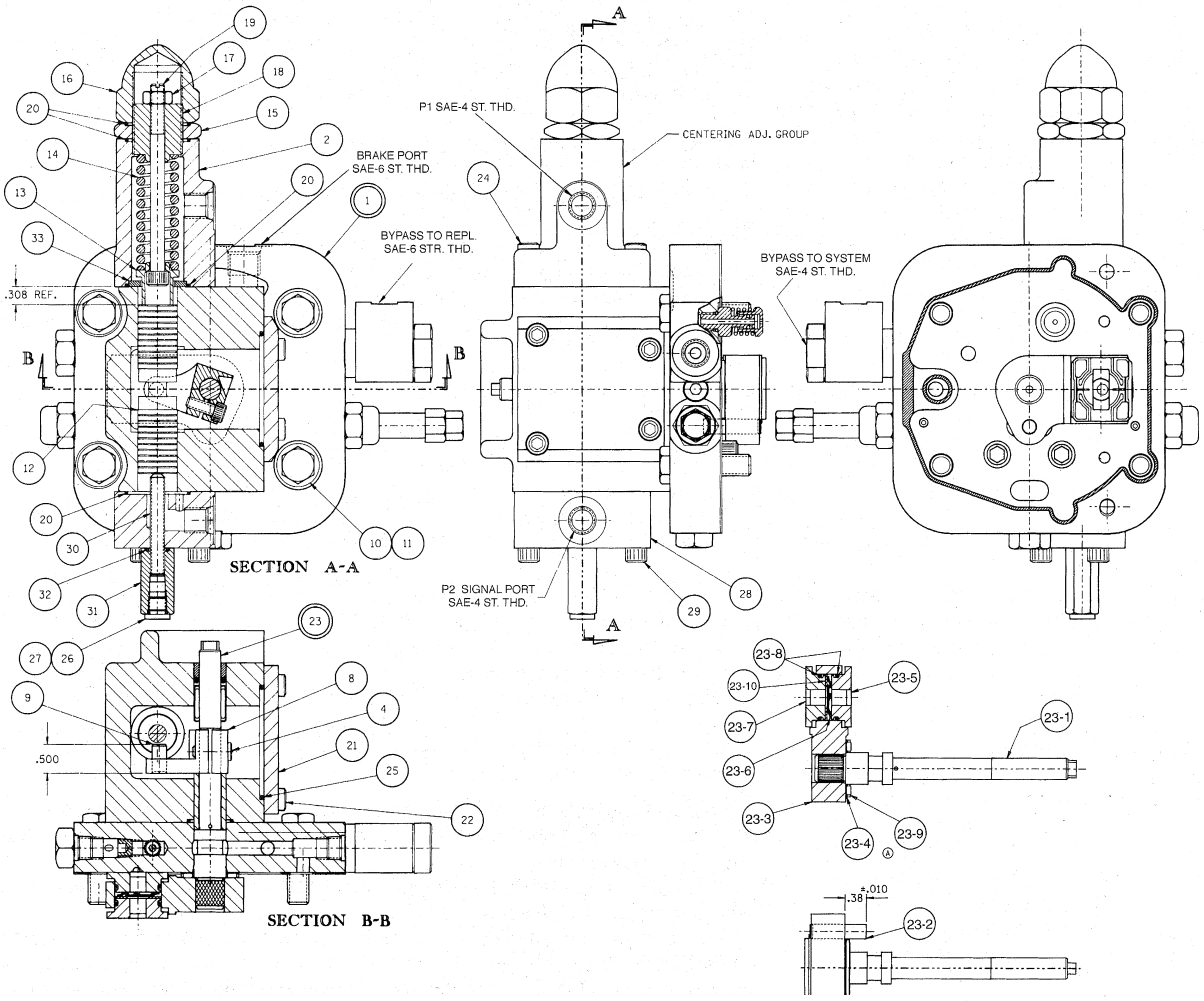



**FIGURE 6C**
**HYDRAULIC STROKER**
**WITH BRAKE AND BYPASS VALVE,**
**ADJUSTABLE STOPS**

**PARTS LIST**

*For Figure 6C - Hydraulic stroker with brake and bypass valve/adj. stops*

*S23-12296 - Feature 00, CW-A, CCW-B (75 - 350 PSI)*

*S23-12297 - Feature 00, CCW-A, CW-B (75 - 350 PSI)*

| | | Feature → | 00 | 01 | 02 | 03 |
|---|---|---|---|---|---|---|
| ITEM | DESCRIPTION | PART NO. | QTY. | QTY. | QTY. | QTY. |
| 1 | Neutral bypass/brake . subassy (Fig. 6B-1) | S23-12335 | 1 | 1 | 1 | 1 |
| 2 | End connection | 033-53880 | 1 | 1 | 1 | 1 |
| 4 | Screw, SHC, 10-24 x 1/2 | 358-10080 | 1 | 1 | 1 | 1 |
| 8 | Clamp | 033-72111 | 1 | 1 | 1 | 1 |
| 9 | Pin | 033-53894 | 1 | 1 | 1 | 1 |
| 10 | Screw, HWHD 3/8-16 x 1 1/4 | 353-25018 | 4 | 4 | 4 | 4 |
| 11 | Washer, Nyltite #37 | 631-45007 | 4 | 4 | 4 | 4 |
| 12 | Spool | 033-53439 | 1 | 1 | 1 | 1 |
| 13 | Spring guide | 033-53420 | 1 | 1 | 1 | 1 |
| 14 | Spring | 033-54269 | 1 | - | 1 | 1 |
| | Spring | 033-57486 | - | 1 | - | - |
| 15 | Locknut | 033-53877 | 1 | 1 | 1 | 1 |
| 16 | Acorn nut, 7/8-14 | 327-25007 | 1 | 1 | 1 | 1 |
| 17 | Hex nut | 333-12614 | 1 | 1 | 1 | 1 |
| 18 | Adjustment screw | 033-53876 | 1 | 1 | 1 | 1 |
| 19 | Slotted screw | 033-53878 | 1 | 1 | 1 | 1 |
| 20 | O-ring, 70 S-1 ARP 022 | 671-00022 | 4 | 4 | 4 | 4 |
| 21 | Cover | 031-53148 | 1 | 1 | 1 | 1 |
| 22 | Screw, SHC 1/4-20 x 5/8 | 358-12100 | 4 | 4 | 4 | 4 |
| 23 | Servo shaft assembly | S23-12497 | (1) | (1) | (1) | (1) |
| 23-1 | Shaft | 033-54841 | 1 | 1 | 1 | 1 |
| 23-2 | Pin | 033-71002 | 1 | 1 | 1 | 1 |
| 23-3 | Link | 033-70536 | 1 | 1 | 1 | 1 |
| 23-4 | Washer | 350-10141 | 1 | 1 | 1 | 1 |
| 23-5 | Shear seal | 033-71371 | 1 | 1 | 1 | 1 |
| 23-6 | Washer, finger spring | 350-10067 | 2 | 2 | 2 | 2 |
| 23-7 | Shear seal | 033-70525 | 1 | 1 | 1 | 1 |
| 23-8 | O-ring 70 S-5 ARP 017 | 675-00017 | 2 | 2 | 2 | 2 |
| 23-9 | Needle bearing | 230-82141 | 1 | 1 | 1 | 1 |
| 23-10 | Thrust washer | 350-10064 | 1 | 1 | 1 | 1 |
| 24 | Screw. SHC 1/4-20 x1 | 358-12160 | 4 | 4 | 4 | 4 |
| 25 | O-ring, 70 S-1 ARP 133 | 671-00133 | 1 | 1 | 1 | 1 |
| 26 | O-ring, 90 S-1 ARP 902 | 691-00902 | 1 | 1 | 1 | 1 |
| 27 | Plug, 2HP5N-S | 488-35046 | 1 | 1 | 1 | 1 |
| 28 | Cover | 033-53879 | 1 | 1 | 1 | 1 |
| 29 | Screw, SHC 1/4-20 x 1 1/2 | 358-12200 | 4 | 4 | 4 | 4 |
| 30 | Setscrew, 1/4-20 x 1 3/4 | 311-12220 | 1 | 1 | 1 | 1 |
| 31 | Cover nut 1/4-20 | 033-91039 | 1 | 1 | 1 | 1 |
| 32 | O-ring, 70 S-1 ARP 011 | 671-00011 | 1 | 1 | 1 | 1 |
| 33 | Thrust washer | 031-53421 | 1 | 1 | 1 | 1 |

## FEEDBACK FOR 700 SERIES HI-IQ SERVOVALVE CONTROL

*S23-02345 Potentiometer feedback for 7E & 7G controls*

*S23-03278 D.C. R.V.D.T.feedback for 7F & 7 H controls*

### DESCRIPTION

The feedback controls provide an electrical signal corresponding to the pump displacement. For the potentiometer feedback, this signal is typically +/- 3.1 volts at full stroke, with a +/- 15 volt input.
The RVDT has internal circuitry to power the RVDT and demodulate the output, converting the rotary input into a proportional D.C. output of +/- 2.3 volts at full stroke with +/- 15 volt input.

### DISASSEMBLY

*See Figure 7*

Remove studs (12) by turning nuts (13) and remove cover (11), cover ring (33) if applicable, and housing (28).
2. Remove connector (22). Unsolder all wires from this connector.
3. Remove screw (27) attaching link (26) to cover.
4. Loosen the nut on the shaft lock (6), closest to the potentiometer or RVDT. Remove potentiometer or RVDT with mounting plate (7).
5. If complete disassembly is required, apply heat to the shaft lock (6), approx. 350°F. (176°C), to soften loctite and permit unscrewing from shaft.
6. Remove retaining ring (21) and press the shaft assembly through the valve body.
7. Examine shoes (1) and (4) for contamination in balance pads or excessive scratching on faces. Note: the two shoes are not identical and must be installed in the proper position on reassembly.

### REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |

### PREPARATION FOR ASSEMBLY

All parts are to be inspected and be free of material defects, dirt, scratches or any foreign material. All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

### ASSEMBLY

1. Apply pipe sealant and Install plug (19) in body. Torque to 100 lbs-in. (11.3 Nm)
2. Install O-ring (2) in groove of shear seal (4). Install shear seal with O-ring in the large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.

> Note: The shear seal will fit in one position only. Otherwise one side will be held up by the lip of the servo link. Shear seal (4) must be installed to face against the cover plate (18). This shear seal differs from shear seal (1) in that the face surface is machined with two .094" (2.4 mm) radius scallops.

3. Install three thrust washers (17) over servo shaft and seat against the servo link.
4. Install O-ring (5) in the second groove from the end of the shaft, using installation tool T-1.
5. Install the servo shaft assembly into the cover plate (18).
6. Install retaining ring (21) into the groove of the servo shaft extending through the cover plate.
7. Place a drop of Loctite #271 on the threads on the end of the servo shaft. Install shaft lock (6) onto the servo shaft.
8. Using rosin flux solder, attach wires to potentiometer according to the wiring diagram, allowing sufficient length to wrap around once, plus 5" (127 mm) extra length.
9. Assemble brace (26) onto mounting plate (7), on side opposite counterbore, using screw (31) and locking nut (32). Hand tighten only.
10. Assemble RVDT or pot. into the counterbore on the mounting plate (7). Install mounting cleats and screws (8).

11. For RVDT assembly, slip sleeve (15) into clamp (6).

Note: Before installing the RVDT to servo shaft, align the scribe mark on the shaft with the scribe mark on the housing. Before installing the potentiometer, align the wiper, (terminal 4), with the center tap, (terminal 2) **Caution! limit electrical current through any terminal on the pot. to 8 ma maximum to avoid damage to resistance element!**

12. Install RVDT or potentiometer assembly into clamp (6), aligning the brace with the attaching hole in the cover, centering the servo arm and maintaining the alignment of the shaft as above. Tighten the clamp nut to 60 lbs-in. (6.8 Nm).
13. Install screw (27). Tighten this screw, and tighten screw (31).
14. Wrap wires once around the RVDT or pot. Feed wires through the drilling in the cover plate (18). Slip tubing (36) over pot. wiring bundle. Trim excess wiring.
15. Slide O-ring (23) and tubing (37) over wires. Solder wires to connector (22) per wiring diagram. Slip tubing (37) over each terminal and heat shrink in place.
16. Place a drop of Loctite #271 on one end of each threaded stud (12). Install acorn nut (13) on this end and tighten.
17. Install two O-rings (20) in housing (28).
18. For pot. assemblies, assemble clamp ring (33) and cover (11), to housing (28), with red dots to inside. Insert four studs with acorn nuts. Assemble indicator (34) with screw (15) to pot. (25). With servo arm centered, align indicator to match center dot on cover (11) as installed. Lock in position. Install housing assembly to cover plate (18). Torque to 48 in.-lbs. (5.42 Nm).
19. For RVDT assemblies, assemble cover (11) to housing and install on cover plate (18) using four studs (12) with nuts (13). Torque to 48 in.-lbs. (5.42 Nm).
20. Place two spring washers (3), nested with the bent sections matching each other, into the large hole in the servo link.
21. Place washer (10) against the spring washers.
22. Install O-ring (2) into groove in the remaining shear seal (1). Note: This shear seal does not contain the two .094" (2.4 mm) radius scallops in the face. Place on top of washer (10). Position shear seal to match the lip on the servo link.
23. Install on pump output control side, engaging servo arm between the spacer and the anti-backlash spring. Align control with housing dowels. Attach with screws (29), new Nyltite washers (30), and gasket (14). Torque screws to 30 lbs-ft. (40.8 Nm). Attach electrical connector to plug.

## FINAL ADJUSTMENT AND TEST

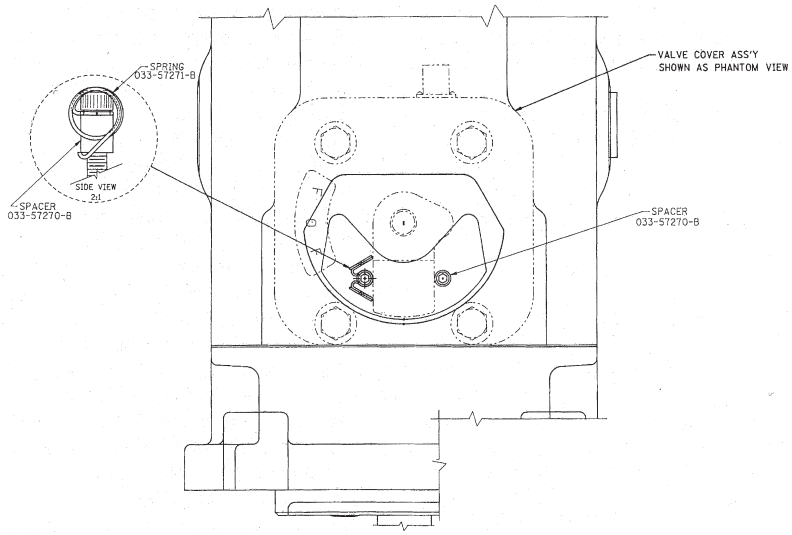
Note: Always have power off when loosening or tightening clamps on feedback pot., to avoid shorting out the electrical terminals and damaging the pot. or the electrical control. Caution! to avoid damage to RVDT check for correct polarity of D.C. signal to RVDT before applying power.

1. Remove housing from feedback control. Loosen clamps on feedback pot. or RVDT. Connect voltmeter between output terminal and common ground. Turn on power. Start pump and confirm that feedback polarity is correct, and servovalve is functioning correctly. (Pump may be controlled through its entire stroke range).
2. Set the displacement command to zero volts, and set the electronic zero adjustment to zero volts.
3. Rotate the feedback pot. or LVDT as necessary to bring the pump to zero stroke, as indicated by minimum system pressure and pump noise.
4. At this point, voltmeter reading should be less than +/-0.1 volts. If not, adjust the electronic zero adjustment till feedback voltage is zero volts, then re-adjust the feedback pot. or LVDT to bring the pump to zero stroke at zero volts feedback. If the wiper is within +/- 0.1 volts, the electronic zero adjustment can correct for this error.
5. Shut off pump and control power. Lock the feedback pot. or LVDT in place. If indicator is not aligned with center red dot, relocate and lock in position. Install housing assembly on control and torque nuts to 48 in.-lbs. (5.42 Nm).

## INSTALLATION OF ANTI-BACK-LASH SPRING

1. Remove control. Remove screws holding servo plate to stem. Replace spacers with 033-57270 spacers, Attach one spacer and screw through servo plate, undercut end toward screw head.. Install spring 033-57271 over undercut on other spacer. Install screw through this end and attach through servo plate in the other hole, with the spring positioned as shown on SK-15045.

*SK-15045*
*Installation of anti-backlash spring*



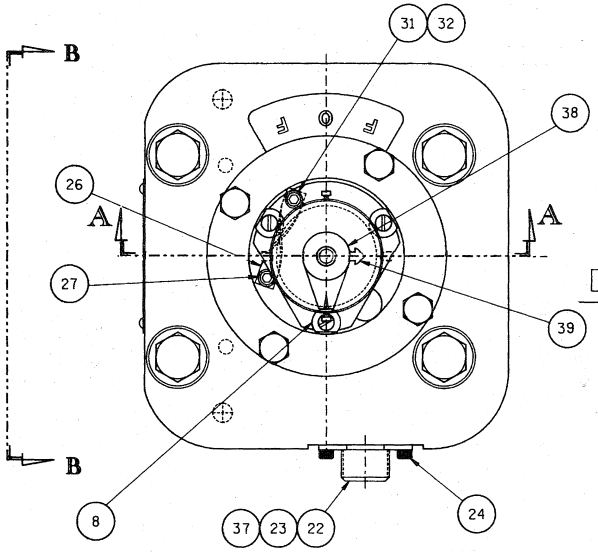
**PARTS LIST**

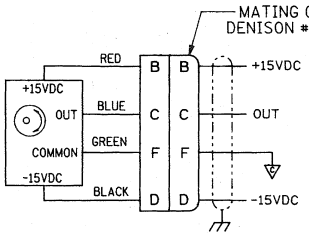
*For Figure 7 - Feedback for 700 series HI-IQ servovalve control*

*S23-02345*
*Potentiometer feedback for 7D & 7F control*

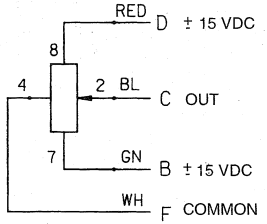
*S23-03278*
*D.C. RVDT feedback for 7E & 7G control*

| ITEM | DESCRIPTION | PT. NO. | QTY. S23-02345 | QTY. S23-03278 |
|---|---|---|---|---|
| 1 | Shear seal | 033-70525 | 1 | 1 |
| 2 | O-ring, 70 S-1 ARP 017 | 671-00017 | 2 | 2 |
| 3 | Finger spring | 350-10067 | 2 | 2 |
| 4 | Shear seal | 033-71371 | 1 | 1 |
| 5 | O-ring, 70 S-1 ARP 013 | 671-00013 | 1 | 1 |
| 6 | Shaft lock | 735-80008 | 1 | 1 |
| 7 | Mtg. plate | 033-54458 | 1 | - |
| | Mtg. plate (RVDT) | 033-54486 | - | 1 |
| 8 | Mtg. cleat with #4-40 screw | 780-00008 | 3 | 3 |
| 10 | Thrust washer | 350-10064 | 1 | 1 |
| 11 | Cover | 033-54459 | 1 | - |
| | Housing spacer | 033-54533 | - | 1 |
| 12 | Thd'd stud, #10-32 x 3 | 033-54535 | 4 | - |
| | Thd'd stud, #10-32 x 3.55 | 033-54536 | - | 4 |
| 13 | Nut, acorn 10-32 | 327-25003 | 4 | 4 |
| 14 | Control cover gasket | 033-91058 | 1 | 1 |
| 15 | RVDT shaft sleeve | 033-54534 | - | 1 |
| 16 | Servo shaft assy. | S23-02346 | 1 | 1 |
| 17 | Washer, hardened | 350-10103 | 3 | 3 |
| 18 | Control cover | 033-54460 | 1 | 1 |
| 19 | Hex flush plug 1/8" pipe | 431-90204 | 1 | 1 |
| 20 | O- ring, 70 S-1 ARP 035 | 671-00035 | 2 | 2 |
| 21 | Ring, WT 5100-50 | 356-65070 | 1 | 1 |
| 22 | Elec. connector | 033-54466 | 1 | 1 |
| 23 | O-ring, 70 S-1 ARP 015 | 671-00015 | 1 | 1 |
| 24 | SHCS #4-40 x 1/4 | 358-02040 | 2 | 2 |
| 25 | Potentiometer | 035-44092 | 1 | - |
| | RVDT, D.C. | 788-20002 | - | 1 |
| 26 | Brace | 033-54461 | 1 | 1 |
| 27 | SHCS #6-32 x 1/4 | 358-06040 | 1 | 1 |
| 28 | Housing cover | 033-54462 | 1 | 1 |
| 29 | Screw, hwhd. 3/8-16 x 1-1/4 | 353-25018 | 4 | 4 |
| 30 | Washer Nyltite #37 | 631-45007 | 4 | 4 |
| 31 | SHCS #6-32 x 1 | 358-06160 | 1 | 1 |
| 32 | Elastic stop nut | 333-06010 | 1 | 1 |
| 33 | Cover ring | 033-54526 | 1 | - |
| 34 | Plate, serial no. | 030-55003 | 1 | 1 |
| 35 | Screw, R.H. drive, #2 x 3/16 SS | 320-10203 | 2 | 2 |
| 36 | Tubing | 739-20016 | .5' | - |
| 37 | Tubing | 739-20019 | .2' | .2' |
| 38 | Indicator | 035-45647 | 1 | - |
| 39 | Rd. hd screw, #4-40 x 3/8 | 336-02061 | 1 | - |

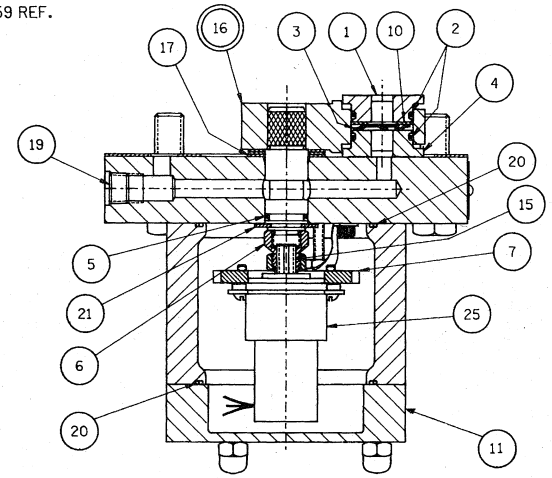



DC RVDT WIRING SCHEMATIC

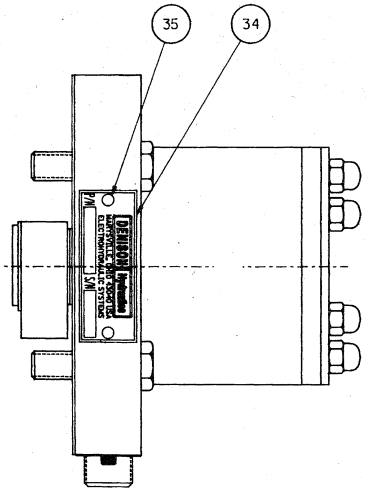



WIRING DIAGRAM

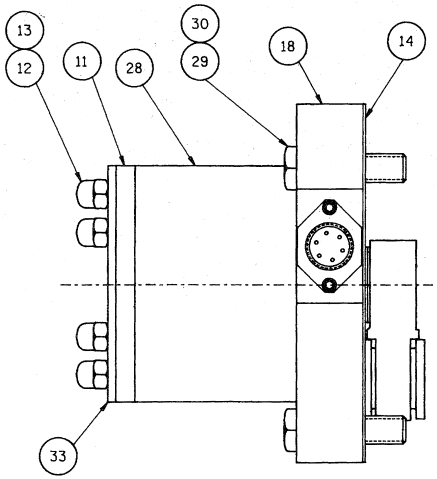


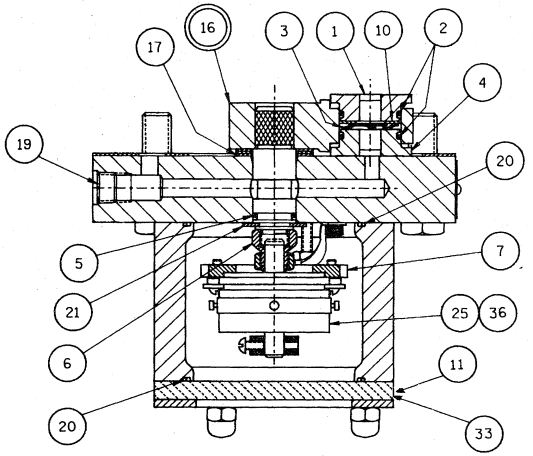

**SECTION A-A**

DC R.V.D.T. (7E, 7G)




**VIEW B-B**




**SECTION A-A**

POTENTIOMETER
(7F, 7H)

**FIGURE 7**
**FEEDBACK FOR 700 SERIES HI IQ**
**SERVO VALVE CONTROL**

## 8A HYDRAULIC STROKER CONTROL

*S23-12268 (Feature 00 Pump)*
*S23-12946 (Feature 00 "R" version)*
*S23-12760 (Feature 01 Pump)*
*S23-12630 (Feature 02 Pump)*
*S23-12529 (Feature 03 Pump)*
*S23-15065 (Feature 04 Pump)*
*S23-12271 (Feature 0* Motor "A" Input)*
*S23-12378 (Feature 0* Motor "B" Input)*
*S23-12527 (Feature 1* Motor "A" Input)*
*S23-12526 (Feature 1* Motor "B" Input)*

### DESCRIPTION

This control is used on both pump and motors. It consists of one spring centered spool in the control cover that is operated by modulation ports P1 or P2. The control may also be manually operated whenever the external control pressure is removed. The control, consisting of the stroking piston and the centering spring, positions the rotary servo proportionally to pilot or control pressure. With no external control pressure and the centering spring properly adjusted, the stroking piston will position the rotary servo: for pumps exactly at the zero stroke position, and for motors at the full stroke position.

### DISASSEMBLY

*See Figure 8A*

1. Remove screws (2) from control.
2. Remove control from pump.
3. Examine servo plate for excessive scratching on surface. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two soc. setscrews from plate, then alternately loosening the two button hd. screws under the setscrews.
4. Remove retaining ring (4) and press the shaft assembly through the valve body.
5. Examine shoes (8) and (18) for contamination in balance pads and excessive scratching on shoe faces. Note the two shoes are not identical and must be installed in the proper position upon reassembly.
6. Remove the plug (13) with the stop assembly intact.
7. Remove the centering adjustment screw (23) with the spool assembly and stop assembly intact. Note: signal pressure setting is determined by the spring preload. Do not disassemble or change unless setting is incorrect.
8. Clean and examine all parts for breakage or evidence of abnormal wear.

### REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |

### ASSEMBLY, 8A CONTROL

*See Figure 8A*

All parts are to be inspected and be free of material defects, dirt, scratches, or any foreign material.
All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

1. Apply pipe sealant to the 1/8" pipe plug (12) and install in the cover plate. Torque to 100 lbs-in. (11.3 Nm)
2. Thread trimmer locknut (22) all the way onto trimmer screw (23). Slip back-up washer (21), small dia. first, onto trimmer screw and against locknut. Using a 3/4 - 16 hex nut, with a 1.030" (26.2mm) dia. x .030/.035" (0.76/0.89mm) deep c'bore, crimp the washer onto the stop. Washer must be free to rotate slightly. Remove crimping nut.

*See Figure 8A-1*

3. Compress spring (4) solid in order to remove spring set. This may be safely accomplished by using a 1/4" (6.35 mm) dia. bolt through the center of the spring.
4. Assemble retaining ring (2), guide (3), spring (4) and guide (6) onto spool (1).
5. Tighten nut (7) till it just starts to load the spring, then tighten the required number of turns to obtain desired preload, as indicated.

**SPRING SETTING**

| Control Feature | Turns Past Contact |
|---|---|
| 00 (PUMP) | 2 |
| 01 (PUMP) | 1-1/2 |
| 02 (PUMP) | 2-1/2 |
| 03 (PUMP) | 3-2/3 |
| 04 (PUMP) | 2-5/6 |
| 0* (MOTOR) | 2 |
| 1* (MOTOR) | 6-1/6 |

6. Install locknut (5) onto spool and lock against nut (7) without changing adjustment.

*See Figure 8A*

7. Insert spool assembly (11), spring end first, into trimmer screw (23). Compress snap ring on the spool assembly until it snaps into internal groove inside trimmer screw. See that it is securely seated.
8. Thread spring stop locknut (24) all the way onto adjusting spring stop (25). Slip back-up washer (26), small diameter first, onto stop and against locknut. Using a 9/16-18 hex nut with a .810/.815" (20.6/20.7mm) dia. x .030-.035" (0.76-0.89mm) dp. c'bore, crimp washer onto stop. Washer must be free to rotate slightly. Remove the crimping nut.
9. Install O-ring (35) on plug (34) and insert into spring stop (25). Install O-ring (27) onto stop (25) and against washer (26).
10. Thread adjusting spring stop (25) into trimmer screw (23) until it just touches the spool assembly. Be sure spool assembly is against snap ring.
11. Determine the correct position of the spool assembly in the valve body. For 8A standard pump controls, and for 8A motor controls mounted on the "B" port side, the spool assembly is installed in the side of the control cap containing the 1/8" pipe plug (12). For controls used on P*R pumps, and motor controls mounted on the "A" port side, the spool assembly is installed on the side opposite the 1/8" pipe plug (12), as shown in Fig. 8A.

| Pump or Motor Model | Control Location | Spool Position Ref. Fig. 8A |
|---|---|---|
| P*P, P*V, P*S | "A" or "B" | Opposite shown |
| P6R, P7R, P8R | "A" or "B" | As shown |
| M*H, M*V | "A" | As shown |
| M*H, M*V | "B" | Opposite shown |

12. Place O-ring (14) on trimmer screw (23) and thread assembly into the cover plate, as noted above.
13. Install 0-ring (7) in groove of shear seal (8).
14. Install shear seal with O-ring in large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.

Note: The shear seal will fit in one position only, otherwise one side will be held up by the lip of the servo link. Shear seal (8) must be installed to face against the cover plate (10). This shear seal (8) differs from shear seal (18) in that the face surface is machined with two .094" (2.4mm) radius scallops.

15 Install thrust bearing (9) over servo shaft and seat against the servo link.
16. Slip washer (33) over the servo shaft and against the thrust bearing.
17. Using installation tool T-1, install O-ring (5) in the second groove from the end of the shaft (1). Warm glyd ring (20) to make it pliable, and install over O-ring (5).
18. Install the servo shaft assembly in the cover plate (10). Pin must engage slot in spool assembly (11).
19. Install retaining ring (4) into the groove of the servo shaft extending thru the cover plate.
20. Install adjusting screw (15) in plug (13). Install O-ring (14) on plug. Thread adjusting screw in until it protrudes approximately 1/2" from top of plug (13). For motor controls, install two nuts (36) on the other end.
21. Thread cover nut (16) with O-ring (31) onto adjusting screw.
22. Install plug (28) and O-ring (29) into cover nut (16).
23. Install this assembly in body on the opposite side from the spool assembly (11).
24. Install nut (36) on adjusting screw (6). Thread adjusting screw into stop (25).
25. Install roll pins (30) into drilled holes in surface of cover. Caution! do not damage

face of cover.
26. Place two spring washers (17), nested with the bent sections matching each other, into the large hole in the servo link.
27. Place washer (32) against the spring washers.
28. Install O-ring (7) into groove in the remaining shear seal (18). Note: This shear seal does not contain the two .094" (2.4mm) radius scallops in the face. Place on top of washer, (32). Position shear seal to match the lip on the servo link.
29. If control is to be tested on pump, install control on pump control pad with gasket (19), nyltite washers (3), and screws (2). Torque to 30 lb. ft. (40.8 Nm).

## 8A CONTROL TEST SETUP

1. Install stroking handle on the shaft.
2. Connect servo source, adjustable to 450 psi (31 bar), to control ports on hydraulic stroker through a 4-way valve. Center position must dump both ports to tank at min. pressure.

## 8A PUMP CONTROL

1. Rotate handle to check for free play. Turn spring stop adjustment in or out till it just contacts the spring and there is no free play. Lock in place. **Note: this adjustment is critical to accurate neutral adjustment!**
2. Turn trimmer screw to place input shaft on the zero stroke position. Set max. volume stops so that servo shaft link touches stop pins when handle is stroked each side of center. Lock in place.
3. Apply servo pressure to one port of stroker. Adjust pressure from minimum to maximum. Note the pressure at which pump just starts to stroke, and the pressure at which the pump reaches full stroke These pressures must be within the following values:

## PUMP CONTROL PRESSURE

| Control Feature | Pressure Start | Pressure Full |
|---|---|---|
| 00 | 75± 15 psi (5.2± 1 bar) | 335± 25 psi (23.1±1.7 bar) |
| 01 | 75± 15 psi (5.2± 1 bar) | 435± 25 psi (30± 1.7 bar) |
| 02 | 100± 15 psi (6.9± 1 bar) | 375± 25 psi (25.9± 1.7 bar) |
| 03 | 150±15 psi (10.3±1 bar) | 400± 25 psi (27.6± 1.7 bar) |
| 04 | 75±15 psi (5.2± 1 bar) | 250± 25 psi (17.2± 1.7 bar) |

If pressures are incorrect, control may be disassembled and adjustment made to the spring preload. The following table may be used to determine adjustment required to the nuts retaining the spring:

## PUMP CONTROL SPRING ADJUSTMENT

| Control Feature | Pressure Change Per 1/6 Turn Adj. |
|---|---|
| 00, 02, 03 | 6.8 psi (0.47 bar) |
| 01 | 9.0 psi (0.62 bar) |
| 04 | 4.6 psi (0.31 bar) |

4. With minimum signal, pump shall return to zero stroke within 200 psi (13.8 bar) max.
5. Repeat test on opposite side of center.
6. Increase and decrease control pressure between 0 and 450 PSI (31 bar) several times . Pump stroke should follow control pressure smoothly and proportionally. Full to zero or zero to full stroke should be achieved in no more than two seconds. Adjust control pressure up to 50% stroke from zero stroke, then adjust down from full stroke to the same value. The control pressure at the two settings shall not vary more than 50 psi (3.4 bar) from each other.

## 8A MOTOR CONTROL

1. Set max. volume stop (6), on spring box end, to just contact the spool assembly. Lock in place. Back trimmer screw out to full stroke position. Lock in place.
2. Set min. volume stop (15) to limit travel to 25% of full stroke. (4 times the rpm at maximum displacement.) **Caution! do not exceed motor rated speed!** Lock in position.

3. Apply servo pressure to control port of stroker. Control port is on the same side as the trimmer adjustment. Adjust pressure from minimum to maximum. Note the control pressure at which motor just starts to de-stroke, and the control pressure at which the motor reaches 25% stroke. These pressures must be within the following values:

## MOTOR CONTROL PRESSURE

| Control Feature | Pressure At Full | Pressure 25% Stroke |
|---|---|---|
| 0* | 75± 15 psi (5.2± 1 bar) | 250± 25 psi (17.2± 1.7 bar) |
| 1* | 250± 15 psi (17.2± 1 bar) | 450± 25 psi (31± 1.7 bar) |

If pressures are incorrect, control may be disassembled and adjustment made to the spring preload. The following table may be used to determine adjustment required to the nuts retaining the spring:

## MOTOR CONTROL SPRING ADJUSTMENT

| Control Feature | Pressure Change Per 1/6 Turn Adj. |
|---|---|
| 0*, 1* | 6.8 psi (0.47 bar) |

4. Increase and decrease control pressure between 0 and 450 PSI (31 bar) several times . Motor stroke should follow control pressure smoothly and proportionally. Full to min. or minimum to full stroke should be achieved in no more than two seconds. Adjust control pressure down to 50% stroke from full stroke, then adjust up from min. stroke to the same value. The control pressure at the two settings shall not vary more than 50 psi (3.4 bar) from each other.
5. When control has satisfactorily passed test, remove stop assembly from control and set the two internal nuts to prevent adjustment of minimum stroke below 25% of stroke. Reassemble stop assembly on control.

## PARTS LIST

*For figure 8A - Hydraulic stroker control*

*S23-12268 (Feature 00 Pump)*
*S23-12946 (Feature 00 6R, 7R, 8R Pump)*
*S23-12760 (Feature 01 Pump)*
*S23-12630 (Feature 02 Pump)*
*S23-12529 (Feature 03 Pump)*
*S23-15065 (Feature 04 Pump)*

*S23-12271 (Feature 0* Motor, A input)*
*S23-12378 (Feature 0* Motor, B input)*
*S23-12527 (Feature 1* Motor, A input)*
*S23-12526 (Feature 1* Motor, B input)*

| | | Feature → | Pump 00 | Pump 01 | Pump 02 | Pump 03 | Pump 04 | Motor 0* | Motor 1* |
|---|---|---|---|---|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **PT. NO.** | **QTY.** | **QTY.** | **QTY.** | **QTY.** | **QTY.** | **QTY.** | **QTY.** |
| 1 | Servo shaft | S23-12267 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | Screw,W.H. 3/8-16 X 1.5 | 353-25074 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 3 | Washer, Nyltite #37 | 631-45007 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 4 | Ring, Truarc #5144-50 | 356-65070 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 5 | O-ring, 70 S-5 ARP 012 | 675-00012 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 6 | HHCS, 5/16-24 x 1" | 307-13160 | 1 | 1 | 1 | 1 | 1 | - | - |
| | Setscrew, 5/16-24 x 1.25" | 312-13180 | - | - | - | - | - | 1 | 1 |
| 7 | O-ring, 70 S-1 ARP 017 | 671-00017 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 8 | Shear seal | 033-71371 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9 | Bearing | 230-82141 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 10 | Cover | 033-57999 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 11 | Spool assy(Fig. 8A-1) | S23-12950 | 1 | - | - | - | - | 1 | - |
| | Spool assy | S23-12951 | - | - | - | - | - | - | 1 |
| | Spool assy | S23-12952 | - | - | - | 1 | - | - | - |
| | Spool assy | S23-12953 | - | - | 1 | - | - | - | - |
| | Spool assy | S23-12954 | - | 1 | - | - | - | - | - |
| | Spool assy | S23-12956 | - | - | - | - | 1 | - | - |
| 12 | Flush plug 1/8" | 431-90204 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 13 | SAE-8 plug | 033-91027 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 14 | O-ring, 90 S-1 ARP 908 | 691-00908 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 15 | Setscrew, 5/16-24 X 2" | 312-35062 | 1 | 1 | 1 | 1 | 1 | - | - |
| | Setscrew, 5/16-24 X 2.50" | 312-35063 | - | - | - | - | - | 1 | 1 |
| 16 | Nut | 033-91033 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 17 | Finger spring | 350-10067 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 18 | Shear seal | 033-70525 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 19 | Gasket | 033-91058 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 20 | Glyd ring | 679-00004 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 21 | Washer | 350-10139 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 22 | Nut | 033-91115 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 23 | Center trimmer | 033-91028 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 24 | Locknut | 492-15353 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 25 | Stop | 033-91026 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 26 | Washer | 350-10126 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 27 | O-ring, 90 S-1 ARP 906 | 691-00906 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 28 | Plug, 2P5N-S | 488-35029 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 29 | O-ring, 90 S-1 ARP 902 | 691-00902 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 30 | Rollpin, 3/16 x .75" | 325-12120 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 31 | O-ring 70 S-1 ARP-013 | 671-00013 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 32 | Washer | 350-10064 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 33 | Washer | 350-10141 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 34 | Piston | 033-91099 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 35 | O-ring, 70 S-1 ARP 010 | 671-00010 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 36 | Nut, 5/16-24 | 335-13100 | 1 | 1 | 1 | 1 | 1 | 3 | 3 |

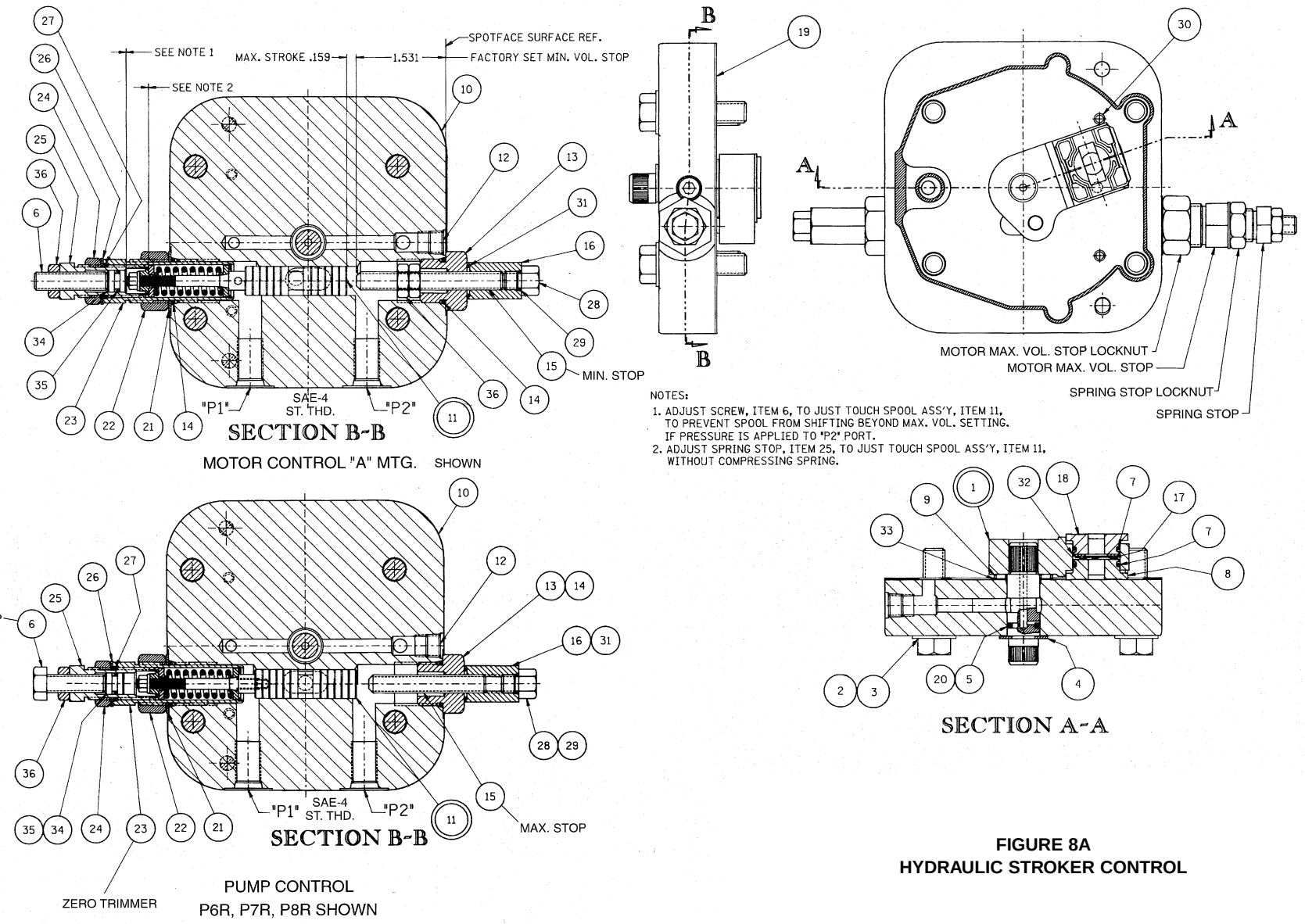


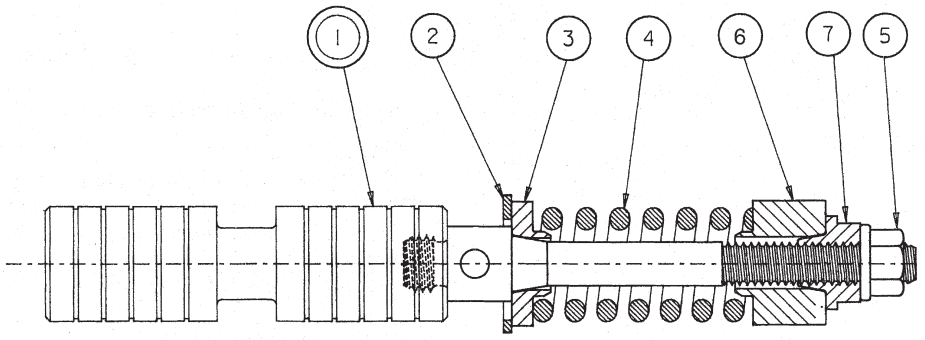

**FIGURE 8A**
**HYDRAULIC STROKER CONTROL**

**PARTS LIST**

*For Figure 8A-1 - Hydraulic/Electric stroker spool assemblies*

*S23-12950 Pump Feature 00, Motor Feature 0**
*S23-12951 Motor Feature 1**
*S23-12952 Pump Feature 03*
*S23-12953 Pump Feature 02*
*S23-12954 Pump Feature 01*
*S23-12956 Pump Feature 04, 9A Electric stroker*

| ITEM | DESCRIPTION | Assembly→ PT. NO. | S23-12950 QTY. | S23-12951 QTY. | S23-12952 QTY. | S23-12953 QTY. | S23-12954 QTY. | S23-12956 QTY. |
|---|---|---|---|---|---|---|---|---|
| 1 | Spool | S23-12949 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | Retainer | 033-91022 | 1 | 1 | 1 | 1 | 1 | 1 |
| 3 | Guide | 033-91426 | 1 | 1 | 1 | 1 | 1 | 1 |
| 4 | Spring | 225-92098 | 1 | 1 | 1 | 1 | - | - |
| | Spring | 225-92101 | - | - | - | - | 1 | - |
| | Spring | 225-92100 | - | - | - | - | - | 1 |
| 5 | Nut | 340-00057 | 1 | 1 | 1 | 1 | 1 | 1 |
| 6 | Guide | 033-91426 | 1 | 1 | 1 | 1 | - | 1 |
| | Guide | 033-91325 | - | - | - | - | 1 | - |
| 7 | Nut | 033-91424 | 1 | 1 | 1 | 1 | 1 | 1 |




**SPRING SETTING**

| ASSEMBLY | TURNS PAST CONTACT |
|---|---|
| S23-12950 | 2 |
| S23-12951 | 6-1/6 |
| S23-12952 | 3-2/3 |
| S23-12953 | 2-1/2 |
| S23-12954 | 1-1/2 |
| S23-12956 | 2-5/6 |

**FIGURE 8A-1**
**SPOOL ASSEMBLIES FOR 8A AND 9A STROKER**

## 8C HYDRAULIC STROKER W/BRAKE & BYPASS VALVE

*S23-12820 (Feature 00)*

### DESCRIPTION

The 8C control incorporates the brake and neutral bypass functions into the body of the proportional hydraulic stroker. A brake spool, when energized, connects the brake port to servo pressure. When de-energized, a spring shifts the spool, connecting the brake port to tank. Servo pressure releases the brake. Another port, located on the end of the brake valve, is closed by the energizing of the brake spool. When de-energized, this port dumps both pump system ports to the replenishing source, thus bypassing the small flow generated by slight errors on zero position.
The operation is controlled in this manner: A metered servo signal is applied to the brake spool. This signal is dumped when a slot in the servo plate aligns with a passage connecting to this spool. This occurs when the pump is on zero stroke. Another signal is applied to a spool adjacent to the brake spool. This metered signal is connected to a port controlled by the input command spool. This port is set to open to tank when the input command is at zero stroke. The brake spool is thus de-energized when BOTH the pump cam is at zero stroke and the rotary servo is at zero command. If the pump is on stroke or the input is on stroke, the brake spool is energized.
For a description of the hydraulic stroker, refer to the 8A control description.

### DISASSEMBLY

*See Figure 8C*

1. Remove screws (2) from control.
2. Remove control from pump.
3. Examine servo plate for excessive scratching on surface. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two soc. setscrews from plate, then alternately loosening the two button hd. screws under the setscrews.
4. Remove retaining ring (4) and press the shaft assembly through the valve body.
5. Examine shoes (8) and (18) for contamination in balance pads and excessive scratching on shoe faces. Note the two shoes are not identical and must be installed in the proper position upon reassembly.
6. Remove the brake trimmer stop assembly (13) intact.
7. Remove the center trimmer screw (23) with the spool assembly and stop assembly intact. Note: signal pressure setting is determined by the spring preload. Do not disassemble or change unless setting is incorrect.
8. Remove tubing assembly (74). Remove bypass valve body (42) with fitting (44) and piston (45). Remove elbow (73) with .0135 orifice (37) and fitting (38). Remove spools (31) and (39).
9. Remove shoe (50), and spring (49).
10. Examine orifices (16) and (29) in body for contamination. Examine passages in body for free flow.
11. Clean and examine all parts for breakage or evidence of abnormal wear.

### REWORK OF WEAR PARTS

| Part Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |
| Shoe | Stone to remove raised burrs or dings. |

### ASSEMBLY

All parts are to be inspected and be free of material defects, dirt, scratches, or any foreign material.
All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

*See Figure 8C*

1. Install .031” orifices (29), checking to see that they clear the bore. Install the .018” orifice (16) in body.
2. Apply pipe sealant and install 1/16 pipe plugs (28) in body as shown. Torque to 25 in.-lbs. (2.8 Nm)
3. Apply pipe sealant to the 1/8” pipe plugs (12) and install in the cover plate. Torque to 100 in.-lbs. (11.3 Nm)
4. Thread trimmer locknut (22) all the way onto center trimmer screw (23). Slip backup washer (21), small dia. first, onto trimmer screw and against locknut. Using a 3/4-16 hex nut, with a 1.030” (26.2mm) dia. x .030/.035” (0.76/0.89mm) deep c’bore, crimp

the washer onto the stop. Washer must be free to rotate slightly. Remove crimping nut.

5. Compress spring (4) solid in order to remove set. This may be safely accomplished using a 1/4" (6.35 mm) dia. bolt, nut and washers.

*See Figure 8C-1*

6. Assemble retaining ring (2), guide (3), spring (4) and guide (9) onto spool (1).
7. Tighten nut (6) till it just starts to load the spring, then tighten the required number of turns to obtain desired preload, as indicated:
8. Install locknut (5) onto spool and lock against nut (6) without changing adjustment.

**SPRING SETTING**

| CONTROL FEATURE | TURNS PAST CONTACT |
|---|---|
| 00 | 2 |
| 04 | 2-5/6 |

9. Install spool (7) onto other end of spool assembly (1). Install nuts (8) and tighten till spool has from .001 to .003" (.025 to .076 mm) clearance. (Barely free to rotate without binding). Lock nuts together and re-check spool fit.

*See Figure 8C*

10. Insert spool assembly (11), spring end first, into center trimmer screw (23). Compress snap ring on the spool assembly until it snaps into internal groove inside trimmer screw. See that it is securely seated.
11. Thread spring stop locknut (24) all the way onto adjusting spring stop (25). Slip back-up washer (26), small diameter first, onto stop and against locknut. Using a 9/16-18 hex nut with a .810/.815" (20.6-20.7mm) dia. x .030-.035" (0.76-0.89mm) dp. c'bore, crimp washer onto stop. Washer must be free to rotate slightly. Remove the crimping nut.
12. Install O-ring (35) on plug (34) and insert into spring stop (25). Install O-ring (27) onto stop (25) and against washer (26).
13. Thread spring adjustment stop (25) into trimmer screw (23) until it just touches the spool assembly. Be sure spool assembly is against snap ring.
14 Place O-ring (14) on trimmer screw (23) and thread assembly into the larger cross-bore in the cover plate. Install from the end which contains the 1/16" pipe plug.
15. Install nut (36) on adjusting screw (6). Thread adjusting screw into stop (25).

*See Figure 8C-2*

16. Thread locknut (8) all the way onto guide (1). Slip back-up washer (7), small dia. first, onto guide and against locknut. Using a 3/4-16 hex nut, with a 1.030" (26.2mm) dia. x .030/.035" (0.76/0.89mm) deep c'bore, crimp the washer onto the stop. Washer must be free to rotate slightly. Remove crimping nut.
17. Install stop (2) into guide. Install O-ring (9) on nut (3) and install over stop (2). Install O-ring (10) over plug (11). Install plug in nut (3).
18. Install O-rings (4,5, and 6) on guide (1). Lubricate O-rings and carefully insert guide into bore and over spool on opposite side from the trimmer screw.
19. Install spools (31) and (39) into the other cross-bore in the cover (10). The slotted end of spool (31) should be to the outside.

*See Figure 8C*

20. Install O-ring (27) on plug (38). Install spring (37) in plug and install plug in cover as shown.
21. Install O-rings (43) on fitting (44). Install piston (45) in bore of body (42). Install O-ring (72) on plug (71) and install in body (42). Install seals (70) on body (42). Install fitting (44) on body and install assembly in cover (10).
22. Install rollpins (30) in cover, being careful not to damage the cover surface.
23. Install O-rings (46) and (47) on vent post (48). Install vent post in cover.
24. Install spring (49) and shoe (50) over vent post.
25. Install 0-ring (7) in groove of shear seal (8).
26. Install shear seal with o-ring in large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.
27. Install thrust bearing (9) over servo shaft and seat against the servo link.

Note: The shear seal will fit in one position only, otherwise one side will be held up by the lip of the servo link. Shear seal (8) must be installed to face against the cover plate (10). This shear seal (8) differs from shear seal (18) in that the face surface is machined with two .094" (2.4mm) radius scallops.

28. Slip washer (33) over the servo shaft and against the thrust bearing.
29. Using installation tool T-1, install O-ring (5) in the second groove from the end of the shaft (1). Warm glyd ring (20) to make it pliable, and install over O-ring (5).
30. Install the servo shaft assembly in the cover plate (10). Pin must engage slot in spool assembly (11).
31. Install retaining ring (4) into the groove of the servo shaft extending thru the cover plate.

32. Place two spring washers (17), nested with the bent sections matching each other,

into the large hole in the servo link.
33. Place washer (32) against the spring washers.
34. Install O-ring (7) into groove in the remaining shear seal (18). Note: This shear seal does not contain the two .094 radius scallops in the face. Place on top of washer, (32). Position shear seal to match the lip on the servo link.
35. If control is to be tested on pump, install on pump control pad with gasket (19), nyltite washers (3), and screws (2). Torque to 30 lb. ft. (40.8 Nm). Install bypass check valves fittings, and lines.

## TEST

Install stroking handle on the shaft.
Connect servo source, adjustable to 450 psi (31 bar), to control ports on hydraulic stroker through a 4-way valve. Center position must dump both ports to tank at min. pressure.
Install a needle valve on the bypass valve exhaust port, connected to tank. Close the valve.
Install a 1000 psi (70 bar) gage in the brake port.
Rotate handle to check for free play. Turn spring stop adjustment in or out till it just contacts the spring and there is no free play. Lock in place. Note: this adjustment is critical to accurate neutral adjustment!

1. Start prime mover and adjust system relief valve for 5000 psi (345 bar).
2. Turn centering trimmer screw to place input shaft on the zero stroke position. Stroke pump to full and release, on both sides of center. Pump shall return to zero stroke within 200 psi (13.8 bar) max.
3. With pump on zero stroke, turn brake trimmer screw CW and CCW while observing gage on brake port. Note the positions where the gage reading changes from case pressure to servo pressure to case pressure. Set and lock the adjustment midway between these two positions.
4. Set max. volume stops so that servo shaft link touches stop pins when handle is stroked each side of center. Lock in place.
5. Apply servo pressure to one port of stroker. Adjust pressure from minimum to maximum. Note the pressure at which pump just starts to stroke, and the pressure at which the pump reaches full stroke These pressures must be within the following values:

## PUMP CONTROL PRESSURE

| CONTROL FEATURE | PRESSURE START | PRESSURE FULL |
|---|---|---|
| 00 | 75± 15 psi (5.2± 1 bar) | 335± 25 psi (23.1±1.7 bar) |
| 04 | 75±15 psi (5.2± 1 bar) | 250± 25 psi (17.2± 1.7 bar) |

If pressures are incorrect, control may be disassembled and adjustment made to the spring preload. The following table may be used to determine adjustment required to the nuts retaining the spring:

## PUMP CONTROL SPRING ADJUSTMENT

6. With minimum signal, pump shall return to zero stroke within 200 psi (13.8 bar) max.

| CONTROL FEATURE | PRESSURE CHANGE PER 1/6 TURN ADJ. |
|---|---|
| 00 | 6.8 psi (0.47 bar) |
| 04 | 4.6 psi (0.31 bar) |

7. Repeat test on opposite side of center.
8. Increase and decrease control pressure between 0 and 450 PSI (31 bar) several times . Pump stroke should follow control pressure smoothly and proportionally. Full to zero or zero to full stroke should be achieved in no more than two seconds. Adjust control pressure up to 50% stroke from zero stroke, then adjust down from full stroke to the same value. The control pressure at the two settings shall not vary more than 50 psi (3.4 bar) from each other.
9. Stroke pump CW. The gage on the brake port should start to indicate servo pressure when the system pressure is between 2000 and 4500 psi (138 and 310 bar), with an increasing signal, and must return to case pressure before system pressure drops to 2000 psi (138 bar), on decreasing signal. Repeat by rotating input shaft CCW. Record both pressures for each rotation of the servo input shaft.
10. Open the needle valve on the neutral bypass port. Measure and record leakage from this port with the pump on center at minimum psi, and with the pump off center, at 5000 psi (345 bar).

**Maximum leakage with control on center:**
2.0 gpm (7.6 l/m)
**Minimum leakage with control on center:**
1.0 gpm (3.8 l/m)
**Maximum leakage with control off center:**
35 cu. in/min or .15 gpm (574 cm3/min. or 0.57 l/m)

11. Stroke pump above and below center. Control should operate smoothly. Brake pressure should drop to case pressure each time control is on center, and it should indicate servo pressure as soon as input shaft is rotated CW or CCW from center, per step 9 above.
12. Release control when pump is off center. Pump should return to center. Repeat several times in each direction and at different pressures from 200 to 5000 psi (13.8 to 345 bar).
13. Remove needle valve from bypass exhaust port and install exhaust line.

**PARTS LIST**

*For Figure 8C - Hydraulic stroker with brake and bypass valve*

*S23-12820*
*Feature 00*

| | | Feature → | 00 | 04 |
|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **PT. NO.** | **QTY** | **QTY.** |
| 1 | Servo Shaft | S23-12267 | 1 | 1 |
| 2 | Screw, W.H., 3/8-16 x 1.5” | 353-25074 | 4 | 4 |
| 3 | Washer, Nyltite #37 | 631-45007 | 4 | 4 |
| 4 | Ring, Truarc #5144-50 | 356-65070 | 1 | 1 |
| 5 | O-ring, 70 S-5 ARP 012 | 675-00012 | 1 | 1 |
| 6 | Screw, HHC 5/16-24 x 1” | 307-13160 | 1 | 1 |
| 7 | O-ring, 70 S-1 ARP 017 | 671-00017 | 2 | 2 |
| 8 | Shear Seal | 033-71371 | 1 | 1 |
| 9 | Bearing | 230-82141 | 1 | 1 |
| 10 | Cover | 033-91433 | 1 | 1 |
| 11 | Spool Assy (Fig. 8C-1) | S23-12911 | 1 | - |
| | Spool Assy | S23-12935 | - | 1 |
| 12 | Hex plug, 1/8” Flush | 431-90204 | 3 | 3 |
| 13 | Brake Trimmer (Fig. 8C-2) | S23-12921 | 1 | 1 |
| 14 | O-ring, 90 S-1 ARP 908 | 691-00908 | 1 | 1 |
| 15 | O-ring, 70 S-5 ARP 015 | 675-00015 | 1 | 1 |
| 16 | Orifice, .018 | 035-19092 | 1 | 1 |
| 17 | Finger Spring | 350-10067 | 2 | 2 |
| 18 | Shear seal | 033-70525 | 1 | 1 |
| 19 | Gasket | 033-91058 | 1 | 1 |
| 20 | Glyd ring | 679-00004 | 1 | 1 |
| 21 | Washer, Backup | 350-10139 | 1 | 1 |
| 22 | Nut | 033-91115 | 1 | 1 |
| 23 | Center Trimmer | 033-91028 | 1 | 1 |
| 24 | Locknut | 492-15353 | 1 | 1 |
| 25 | Stop | 033-91026 | 1 | 1 |
| 26 | Washer | 350-10126 | 1 | 1 |
| 27 | O-ring, 90 S-1 ARP 906 | 691-00906 | 3 | 3 |
| 28 | Plug, 1/16” Flush | 431-90104 | 4 | 4 |
| 29 | Orifice, .031 | 035-91757 | 2 | 2 |
| 30 | Rollpin, 3/16” x.75” | 325-12120 | 2 | 2 |
| 31 | Spool | 033-70999 | 1 | 1 |
| 32 | Washer | 350-10064 | 1 | 1 |
| 33 | Washer | 350-10141 | 1 | 1 |
| 34 | Piston | 033-91099 | 1 | 1 |
| 35 | O-ring, 70 S-1 ARP 010 | 671-00010 | 1 | 1 |
| 36 | Nut, 5/16-24 | 335-13100 | 1 | 1 |
| 37 | Orifice, .0135 | 033-91758 | 1 | 1 |
| 38 | Fitting | 492-15375 | 1 | 1 |
| 39 | Spool | 033-91685 | 1 | 1 |
| 40 | Spring | 033-70992 | 1 | 1 |
| 41 | Dowel Pin, 1/16 x .50 | 324-30026 | 1 | 1 |
| 42 | Body | 033-91090 | 1 | 1 |
| 43 | O-ring, 90 S-1 ARP 016 | 691-00016 | 1 | 1 |
| 44 | Fitting | 033-91700 | 1 | 1 |
| 45 | Piston | 033-91699 | 1 | 1 |
| 46 | O-ring, 90 S-1 ARP 902 | 691-00902 | 1 | 1 |

**PARTS LIST**

*For Figure 8C - Hydraulic stroker with brake and bypass valve*

*S23-12820*
*Feature 00*

| | | Feature → | 00 | 04 |
|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **PT. NO.** | **QTY** | **QTY.** |
| 47 | O-ring, 70 S-1 ARP 006 | 671-00006 | 1 | 1 |
| 48 | Vent post | 033-70995 | 1 | 1 |
| 49 | Spring | 225-92044 | 1 | 1 |
| 50 | Shoe | 033-91701 | 1 | 1 |
| 68 | O-ring, 90 S-1 ARP 904 | 691-00904 | 1 | 1 |
| 69 | Seat, spring | 033-91686 | 1 | 1 |
| 70 | Tetraseal | 691-10013 | 2 | 2 |
| 71 | Plug, SAE-3 | 488-35049 | 1 | 1 |
| 72 | O-ring, 90S-1 ARP 903 | 691-00903 | 1 | 1 |
| 73 | Fitting, elbow | 033-91702 | 1 | 1 |
| 74 | Tube assembly | S23-15202 | 1 | 1 |
| 75 | Tee, st. thd run, SAE-6 | 497-15008 | 1 | 1 |
| 76 | Reducer | 492-15376 | 1 | 1 |
| 77 | Nut | 492-10012 | 1 | 1 |

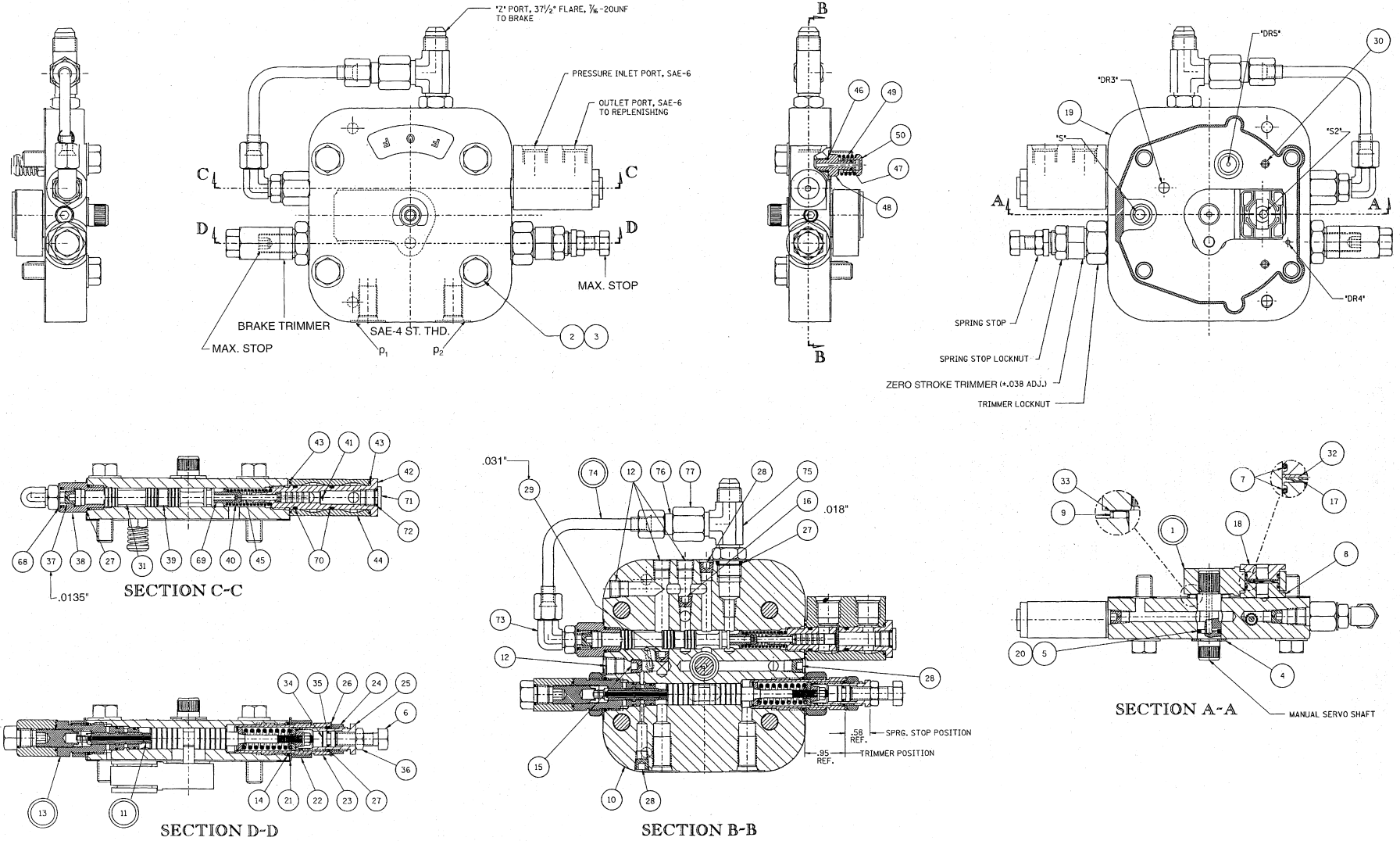



**FIGURE 8C**
**HYDRAULIC STROKER WITH BRAKE AND BYPASS VALVE**

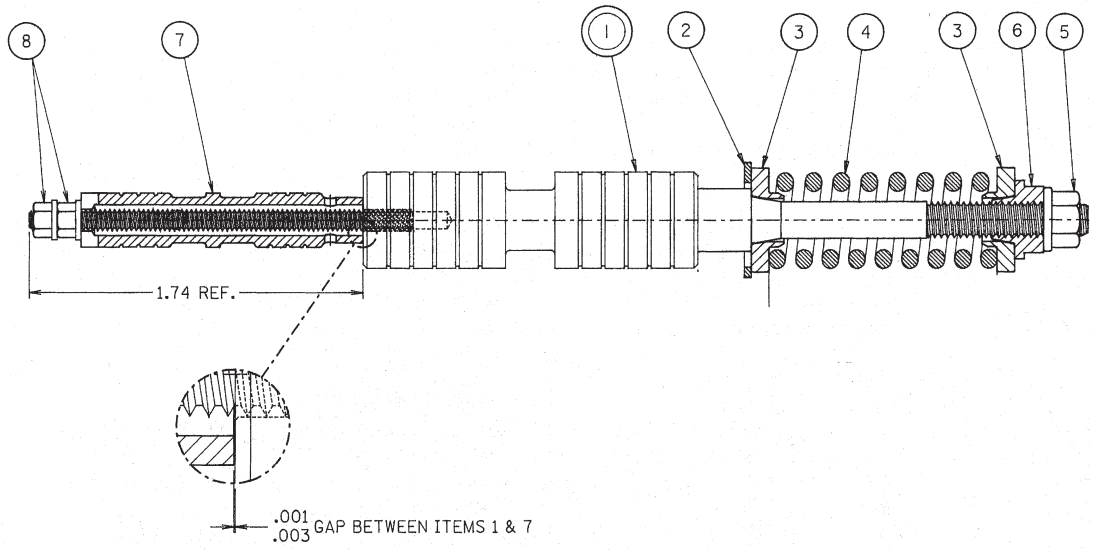
**PARTS LIST**

*For Figure 8C-1 - Spool assemblies for 8C and 9C stroker w/brake and bypass valve*

*Assembly S23-12911 8C Feature 00*

*Assembly S23-12935 8C Feature 04, 9C Electric stroker*

| ITEM | DESCRIPTION | Assembly → PT. NO. | S23-12911 QTY. | S23-12935 QTY. |
|---|---|---|---|---|
| 1 | Spool | S23-12910 | 1 | 1 |
| 2 | Retainer | 033-91022 | 1 | 1 |
| 3 | Guide | 033-91426 | 1 | 1 |
| 4 | Spring | 225-92098 | 1 | - |
| | Spring | 225-92100 | - | 1 |
| 5 | Nut | 340-00057 | 1 | 1 |
| 6 | Nut | 033-91424 | 1 | 1 |
| 7 | Spool | 033-91434 | 1 | 1 |
| 8 | Nut | 340-00058 | 2 | 2 |




**SPRING SETTING**

| ASSEMBLY | TURNS PAST CONTACT |
|---|---|
| S23-12911 | 2 |
| S23-12935 | 2-5/6 |

**FIGURE 8C-1**
**SPOOL ASSEMBLIES FOR 8C AND 9C STROKER W/BRAKE AND BYPASS VALVE**

**PARTS LIST**

*For Figure 8C-2 Brake trimmer for 8C & 9C stroker w/brake and bypass valve*

*Assembly S23-12921*

| ITEM | DESCRIPTION | PT. NO. | QTY |
|---|---|---|---|
| 1 | Guide | 033-91452 | 1 |
| 2 | Stop | 033-91462 | 1 |
| 3 | Nut | 033-91463 | 1 |
| 4 | O-ring, 70 S-1 ARP 012 | 671-00012 | 1 |
| 5 | O-ring, 70 S-1 ARP 013 | 671-00013 | 1 |
| 6 | O-ring 90 S-1 ARP 908 | 691-00908 | 1 |
| 7 | Washer, Backup | 350-10139 | 1 |
| 8 | Locknut, 3/4-16 | 492-15364 | 1 |
| 9 | O-ring, 70 S-1 ARP 014 | 671-00014 | 1 |
| 10 | O-ring, 90 S-1 ARP 904 | 691-00904 | 1 |
| 11 | Plug, Parker 4-P5 N-S | 488-35013 | 1 |

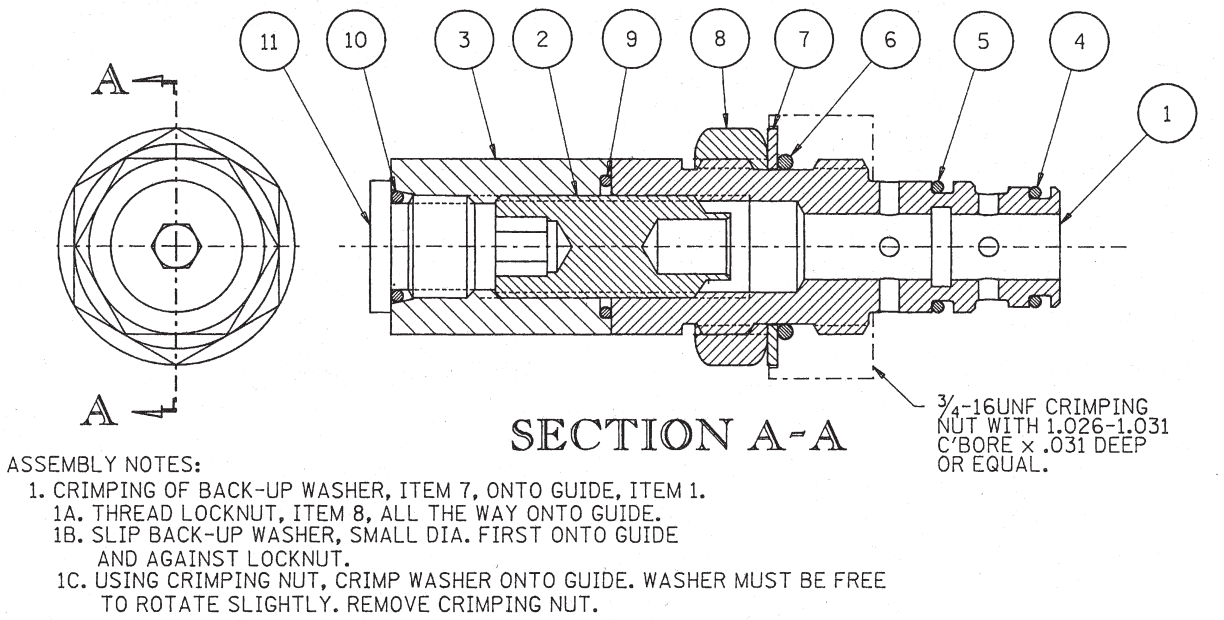



**FIGURE 8C-2**
**BRAKE TRIMMER FOR 8C AND 9C STROKER**
**WITH BRAKE AND BYPASS VALVE**

## 9A ELECTRIC STROKER

*S23-12667 Feature 00 cross ctr. Pump*

*S23-12957 Feature 01 cross ctr. Pump*

*S23-12940 Feature 00 cross ctr. P6R,P7R,P8R*

*S23-12734 Feature 00 CW-A,CCW-B-Pump)*

*S23-12733 Feature 00 CCW-A,CW-B-Pump)*

*S23-15050 Feature 0* A Mtg. Motor)*

*S23-15051 Feature 0* B Mtg. Motor)*

### DESCRIPTION

The 9A consists of one or two electric proportional pressure control valves mounted on the 8A cover to provide the pilot pressure signal. It is a simple electrohydraulic control with comparable performance to the 5A in most applications. Refer to 8A for stroker description.
The Jupiter 900 Driver Card has been developed to accompany the 9A control with 24V coil.

### DISASSEMBLY
*See Figure 9A*

1. Disconnect connector (46) from coil (52).
2. Remove proportional valve or valves from block (39). Do not attempt disassembly of the valve, other than replacement of the coil, (52) and external O-rings, (38-a), (38-b) and (38-c).
3. Remove screws (2) from control. Remove proportional valve block (39) from control. Remove control from pump.
4. Examine orifices (37) for plugging or contamination. Examine servo plate for excessive scratching on surface. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two soc. setscrews from plate, then alternately loosening the two button hd. screws under the setscrews.
5. Remove retaining ring (4) and press the shaft assembly through the valve body (10).
6. Examine shoes (8) and (18) for contamination in balance pads and excessive scratching on shoe faces. Note the two shoes are not identical and must be installed in the proper position upon reassembly.
7. Remove the plug (13) with the stop assembly intact.
8. Remove the centering adjustment screw (23) with the spool assembly and stop assembly intact. Note: positive centering and control starting current are determined by the spring preload. Do not disassemble or change unless setting is incorrect.
9. Clean and examine all parts for breakage or evidence of abnormal wear.

### REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |

### ASSEMBLY

All parts are to be inspected and be free of material defects, dirt, scratches, or any foreign material.
All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

1. Apply pipe sealant to the 1/8” pipe plug (12) and install in the cover plate. Torque to 100 lbs-in. (11.3 Nm).

2. Thread trimmer locknut (22) all the way onto trimmer screw (23). Slip back-up washer (21), small dia. first, onto trimmer screw and against locknut. Using a 3/4-16 hex nut with a 1.030" (26.2mm) dia. x .030/.035" (0.76/0.89mm) deep c'bore, crimp the washer onto the stop. Washer must be free to rotate slightly. Remove crimping nut.

*See Figure 8A-1*

3. Compress spring (4) solid in order to remove spring set. This may be safely accomplished using a 1/4" (6.35 mm) dia. bolt, nut and washers.
4. Assemble retaining ring (2), guide (3), spring (4) and guide (3) onto spool (1).
5. Tighten nut (7) till it just starts to load the spring, then tighten 2-5/6 additional turns.
6. Install locknut (5) onto spool and lock against nut (7) without changing adjustment.

*See Figure 9A*

7. Insert spool assembly (11), spring end first, into trimmer screw (23). Compress snap ring on the spool assembly until it snaps into internal groove inside trimmer screw. See that it is securely seated.
8. Thread spring stop locknut (24) all the way onto adjusting spring stop (25). Slip back-up washer (26), small diameter first, onto stop and against locknut. Using a 9/16-18 hex nut with a .810/.815" (20.6/20.7mm) dia. x .030-.035" (0.76-0.89mm) dp. c'bore, crimp washer onto stop. Washer must be free to rotate slightly. Remove the crimping nut.
9. Install O-ring (35) on plug (34) and insert into spring stop (25). Install O-ring (27) onto stop (25) and against washer (26).
10. Thread adjusting spring stop (25) into trimmer screw (23) until it just touches the spool assembly. Be sure spool assembly is against snap ring.
11. Determine the correct position of the spool assembly in the valve body. For 9A standard pump controls, and for 9A motor controls mounted on the "B" port side, the spool assembly is installed in the side of the control cap containing the 1/8" pipe plug (12). For controls used on P*R pumps, and motor controls mounted on the "A" port side, the spool assembly is installed on the side opposite the 1/8" pipe plug (12).

| MODEL | CONTROL LOCATION | SPOOL POS. REF. FIG. 9A |
|---|---|---|
| P*P, P*V, P*S | "A" OR "B" | OPPOSITE |
| P*R | "A" OR "B" | AS SHOWN |
| M*H, M*V | "A" | AS SHOWN |
| M*H, M*V | "B" | OPPOSITE |

12. Place O-ring (14) on trimmer screw (23) and thread assembly into the cover plate, as noted above.
13. Install adjusting screw (15) in plug (13). Install O-ring (14) on plug. Thread adjusting screw in until it protrudes approximately 1/2" from top of plug (13). For motor controls, install two nuts (36) on the inner end.
14. Thread cover nut (16) with O-ring (31) onto adjusting screw.
15. Install plug (28) and O-ring (29) into cover nut (16).
16. Install this assembly in body on the opposite side from the spool assembly (11).
17. Install nut (36) on adjusting screw (6). Thread adjusting screw into stop (25).
18. Install roll pins (30) into drilled holes in surface of cover, being careful not to damage surface.
19. Install 0-ring (7) in groove of shear seal (8).
20. Install shear seal with o-ring in large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.

Note: The shear seal will fit in one position only, otherwise one side will be held up by the lip of the servo link. Shear seal (8) must be installed to face against the cover plate (10). This shear seal (8) differs from shear seal (18) in that the face surface is machined with two .094" (2.4mm) radius scallops.

21. Install thrust bearing (9) over servo shaft and seat against the servo link.
22. Slip washer (33) over the servo shaft and against the thrust bearing.
23. Using installation tool T-1, install O-ring (5) in the second groove from the end of the shaft (1). Warm glyd ring (20) to make it pliable, and install over O-ring (5).
24. Install the servo shaft assembly in the cover plate (10). Pin must engage slot in spool assembly (11).
25. Install retaining ring (4) into the groove of the servo shaft extending thru the cover plate.
26. Apply loctite® 271 on threads of screw (43), and on threads of shaft assembly (1). Assemble nut (44) on screw, insert screw into shaft assembly and turn in snugly. Hold screw and arm. Torque nut to 14 lb.-ft. (19 Nm).
27. Place two spring washers (17), nested with the bent sections matching each other, into the large hole in the servo link.

28. Place washer (32) against the spring washers.
29. Install O-ring (7) into groove in the remaining shear seal (18). Note: This shear seal does not contain the two .094" (2.4mm) radius scallops in the face. Place on top of washer, (32). Position shear seal to match the lip on the servo link.
30. Install four orifices (37) in two tapped holes in stroker block (39) closest to the valve opening. Insert one orifice, then another on top of the first. Torque to 70 lbs-in. (7.9 Nm).
31. Install proportional pressure valve(s) in block (39). Torque to 20 lb.-ft. (27 Nm). Cross-center pumps use two valves. One side of center pumps and motors use one valve. See chart for location of single valve:

| CONT. LOCATION | VALVE LOCATION |
|---|---|
| PUMP, CW-A, CCW-B | VALVE "B", FIG. 9A |
| PUMP, CW-B, CCW-A | VALVE "A", FIG. 9A |
| MOTOR, B MTG. | VALVE "B", FIG. 9A |
| MOTOR, A MTG. | VALVE "A", FIG. 9A |

32. For controls with single valve, install soc. setscrew (54) in the tapped hole furthest in from the unused opening. Torque to 70 in.-lb. (7.9 Nm). Install plug (53) and O-ring (55) in the unused opening. Torque to 20 lb.-ft. (27 Nm).
33. Install coil(s) (52) on proportional valve (38). **CAUTION! Torque to 20-25 in.-lb. (2.2-2.8 Nm) max.**
34. Install remaining parts.
35. If control is to be tested on unit, install stroker block assembly and control on pump control pad with O-rings (3, 31, and 45), gasket (19), washers (49) and screws (2). Torque to 30 Lb.-ft. (40.8 Nm).

## 9A CONTROL TEST SETUP

Remove plug over input shaft. Insert T handle 3/16" Allen wrench into opening. Connect proportional control driver to proportional valve. Connect pressure gage on SAE-4 port adjacent to proportional valve or valves.
Rotate wrench handle to check for free play. Turn spring stop adjustment in or out till it just contacts the spring and there is no free play. Lock in place. Note: this adjustment is critical to accurate neutral adjustment!

## 9A PUMP TEST

1. Turn trimmer screw to place input shaft on the zero stroke position. Check for positive centering. Lock in place. For cross-center pumps, set max. volume stops so that servo shaft link touches stop pins when handle is stroked each side of center. For one side of center pumps, set max. stop so that servo shaft link touches the stop pin. Set min stop to prevent crossing over center. Lock stops in place.
2. Apply signal current to one proportional valve. Adjust current from minimum to maximum. Note the pressure and current value at which pump just starts to stroke, and at which the pump reaches full stroke These must be within the following values:

| Coil | Cont. Pr. Min. Disp. | Ma. Min. Disp. | Cont. Pr. Max. Disp. | Ma Max. Disp. |
|---|---|---|---|---|
| 12 Volt | 75 ±15psi (5.17±1bar) | 360 ± 60 | 250±25psi (17.2±1.7bar) | 650 ± 110 |
| 24 Volt | 75±15psi (5.17±1bar) | 180 ± 30 | 250±25psi (17.2±1.7bar) | 325 ± 55 |

3. If control pressure is off the same amount at start and end of stroke, the control may be disassembled and the spring (Figure 2) readjusted. One flat (1/6 turn) of adjustment will change the pressure by 4.6 psi (0.31 bar).
4. If the change in pressure from start to end of stroke is incorrect, the spring (Figure 2) is incorrect and must be replaced.
5. If pressures are correct but current is incorrect, then either the coil is incorrect or the proportional valve is bad.
6. With minimum signal, pump shall return to zero stroke within 200 psi. (13.8 bar) max.
7. For cross-center pumps, repeat test on opposite side of center.
8. Increase and decrease current between minimum and maximum several times. Pump stroke should follow control pressure smoothly and proportionally. Full to zero or zero to full stroke should be achieved in no more than two seconds. Adjust stroke up to approximately 50% stroke from zero stroke, then adjust down from full stroke to the same current value. The flow at the two settings shall not vary more than 25%.

## 9A MOTOR TEST

1. Turn trimmer screw to place input shaft on the full stroke position. Lock in position.
2. Rotate input handle to reduce motor displacement to minimum. **CAUTION!** do not exceed motor rated speed! Adjust minimum stop screw to set minimum displacement at 25% of full displacement. (4 times the rpm at maximum displacement.)

3. Lock screw in this position.
4. Apply signal current to proportional valve. Adjust current from minimum to maximum. Note the pressure and current value at which motor just starts to reduce stroke, and at which the motor reaches minimum stroke. These must be within the following values:

| Coil | Cont. Pr. Max. Disp. | Ma. Min. Disp. | Cont. Pr. Min. Disp. | Ma Min. Disp. |
|---|---|---|---|---|
| 12 Volt | 75 ±15psi (5.17±1bar) | 360 ± 60 | 205±25psi (14.1±1.7bar) | 580 ± 100 |
| 24 Volt | 75±15psi (5.17±1bar) | 180 ± 30 | 205±25psi (14.1±1.7bar) | 290 ± 50 |

5. If control pressure is off the same amount at start and end of stroke, the control may be disassembled and the spring (Figure 2) readjusted. One flat (1/6 turn) of adjustment will change the pressure by 4.6 psi (0.31 bar).
6. If the change in pressure from start to end of stroke is incorrect, the spring (Figure 2) is incorrect and must be replaced.
7. If pressures are correct but current is incorrect, then either the coil is incorrect or the proportional valve is bad.
8. With minimum signal, motor shall return to full stroke.
9. Increase and decrease current between minimum and maximum several times. Motor stroke should follow control pressure smoothly and proportionally. Full to min. or min. to full stroke should be achieved in no more than two seconds. Adjust stroke down to approximately 50% stroke from full stroke, then adjust up from 25% stroke to the same signal. The speed at the two settings shall vary no more than 25%.
10. When control has satisfactorily passed test, remove stop assembly, set and lock the two nuts on the inside to prevent adjustment below 25% stroke. Re-install stop.

**PARTS LIST**

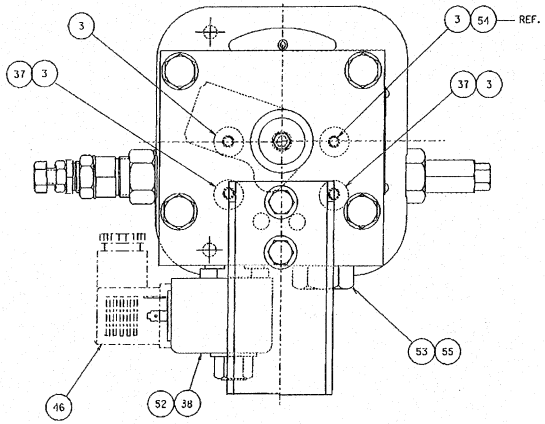
*Figure 9A Electric stroker*

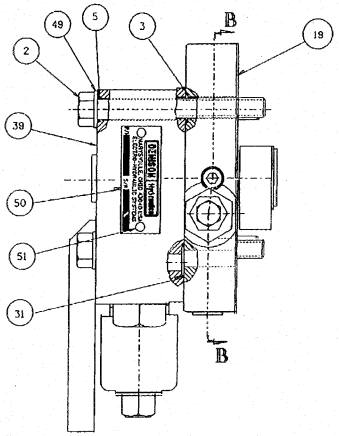
| | | | Feature → | 00 | 00 | 01 | 00 | 0* |
|---|---|---|---|---|---|---|---|---|
| | | | Option → | P*P, P*S Pump | 6R,7R,8R Pump | P*P,P*S Pump | P*V Pump | M*H, M*V Motor |
| | | | Assembly No. → | S23-12667 | S23-12940 | S23-12957 | S23-12734 S23-12733 | S23-15050 S23-15051 |
| **ITEM** | **DESCRIPTION** | **PT. NO.** | | **QTY.** | **QTY.** | **QTY.** | **QTY.** | **QTY.** |
| 1 | Servo shaft | S23-12267 | | 1 | 1 | 1 | 1 | 1 |
| 2 | HHCS 3/8-16 X 3.25” | 306-40184 | | 4 | 4 | 4 | 4 | 4 |
| 3 | O-ring, 70- S-5 ARP 013 | 675 00013 | | 9 | 9 | 9 | 9 | 9 |
| 4 | Ring, Truarc #5144-50 | 356-65070 | | 1 | 1 | 1 | 1 | 1 |
| 5 | O-ring, 70 S-5 ARP 012 | 675-00012 | | 5 | 5 | 5 | 5 | 5 |
| 6 | HHCS, 5/16-24 X 1” | 307-13160 | | 1 | 1 | 1 | 1 | - |
| | Setscrew, 5/16-24 X 1.25” | 312-13180 | | - | - | - | - | 1 |
| 7 | O-ring, 70 S-5 ARP 017 | 675-00017 | | 2 | 2 | 2 | 2 | 2 |
| 8 | Shear Seal | 033-71371 | | 1 | 1 | 1 | 1 | 1 |
| 9 | Bearing | 230-82141 | | 1 | 1 | 1 | 1 | 1 |
| 10 | Cover-9A | 033-91220 | | 1 | 1 | 1 | 1 | 1 |
| 11 | Spool Assy (Fig. 8A-1) | S23-12956 | | 1 | 1 | 1 | 1 | 1 |
| 12 | Flush plug 1/8” | 431-90204 | | 1 | 1 | 1 | 1 | 1 |
| 13 | SAE plug | 033-91027 | | 1 | 1 | 1 | 1 | 1 |
| 14 | O-ring, 90 S-5 ARP 908 | 695-00908 | | 3 | 3 | 3 | 3 | 3 |
| 15 | Soc. setscrew, 5/16-24 X 2” | 312-35062 | | 1 | 1 | 1 | 1 | - |
| | Setscrew, 5/16-24 X 2.50” | 312-35063 | | - | - | - | - | 1 |
| 16 | Nut | 033-91033 | | 1 | 1 | 1 | 1 | 1 |
| 17 | Finger Spring | 350-10067 | | 2 | 2 | 2 | 2 | 2 |
| 18 | Shear seal | 033-70525 | | 1 | 1 | 1 | 1 | 1 |
| 19 | Gasket | 033-91058 | | 1 | 1 | 1 | 1 | 1 |
| 20 | Glyd ring | 679-00004 | | 1 | 1 | 1 | 1 | 1 |
| 21 | Washer | 350-10139 | | 1 | 1 | 1 | 1 | 1 |
| 22 | Nut | 033-91115 | | 1 | 1 | 1 | 1 | 1 |
| 23 | Center trimmer | 033-91028 | | 1 | 1 | 1 | 1 | 1 |
| 24 | Locknut | 492-15353 | | 1 | 1 | 1 | 1 | 1 |
| 25 | Stop | 033-91026 | | 1 | 1 | 1 | 1 | 1 |
| 26 | Washer | 350-10126 | | 1 | 1 | 1 | 1 | 1 |
| 27 | O-ring, 90 S-5 ARP 906 | 695-00906 | | 1 | 1 | 1 | 1 | 1 |
| 28 | Plug, Parker 2P5N-S | 488-35029 | | 1 | 1 | 1 | 1 | 1 |
| 29 | O-ring, 90 S-5 ARP 902 | 695-00902 | | 1 | 1 | 1 | 1 | 1 |
| 30 | Rollpin 3/16 X .75” | 325-12120 | | 2 | 2 | 2 | 2 | 2 |
| 31 | O-ring, 70 S-5 ARP 014 | 675-00014 | | 2 | 2 | 2 | 2 | 2 |
| 32 | Washer | 350-10064 | | 1 | 1 | 1 | 1 | 1 |
| 33 | Washer | 350-10141 | | 1 | 1 | 1 | 1 | 1 |
| 34 | Piston | 033-91099 | | 1 | 1 | 1 | 1 | 1 |
| 35 | O-ring, 70 S-5 ARP 010 | 675-00010 | | 1 | 1 | 1 | 1 | 1 |
| 36 | Nut, 5/16-24 | 335-13100 | | 1 | 1 | 1 | 1 | 3 |
| 37 | Orifice, .025” | 033-91225 | | 4 | 4 | 4 | 4 | 4 |
| 38 | Valve- proportional | 517-00085 | | 2 | 2 | 2 | 1 | 1 |
| 38-a | O-ring, 70 S-5 ARP 015 | 675-00015 | | 2 | 2 | 2 | 1 | 1 |
| 38-b | O-ring, 90 S-5 ARP 016 | 695-00016 | | 2 | 2 | 2 | 1 | 1 |

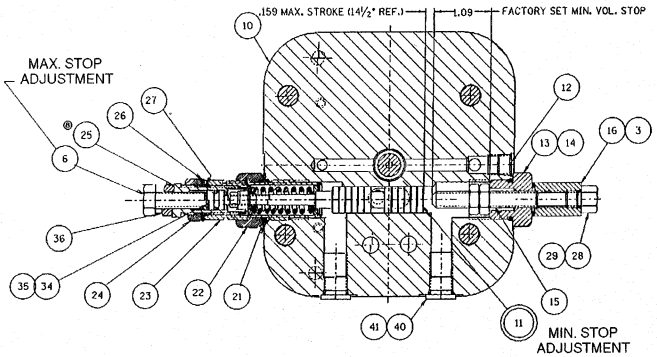
**PARTS LIST**

*Figure 9A Electric stroker*

| | | Feature → | 00 | 00 | 01 | 00 | 0* |
|---|---|---|---|---|---|---|---|
| | | Option → | P*P, P*S Pump | 6R,7R,8R Pump | P*P,P*S Pump | P*V Pump | M*H, M*V Motor |
| | | Assembly No. → | S23-12667 | S23-12940 | S23-12957 | S23-12734 S23-12733 | S23-15050 S23-15051 |
| **ITEM** | **DESCRIPTION** | **PT. NO.** | **QTY.** | **QTY.** | **QTY.** | **QTY.** | **QTY.** |
| 38-c | O-ring, 90 S-5 ARP 116 | 695-00116 | 2 | 2 | 2 | 1 | 1 |
| 39 | Stroker Block | 033-54991 | 1 | 1 | 1 | 1 | 1 |
| 40 | Plug, SAE-4 | 488-35061 | 2 | 2 | 2 | 2 | 2 |
| 41 | O-ring, 90 S-5 ARP 904 | 695-00904 | 2 | 2 | 2 | 2 | 2 |
| 42 | Plug. Parker 8HP N-S | 488-35018 | 1 | 1 | 1 | 1 | 1 |
| 43 | SHCS, 1/4-20 X 2.25” | 358-12100 | 1 | 1 | 1 | 1 | 1 |
| 44 | Nut, 1/4-20 | 333-12001 | 1 | 1 | 1 | 1 | 1 |
| 45 | O-ring, 70 S-5 ARP 121 | 675-00121 | 1 | 1 | 1 | 1 | 1 |
| 46 | Connector | 167-01008 | 2 | 2 | 2 | 1 | 1 |
| 47 | Guard | 033-54994 | 1 | 1 | 1 | 1 | 1 |
| 48 | SHCS, 1/4-20 X 2.25” | 306-12260 | 2 | 2 | 2 | 2 | 2 |
| 49 | Washer | 350-10144 | 4 | 4 | 4 | 4 | 4 |
| 50 | Plate | 030-55002 | 1 | - | - | - | - |
| | Plate | 030-55003 | - | 1 | 1 | 1 | 1 |
| 51 | Drive screw | 320-10203 | 2 | 2 | 2 | 2 | 2 |
| 52 | Coil, 24 VDC. | 517-00086 | 2 | 2 | - | 1 | 1 |
| | Coil, 12 VDC | 517-00087 | - | - | 2 | - | - |
| 53 | Plug, Parker 10 P50N-S | 488-35016 | - | - | - | 1 | 1 |
| 54 | SHCS, 10-32 X .19” | 312-09030 | - | - | - | 1 | 1 |
| 55 | O-ring, 90 S-5 ARP 910 | 695-00910 | - | - | - | 1 | 1 |
| 56 | Washer | 345-10016 | 2 | 2 | 2 | 2 | 2 |

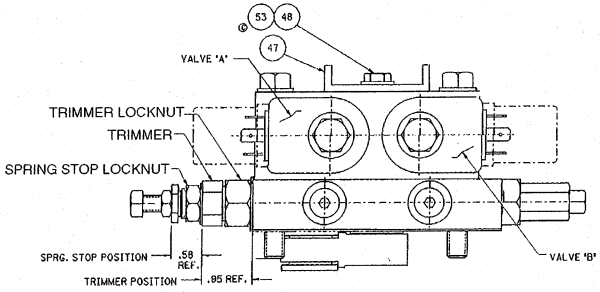


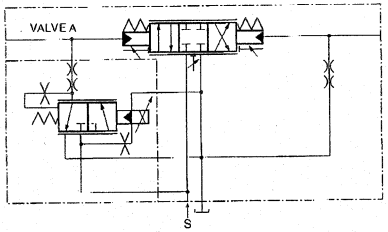



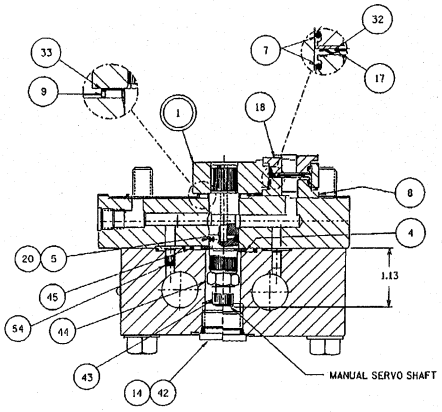

SECTION B-B

MOTOR

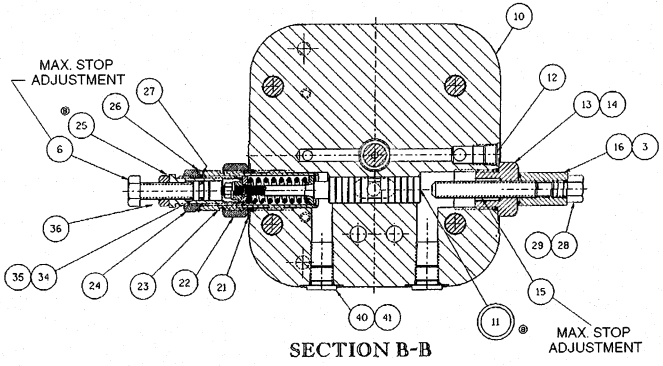


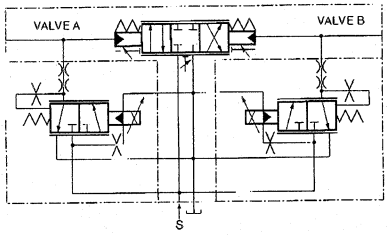

SINGLE VALVE




SECTION A-A




SECTION B-B




CROSS CENTER

CIRCUIT-900 SERIES HYDRAULIC

**FIGURE 9A**
**ELECTRIC STROKER**

## 9C ELECTRIC STROKER WITH BRAKE AND BYPASS VALVE

*S23-12925 - A/B - 00 Pump (Cross ctr. 24V)*

### DESCRIPTION

The 9C is basically an 8C package with the addition of two electric proportional pressure control valves mounted in a manifold block, thus proportionally controlling pump stroke by means of an electrical signal, while incorporating a brake and bypass valve function in the package. The Jupiter 900 Driver Card has been developed to accompany the 9C control with 24V coil.
Refer to 8C and 8A for brake and stroker description.

### DISASSEMBLY

*See Figure 9C*

1. Disconnect connector (58) from coil (64).
2. Remove proportional valves from block (53). Do not attempt disassembly of the valve, other than replacement of the coil, (64) and external O-rings, (53-a), (53-b) and (53-c).
3. Remove screws (2) from control. Remove proportional valve block (54) from control. Remove control from pump.
4. Examine servo plate for excessive scratching on surface. Note if orifices in stem are open. If servo plate is scratched or orifices appear to be plugged, remove plate and servo stem by removing two soc. setscrews from plate, then alternately loosening the two button hd. screws under the setscrews.
5. Remove retaining ring (4) and press the shaft assembly through the valve body.
6. Examine shoes (8) and (18) for contamination in balance pads and excessive scratching on shoe faces. Note the two shoes are not identical and must be installed in the proper position upon reassembly.
7. Remove the brake trimmer stop assembly (13) intact.
8. Remove the center trimmer screw (23) with the spool assembly and stop assembly intact. Note: signal pressure setting is determined by the spring preload. Do not disassemble or change unless setting is incorrect.
9. Remove tubing assembly (74). Remove bypass valve body (42) with fitting (44) and piston (45). Remove elbow (73) with orifice (37) and fitting (38). Remove spools (31) and (39).
10. Remove shoe (50), and spring (49).
11. Examine orifices (16) and (29) in body for contamination. Examine passages in body for free flow.
12. Clean and examine all parts for breakage or evidence of abnormal wear.

### REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |
| Spool | Break sharp edges or dings. |
| Shoe | Stone to remove raised burrs or dings. |

### ASSEMBLY

All parts are to be inspected and be free of material defects, dirt, scratches, or any foreign material.
All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

*See Figure 9C*

1. Install .031” orifices (29), checking to see that they clear the bore. Install the .018” orifice (16) in body.
2. Apply pipe sealant and install 1/16 pipe plugs (28) in body as shown. Torque to 25 lbs-in.. (2.8 Nm)
3. Apply pipe sealant to the 1/8” pipe plugs (12) and install in the cover plate. Torque to 100 lbs-in.. (11.3 Nm)
4. Thread trimmer locknut (22) all the way onto center trimmer screw (23). Slip backup washer (21), small dia. first, onto trimmer screw and against locknut. Using a 3/4-16 hex nut, with a 1.030” (26.2mm) dia. x .030/.035” (0.76/0.89mm) deep c’bore, crimp the washer onto the stop. Washer must be free to rotate slightly. Remove crimping nut.

*See Figure 8C-1*

5. Compress spring (4) solid in order to remove set. This may be safely accomplished using a 1/4" (6.35 mm) dia. bolt, nut and washers.
6. Assemble retaining ring (2), guide (3), spring (4) and guide (9) onto spool (1).
7. Tighten nut (6) till it just starts to load the spring, then tighten 2 5/6 additional turns
8. Install locknut (5) onto spool and lock against nut (6) without changing adjustment.
9. Install spool (7) onto other end of spool assembly (1). Install nuts (8) and tighten till spool has from .001 to .003" (.025 to .076 mm) clearance. (Barely free to rotate without binding). Lock nuts together and re-check spool fit.

*See Figure 9C*

10. Insert spool assembly (11), spring end first, into center trimmer screw (23). Compress snap ring on the spool assembly until it snaps into internal groove inside trimmer screw. See that it is securely seated.
11. Thread spring stop locknut (24) all the way onto adjusting spring stop (25). Slip back-up washer (26), small diameter first, onto stop and against locknut. Using a 9/16-18 hex nut with a .810/.815" (20.6-20.7mm) dia. x .030-.035" (0.76-0.89mm) dp. c'bore, crimp washer onto stop. Washer must be free to rotate slightly. Remove the crimping nut.
12. Install O-ring (35) on plug (34) and insert into spring stop (25). Install O-ring (27) onto stop (25) and against washer (26).
13. Thread spring adjustment stop (25) into trimmer screw (23) until it just touches the spool assembly. Be sure spool assembly is against snap ring.
14. Place O-ring (14) on trimmer screw (23) and thread assembly into the larger cross-bore in the cover plate. Install from the end which contains the 1/16" pipe plug.
15. Install nut (36) on adjusting screw (6). Thread adjusting screw into stop (25).

*See Figure 8C-2*

16. Thread locknut (8) all the way onto guide (1). Slip back-up washer (7), small dia. first, onto guide and against locknut. Using a 3/4-16 hex nut, with a 1.030" (26.2mm) dia. x .030/.035" (0.76/0.89mm) deep c'bore, crimp the washer onto the stop. Washer must be free to rotate slightly. Remove crimping nut.
17. Install stop (2) into guide. Install O-ring (9) on nut (3) and install over stop (2). Install O-ring (10) over plug (11). Install plug in nut (3).
18. Install O-rings (4,5, and 6) on guide (1). Lubricate O-rings and carefully insert guide into bore and over spool on opposite side from the trimmer screw.

*See Figure 9C*

19. Install spools (31) and (39) into the other cross-bore in the cover (10). The slotted end of spool (31) should be to the outside.
20. Install O-ring (27) on plug (38). Install spring (37) in plug and install plug in cover as shown.
21. Install O-rings (43) on fitting (44). Install piston (45) in bore of body (42). Install O-ring (72) on plug (71) and install plug in body (42). Install seals (70) on body (42). Install fitting (44) on body and install assembly in cover (10).
22. Install rollpins (30) in cover, being careful not to damage the cover surface.
23. Install O-rings (46) and (47) on vent post (48). Install vent post in cover.
24. Install spring (49) and shoe (50) over vent post.
25. Install 0-ring (7) in groove of shear seal (8).
26. Install shear seal with o-ring in large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.

> Note: The shear seal will fit in one position only, otherwise one side will be held up by the lip of the servo link. Shear seal (8) must be installed to face against the cover plate (10). This shear seal (8) differs from shear seal (18) in that the face surface is machined with two .094" (2.4mm) radius scallops.

27. Install thrust bearing (9) over servo shaft and seat against the servo link.
28. Slip washer (33) over the servo shaft and against the thrust bearing.
29. Using installation tool T-1, install O-ring (5) in the second groove from the end of the shaft (1). Warm glyd ring (20) to make it pliable, and install over O-ring (5).
30. Install the servo shaft assembly in the cover plate (10). Pin must engage slot in spool assembly (11).
31. Install retaining ring (4) into the groove of the servo shaft extending thru the cover plate.
32. Apply Loctite 271 on threads of screw (55), and on threads of shaft assembly (1). Assemble nut (56) on screw, insert screw into shaft assembly and turn in snugly. Torque nut to 14 lb.-ft. (19 Nm).
33. Place two spring washers (17), nested with the bent sections matching each other, into the large hole in the servo link.
34. Place washer (32) against the spring washers.
35. Install O-ring (7) into groove in the remaining shear seal (18). Note: This shear seal does not contain the two .094 radius scallops in the face. Place on top of washer, (32). Position shear seal to match the lip on the servo link.

36. Install four orifices (52), two each in two tapped holes in stroker block (54) closest to the proportional valve.
37. Install proportional pressure valves (53) in block (54). Torque to 20 lb.-ft. (27 Nm).
38. Install coils (64) on proportional valves (53). **CAUTION! Torque to 20-25 in.-lb. (2.2-2.8 Nm) MAX.**
39. Install remaining parts.
40. If control is to be tested on pump, install on pump control pad with O-rings (3), (5) and (57), gasket (19), washers (61), and screws (2). Torque to 30 lb. ft. (40.8 Nm). Install bypass check valves fittings, and lines.

## TEST

Remove plug over input shaft. Insert T handle 3/16" (4.76mm) hex wrench into opening
Connect proportional control driver to proportional valves electrical connection.
Install a needle valve on the bypass valve exhaust port, connected to tank. Close the valve.
Install a 500 psi (35 Bar) gage in the brake port.
Rotate the T handle to check for free play. Turn spring adjustment in or out till there is no free play. Lock in place. **Note: this adjustment is critical to accurate neutral adjustment!**

1. Start prime mover and adjust system relief valve for 5000 psi (345 bar).
2. Turn centering trimmer screw to place input shaft on the zero stroke position. Stroke pump to full and release, on both sides of center. Pump shall return to zero stroke within 200 psi (13.8 bar) max.
3. With pump on zero stroke, turn brake trimmer screw CW and CCW while observing gage on brake port. Note the positions where the gage reading changes from case pressure to servo pressure to case pressure. Set and lock the adjustment midway between these two positions.
4. Set max. volume stops so that servo shaft link touches stop pins when T handle is rotated each side of center. Caution! Do not exceed 100 in. lb. (11.3 Nm) torque. Lock in place.
5. Apply signal current to one proportional valve. Adjust current from minimum to maximum. Note the pressure and current value at which pump just starts to stroke, and at which the pump reaches full stroke These must be within the following values:

| Coil | Cont. Pr. Min. Disp. | Ma. Min. Disp. | Cont. Pr. Max. Disp. | Ma Max. Disp. |
|---|---|---|---|---|
| 12 Volt | 75 ±15psi (5.17±1bar) | 360 ± 60 | 250±25psi (17.2±1.7bar) | 650 ± 110 |
| 24 Volt | 75±15psi (5.17±1bar) | 180 ± 30 | 250±25psi (17.2±1.7bar) | 325 ± 55 |

6. If control pressure is off the same amount at start and end of stroke, the control may be disassembled and the spring (Figure 2) readjusted. One flat (1/6 turn) of adjustment will change the pressure by 4.6 psi (0.31 bar).
7. If the change in pressure from start to end of stroke is incorrect, the spring (Figure 2) is incorrect and must be replaced.
8. If pressures are correct but current is incorrect, then either the coil is incorrect or the proportional valve is bad.
9. With minimum signal, pump shall return to zero stroke within 200 psi. (13.8 bar) max.
10. Repeat test on opposite side of center.
11. Increase and decrease current between minimum and maximum several times. Pump stroke should follow control pressure smoothly and proportionally. Full to zero or zero to full stroke should be achieved in no more than two seconds. Adjust stroke up to approximately 50% stroke from zero stroke, then adjust down from full stroke to the same current value. The flow at the two settings shall not vary more than 25%.
12. Stroke pump control one side of center. The gage on the brake port should start to indicate servo pressure when the system pressure is between 2000 and 4500 psi (138 and 310 bar), with an increasing signal, and must return to case pressure before system pressure drops to 2000 psi (138 bar), on decreasing signal. Repeat by stroking control other side of center. Record both pressures for each side of center.
13. Open the needle valve on the neutral bypass port. Measure and record leakage from this port with the pump on center at minimum psi, and with the pump off center, at 5000 psi

**Maximum leakage with control on center:**
2.0 gpm (7.6 l/m)
**Minimum leakage with control on center:**
1.0 gpm (3.8 l/m)
**Maximum leakage with control off center:**
35 cu. in/min or .15 gpm (574 cm3/min. or 0.57 l/m)

14. Stroke pump above and below center. Control should operate smoothly. Brake pressure should drop to case pressure each time control is on center, and it should indicate servo pressure as soon as input shaft is rotated CW or CCW from center, per step 12 above.
15. Remove needle valve from bypass exhaust port and install exhaust line.
16. Release control when pump is off center. Pump should return to center. Repeat several times in each direction and at different pressures from 200 to 5000 psi (13.8 to 345 bar). Observe for leaks and proper operation.

**PARTS LIST**

*Figure 9C Electric stroker with brake and bypass valve*

*S23-12925 (Feature 00)*

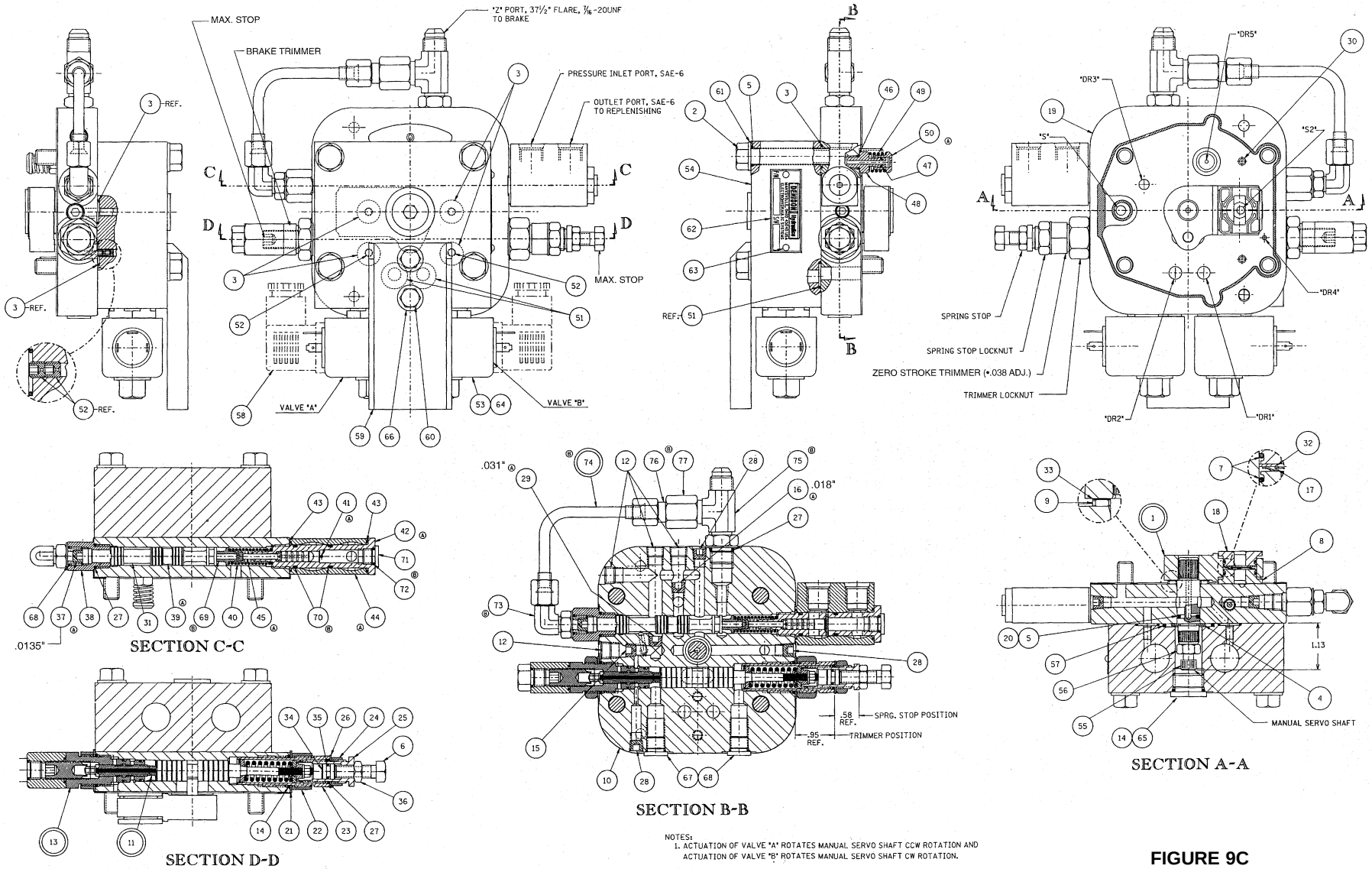
| ITEM | DESCRIPTION | PT. NO. | QTY. |
|---|---|---|---|
| 1 | Servo shaft | S23-12267 | 1 |
| 2 | HHCS, 3/8-24 X 3.25 | 306-40184 | 4 |
| 3 | O-ring, 70 S-5 ARP 013 | 675-00013 | 8 |
| 4 | Ring, Truarc 5144-50 | 356-65070 | 1 |
| 5 | O-ring, 70 S-5 ARP 012 | 675-00012 | 5 |
| 6 | Screw, HHC 5/16-24 X 1” | 307-13160 | 1 |
| 7 | O-ring, 70 S-5 ARP 017 | 675-00017 | 2 |
| 8 | Shear seal | 033-71371 | 1 |
| 9 | Bearing | 230-82141 | 1 |
| 10 | Cover | 033-91470 | 1 |
| 11 | Spool Assy (Fig. 8C-1) | S23-12935 | 1 |
| 12 | Flush plug 1/8” | 431-90204 | 4 |
| 13 | Brake trimmer (Fig. 8C-2) | S23-12921 | 1 |
| 14 | O-ring, 90 S-5 ARP 908 | 695-00908 | 2 |
| 15 | O-ring, 70 S-5 ARP 015 | 675-00015 | 1 |
| 16 | Orifice, .018” | 035-19092 | 1 |
| 17 | Finger spring | 350-10067 | 2 |
| 18 | Shear seal | 033-70525 | 1 |
| 19 | Gasket | 033-91058 | 1 |
| 20 | Glyd ring | 679-00004 | 1 |
| 21 | Washer | 350-10139 | 1 |
| 22 | Nut | 033-91115 | 1 |
| 23 | Center trimmer | 033-91028 | 1 |
| 24 | Locknut | 492-15353 | 1 |
| 25 | Stop | 033-91026 | 1 |
| 26 | Washer | 350-10126 | 1 |
| 27 | O-ring, 90 S-5 ARP 906 | 695-00906 | 2 |
| 28 | Plug, 1/16” flush | 431-90104 | 3 |
| 29 | Orifice | 033-91757 | 2 |
| 30 | Rollpin, 3/16 X .75” | 325-12120 | 2 |
| 31 | Spool | 033-70999 | 1 |
| 32 | Washer | 350-10064 | 1 |
| 33 | Washer | 350-10141 | 1 |
| 34 | Piston | 033-91099 | 1 |
| 35 | O-ring, 70 S-5 ARP 010 | 675-00010 | 1 |
| 36 | Nut, 5/16-24 | 335-13100 | 1 |
| 37 | Orifice, .0135” | 033-91758 | 1 |
| 38 | Fitting | 492-15375 | 1 |
| 39 | Spool | 033-91685 | 1 |
| 40 | Spring | 033-70992 | 1 |
| 41 | Dowel pin, 1/16 X .50” | 324-30026 | 1 |
| 42 | Body | 033-91698 | 1 |
| 43 | O-ring, 90 S-5 ARP 016 | 695-00016 | 2 |
| 44 | Fitting | 033-91700 | 1 |
| 45 | Piston | 033-91699 | 1 |
| 46 | O-ring, 90 S-5 ARP 902 | 695-00902 | 1 |

**PARTS LIST**

*Figure 9C Electric stroker with brake and bypass valve*

*S23-12925 (Feature 00)*

| ITEM | DESCRIPTION | PT. NO. | QTY. |
|---|---|---|---|
| 47 | O-ring, 70 S-5 ARP 006 | 675-00006 | 1 |
| 48 | Vent post | 033-70995 | 1 |
| 49 | Spring | 225-92044 | 1 |
| 50 | Shoe | 033-70996 | 1 |
| 51 | O-ring, 70 S-5 ARP 014 | 675-00014 | 2 |
| 52 | Orifice, .025” | 033-91225 | 4 |
| 53 | Valve-proportional | 517-00085 | 2 |
| 53-a | O-ring, 70 S-5 ARP 015 | 675-00015 | 2 |
| 53-b | O-ring, 90 S-5 ARP 016 | 695-00016 | 2 |
| 53-c | O-ring, 90 S-5 ARP 116 | 695-00116 | 2 |
| 54 | Stroker block | 033-54991 | 1 |
| 55 | SHCS, 1/4-20 X .625” | 358-12100 | 1 |
| 56 | Nut, 1/4-20 | 333-12001 | 1 |
| 57 | O-ring, 70 S-5 ARP 121 | 675-00121 | 1 |
| 58 | Connector | 167-01008 | 2 |
| 59 | Guard | 033-54994 | 1 |
| 60 | Screw, 1/4-20 X 2.25” | 306-12260 | 2 |
| 61 | Washer | 350-10144 | 4 |
| 62 | Plate | 030-55003 | 1 |
| 63 | Drive screw | 320-10203 | 2 |
| 64 | Coil - 24 VDC | 517-00086 | 2 |
| 65 | Plug, Parker 8HP N-S | 488-35018 | 1 |
| 66 | Washer | 345-10016 | 2 |
| 67 | Plug, SAE-4 | 488-35061 | 2 |
| 68 | O-ring, 90 S-5 ARP 904 | 695 00904 | 2 |
| 69 | Seat, spring | 033-91686 | 1 |
| 70 | Tetraseal | 695-10013 | 2 |
| 71 | Plug, SAE-3 | 488-35049 | 1 |
| 72 | O-ring, 90 S-5 ARP 903 | 695-00903 | 1 |
| 73 | Elbow | 033-91702 | 1 |
| 74 | Tube assembly | S23-15202 | 1 |
| 75 | Tee, st. thd run, SAE-6 | 497-15008 | 1 |
| 76 | Reducer | 492-15376 | 1 |
| 77 | Nut | 492-10012 | 1 |




NOTES:
1. ACTUATION OF VALVE "A" ROTATES MANUAL SERVO SHAFT CCW ROTATION AND ACTUATION OF VALVE "B" ROTATES MANUAL SERVO SHAFT CW ROTATION.

**FIGURE 9C**
**ELECTRIC STROKER WITH BRAKE AND BYPASS VALVE**

## CODE **4 - TORQUE LIMITER OPTION

*S23-12299*
*Both sides of center*

*S23-12298*
*"A" Mounting CCW Rotation*
*"B" Mounting CW Rotation*

*S23-12300*
*"A Mounting CW Rotation*
*"B Mounting CCW Rotation*

## DESCRIPTION

The torque limiter override hydraulically limits the maximum shaft torque imposed by the pump load at all speeds.
This operation is in addition to the pressure compensator override. It limits the compensating pressure in proportion to displacement so that the product of pressure and displacement, P x Q, does not exceed the set value.
A fixed flow of servo oil is applied to the end of a spool. A stroke controlled orifice meters this flow to the pump case, establishing a pressure on the end of the spool. System pressure is applied to the end of a pin in contact with the opposite end of the spool. A port opens to allow system pressure into the control chamber to de-stroke the pump whenever the force on the 1/8" (3.18mm) dia. pin overcomes the force on the end of the 7/16" (11.1mm) dia. spool.
The area of the orifice is varied by the pump stroke in such a manner that the pressure developed will be inversely proportional to stroke. For example, at 1/2 stroke, the pressure will be twice the pressure at full stroke. At 1/3 stroke, the pressure will be 3 times the pressure at full stroke. An adjustable flow control establishes the pilot flow, and thereby the controlled torque value. An adjustable restriction in series with the stroke controlled orifice permits adjustment of linearity.
For limiting on both system ports, two independent torque limiters are required. The control contains both in the same body.
The one side of center control contains one torque limiter, to limit the "A" system port.

## DISASSEMBLY

*See S23-12299*

1. Disconnect tubing lines from pump. Remove screws (2). Remove control from pump.
2. Remove indicator (39). Remove retaining ring (3) and press the shaft assembly through the valve body.
3. Examine shoes (7) and (41) for contamination in balance pads or excessive scratching on faces. Note: the two shoes are not identical and must be installed in the proper position on reassembly.
4. Remove the bodies (27) with attached parts. Remove the spools (25). Examine spools and bores for free motion, wear or contamination.
5. Remove cover nuts (36) and screws (35).
6. Remove plug (34), spring (32), retainer (31) and filter assembly (28). Examine filter assembly carefully for contamination.
7. Remove cover nuts (38) and screws (44).
8. Remove plugs (21) springs (19) and spools (18).
9. Solvent wash and check all passageways for free flow.

## REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover dings. | Stone or lap inside face to remove raised burrs & |
| Spool | Break sharp edges or dings. |

Preparation for assembly
All parts are to be inspected and be free of material defects, dirt, scratches or any foreign material.
All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit.
During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

**ASSEMBLY**
*See S23-12299*

1. Apply loctite pipe sealant and install plugs (12) in body. Torque to 25 in.-lb. (2.8 Nm)
2. Press dowel pin (9) into the .125" (3.18mm) dia. hole directly over the centerline of the 7/16" (11.1mm) diameter spool bore of the cover plate (10). Press to .125" (3.18mm) below the surface, being careful not to mar the surface.
3. Press spring pin (11) into the stepped bore from the end of the body. The end of the spring pin must be positioned 1.00" (25.4mm) below the spotface.

*Cross center control S23-12299*

4. Install the two spools (18) into the 7/16" (11.1 mm) bore that has the spring pin passing through it. The end of the spools having the drilled hole should extend towards the outer edge of the cover plate. Install the two springs (19) into the installed spools (18). Install the two O-rings (20) and the two plugs (21).
5. In the remaining bore, install one spacer (22) against the dowel pin (9). The tetraseal groove and tapped hole should be facing towards the outer end of the bore. Place the tetraseal (23) into the bore and slide it past the cross drilled hole and up against the spacer (22). Drop the ring (24) down against the tetraseal (23). Using a squared end rod slightly smaller than the bore, push the tetraseal onto the shoulder groove of the spacer (22). Fill the bore with hydraulic fluid and install spool (25), displacing the hydraulic fluid, to insure an air free cavity under the spool.
6. Press dowel pin (13) into body (27), using care not to damage the surface. Center the pin in the body. If the pin protrudes, carefully grind flush to clear fitting (26).
7. Slip pin (14) into body (27).
8. Install O-rings (29) in fitting (26) and insert body (27). Thread into bore on top of spool (25), with open port of fitting (26) toward center of control. Torque to 15 lbs-ft.. (20.3 Nm).
9. Repeat steps 5 thru 8 on other end of bore.

*One side center controls*
*See S23-12298, S23-12300*

10. Install spool (18) and spring (19) on one side only per chart below.
11. Complete steps 5 thru 8 on one side only per chart below. Install spool (18) on opposite side of this bore, then install plug (21) with O-ring (20).

| Pump Rotation & Input Control mtg.* | Location of T. L. parts |
|---|---|
| CW-B, CCW-A | See S23-12298 |
| CW-A, CCW-B | See S23-12300 |

*Note: Torque limiter is mounted on the opposite side from the input control.

**ALL CONTROLS**

12. Install strainer ass'y (28) piloted over the spring pin (11). Push the O-ring (30) down against the assembled filter and install the retainer (31). The tapered end must rest against the O-ring. Install the spring (32) into the tapered socket of the retainer (31) and install the O-ring (33) and the plug (34).
13. Install the two #10-32 socket setscrews (35). Bottom these screws out lightly, then back out approximately two turns. Install nuts (36), O-ring (37), plug (15) and O-rings (16).
14. Install the 1/4-20 socket set screws (44). Bottom these screws out lightly, then back out approximately 1-3/4 turns. Install nuts (38) with O-ring (30), plugs (15) and O-ring (16).
15. Install O-ring in groove of shear seal (7). Install shear seal with O-ring in the large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.

Note: The shear seal will fit in one position only. Otherwise one side will be held up by the lip of the servo link. Shear seal (7) must be installed to face against the cover plate (10). This shear seal contains two variable width slots. The width and depth are critical to accuracy of control.

16. Install needle bearing (8) over servo shaft and seat against the servo link. Install thrust washer (45) over needle bearing.
17. Install O-ring (4) in the second groove from the end of the shaft, using installation tool T-1.
18. Install the servo shaft assembly in the cover plate. (10).
19. Install retaining ring (3) into the groove of the servo shaft extending through the cover plate.
20. Place two spring washers (40), nested with the bent sections matching each other, into the large hole in the servo link.
21. Place washer (43) against the spring washers.
22. Install O-ring into groove in the remaining shear seal (41). Note: This shear seal does not contain the two tapered grooves in the face. Place on top of washer (43). Position shear seal to match the lip on the servo link.
23. Place servo link against a solid object and press indicator (39) on the servo shaft end. Align the pointer line on the indicator with the scribed line across the shaft.

When the pointer is towards the letter “O”, the link should be centered over the 1/8” (3.18mm) dowel pin. Install screw (17).
24. To mount on pump, set the gap between the spacers which drive the servo arm to .010” (0.254 mm) clearance with the arm. Slip servo arm between the two spacers and align control with housing dowels. Install control on pump with screws (2), new Nyltite washers (5), and gasket (42). Torque screws to 30 ft.-lb. (40.8 Nm). Install fittings and tube lines to torque limiter control.

**TEST**

1. Use formula below to calculate (a) the flow with the pump at the maximum pressure, and (b) the pressure with the pump at maximum stroke, for the desired power setting at the test stand R.P.M.

HP = PxQ/(Eff.x1714)
Where P = Pressure in PSI
Q = flow in GPM

Example: 50=5000xQ/(.85 x 1714) (a) Q=14.6 GPM
50=Px46.8/(.85 x 1714) (b) P=1557 PSI
for 50 HP with maximum pressure 5000 PSI, maximum flow 46.8 GPM (Series 6 at 1800 RPM) and efficiency of 85% at these conditions.

or KW = PxQ/(Eff.x600)
where P = pressure in Bar
Q = flow in l/min.

Example: 50=345xQ/(.85 x 600) (a) Q=73.9 l/min.
50=Px177/(.85 x 600) (b) P=144 bar
for 50 KW with maximum pressure 345 bar, maximum flow 177 l/min. (Series 6 at 1800 RPM) and 85% efficiency at these conditions.

2. Set the test stand at the maximum pressure for the system. Set the pump compensator above this value. Place the pump on stroke. If the pump does not meet the calculated flow (a) for this pressure, back the torque adjusting screw out, till the pump provides this flow. If the pump exceeds this flow, turn the torque adjusting screw in, till the control limits at this flow.
3. Reduce the test stand pressure setting to the calculated value (b) for the pump at full flow. Set the pump control to full stroke. If the pump fails to reach full flow, turn the linearity screw in till the pump hits full flow. If the pump reaches full flow, back the linearity screw out till the pump just commences to reduce stroke.
4. If linearity adjustment was required, repeat steps.

Note: Electric motor current may be used instead of the calculated values of pressure and flow. In step 2, adjust the torque adjusting screw to obtain the motor amperes at maximum pressure. In step 3, adjust the linearity screw to obtain the same motor amperes at full flow.

Chart for location of torque adjustment screws
(See S23-12298, S23-12299, S23-12300)

| *Servo Rot. | Torque & Linearity Adj. |
|---|---|
| CW | “E” |
| CCW | “F” |

*Note: Torque limiter indicator rotation is opposite to servo rotation.

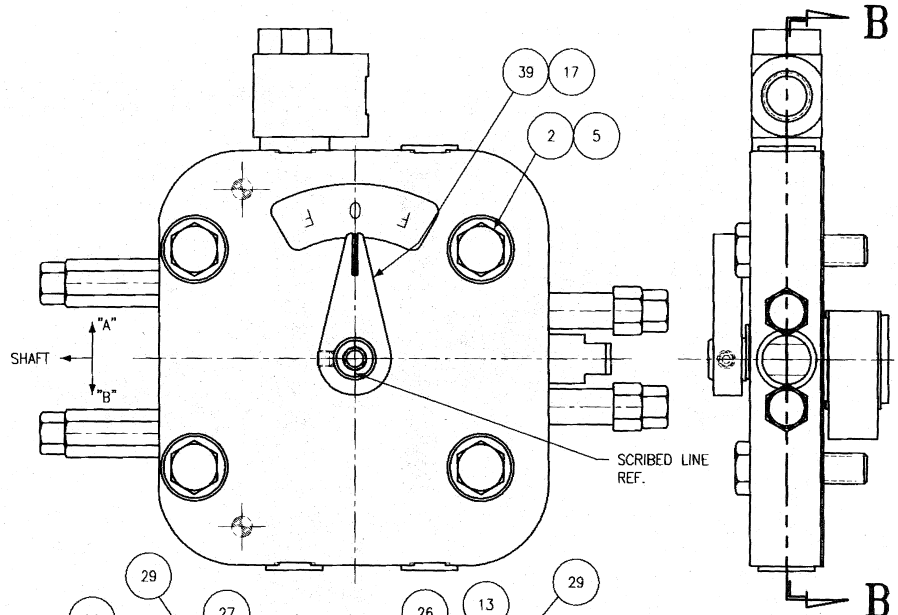
**PARTS LIST**
*For torque limiter*

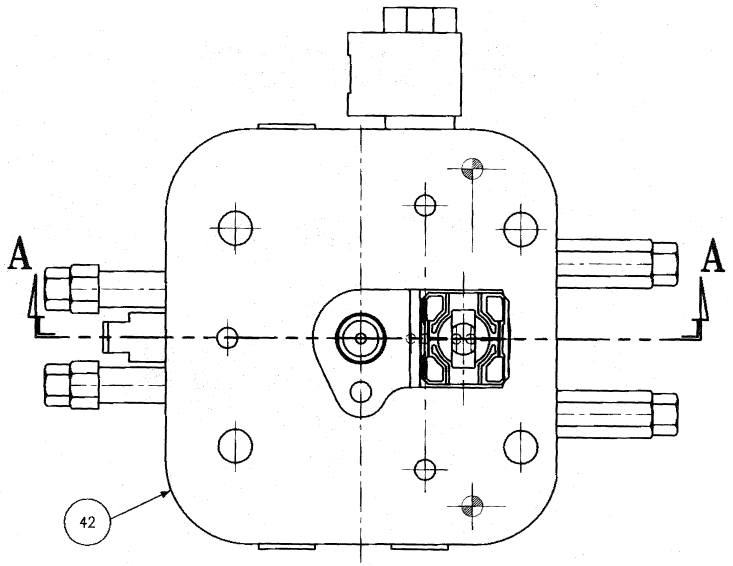
*S23-12299*
*Control both sides of center, A & B mounting*

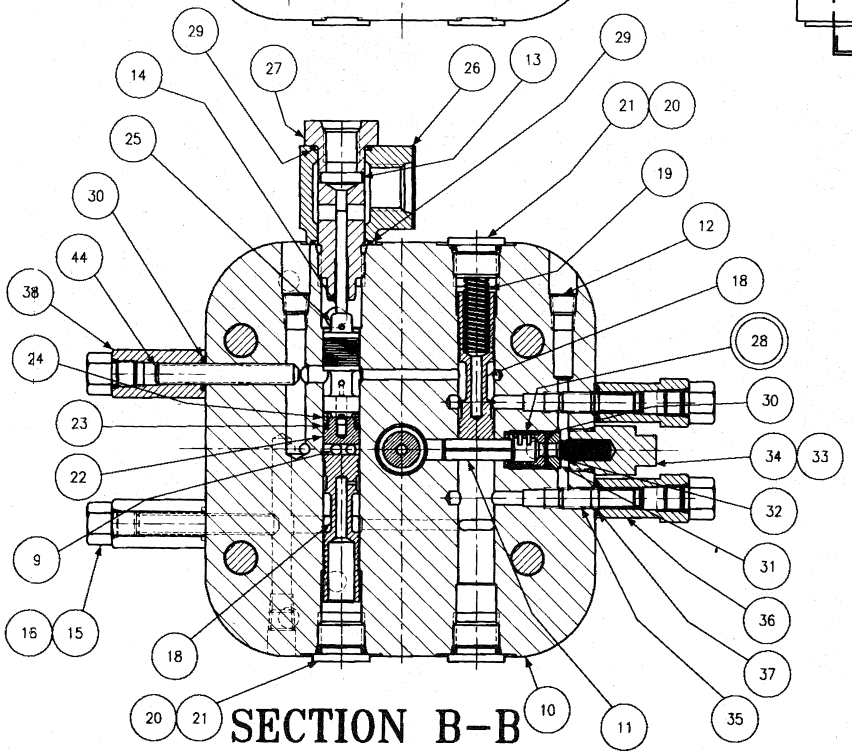
*S23-12298*
*Control 1 Side, CW rotation B mounting, CCW rotation A mounting*

*S23-12300*
*Control 1 Side, CW rotation A mounting, CCW rotation B mounting*

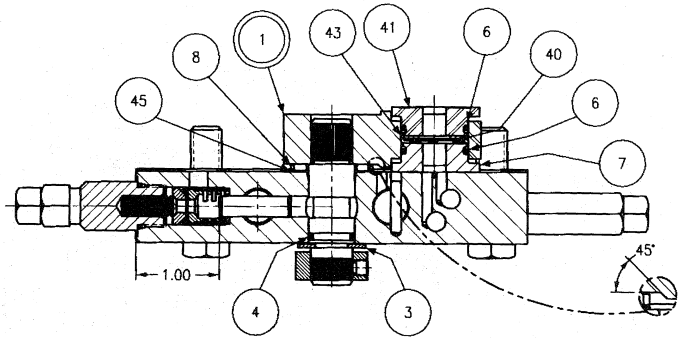
| ITEM | DESCRIPTION | PART NO | 1 Side Ctr. QTY | 2 Sides Ctr. QTY |
|---|---|---|---|---|
| 1 | Servo shaft assembly | S13-48437 | 1 | 1 |
| 2 | Screw, hwhd. 3/8-16 x 1 1/4 | 353-25018 | 4 | 4 |
| 3 | Retaining ring, #5144-50 | 356-65070 | 1 | 1 |
| 4 | O-ring, 70 S-1 ARP 013 | 671-00013 | 1 | 1 |
| 5 | Washer, Nyltite #37 | 631-45007 | 4 | 4 |
| 6 | O-ring, 70 S-1 ARP 017 | 671-00017 | 2 | 2 |
| 7 | Torque limiter shoe | 033-71204 | 1 | 1 |
| 8 | Needle bearing | 230-82141 | 1 | 1 |
| 9 | Dowel pin, 1/8 x 5/8 | 324-20810 | 1 | 1 |
| 10 | Cover | 033-92187 | 1 | 1 |
| 11 | Spring pin, 1/4 x 7/8 | 325-16140 | 1 | 1 |
| 12 | 1/16 pipe plug | 431-90100 | 3 | 3 |
| 13 | Dowel pin, 1/8 x 5/8 | 324-20810 | 1 | 2 |
| 14 | Pin | 230-82190 | 1 | 2 |
| 15 | O-ring, 90 S-1 ARP 902 | 691-00902 | 4 | 4 |
| 16 | Plug, 2P5N-S | 488-35029 | 4 | 4 |
| 17 | Soc. setscrew 10-32 | 312-09032 | 1 | 1 |
| 18 | Spool | 033-71198 | 2 | 2 |
| 19 | Compression spring | 225-92049 | 1 | 2 |
| 20 | O-ring, 90 S-1ARP 906 | 691-00906 | 3 | 2 |
| 21 | Plug, 6HP5ON-S | 488-35041 | 3 | 2 |
| 22 | Retaining ring | 033-71203 | 1 | 2 |
| 23 | Tetraseal,90 S-1 ARP 011 | 691-10011 | 1 | 2 |
| 24 | Spacer | 033-71201 | 1 | 2 |
| 25 | Spool | 033-54473 | 1 | 2 |
| 26 | Fitting | 033-70998 | 1 | 2 |
| 27 | Body | 033-54472 | 1 | 2 |
| 28 | Filter | S13-46764 | 1 | 1 |
| 29 | O-ring, 90 S-1 ARP 016 | 691-00016 | 2 | 4 |
| 30 | O-ring, 70 S-1 ARP 011 | 671-00011 | 3 | 3 |
| 31 | Retainer | 033-71196 | 1 | 1 |
| 32 | Compression spring | 225-92048 | 1 | 1 |
| 33 | O-ring, 90 S-1 ARP 905 | 691-00905 | 1 | 1 |
| 34 | Plug | 033-92186 | 1 | 1 |
| 35 | Soc. Setscrew | 311-12160 | 2 | 2 |
| 36 | Cover nut | 033-92191 | 2 | 2 |
| 37 | O-ring, 70 S-1 ARP 011 | 671-00011 | 2 | 2 |
| 38 | Cover nut, 1/4-20 | 033-91039 | 2 | 2 |
| 39 | Indicator | 033-70624 | 1 | 1 |
| 40 | Finger spring washer | 350-10067 | 2 | 2 |
| 41 | Shear seal | 033-70525 | 1 | 1 |
| 42 | Control cover gasket | 033-91058 | 1 | 1 |
| 43 | Thrust washer | 350-10064 | 1 | 1 |
| 44 | Soc. setscrew, 1/4-20 x 1 3/4 | 311-12220 | 2 | 2 |
| 45 | Washer | 350-10141 | 1 | 1 |




SECTION B–B

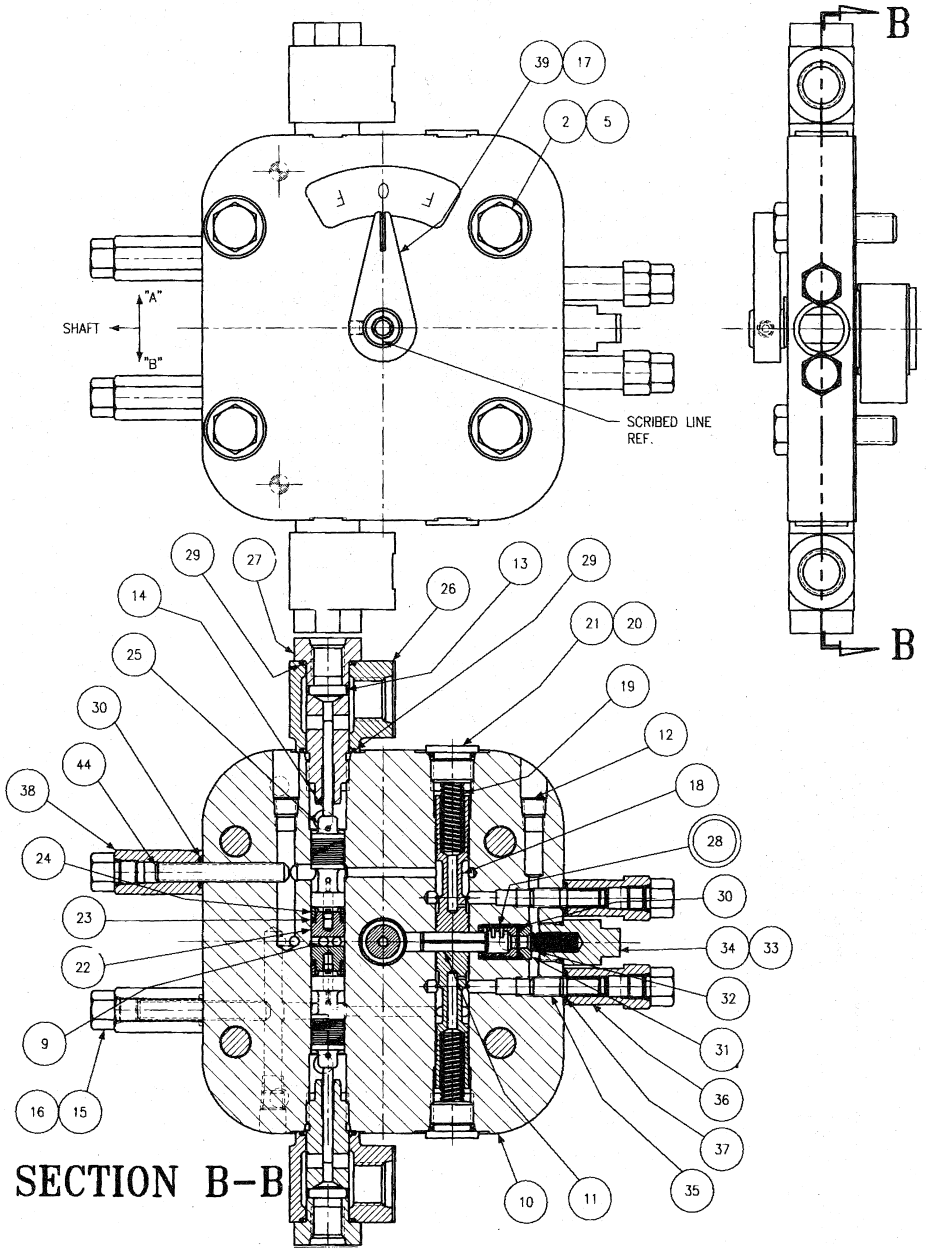


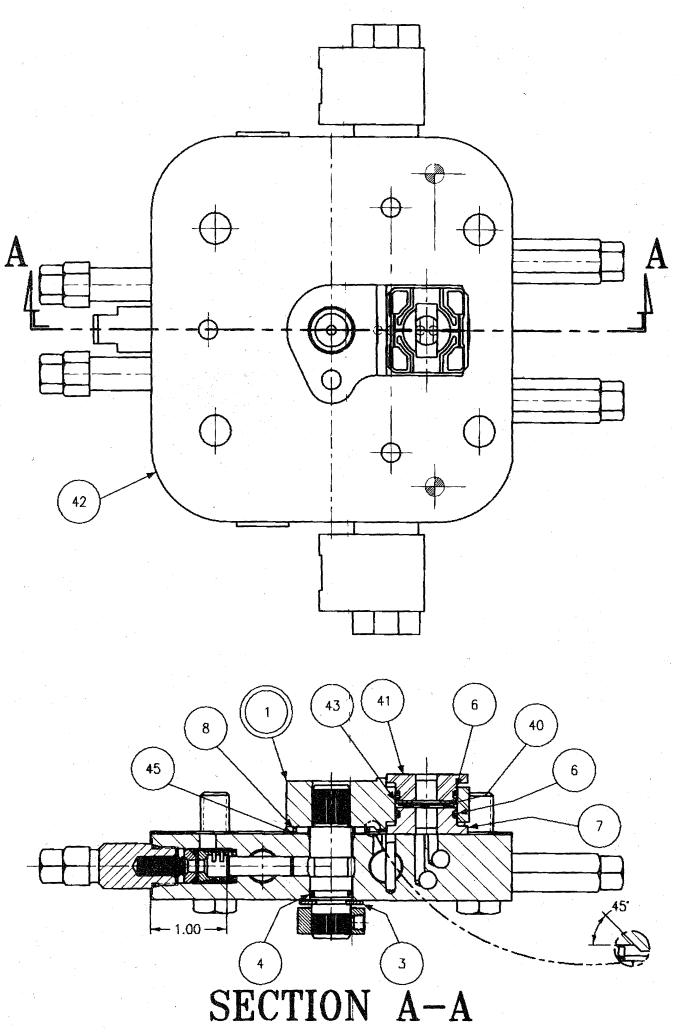

SECTION A–A

CCW ROTATION– "A" MTG.
CW ROTATION– "B" MTG.

**CONTROL TORQUE LIMITER**
**(1 SIDE OF CENTER)**
**CW-B CCW-A**

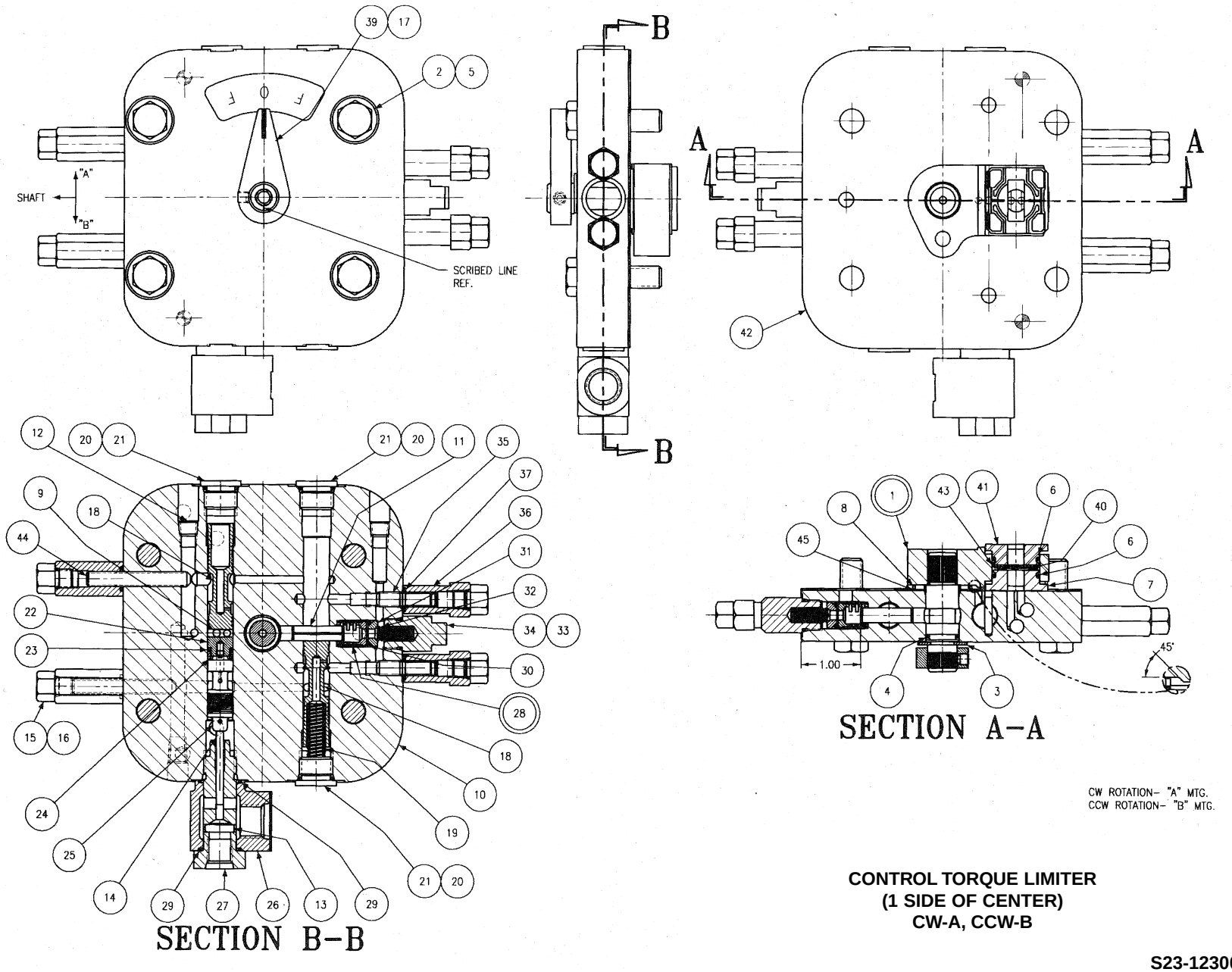
**S23-12298**




**CONTROL TORQUE LIMITER**
**(BOTH SIDES OF CENTER)**

**S23-12299**




**CONTROL TORQUE LIMITER**
**(1 SIDE OF CENTER)**
**CW-A, CCW-B**

**S23-12300**

## STROKE INDICATOR

*S13-42064*

### DESCRIPTION

The output stroke indicator mounts on the opposite side from the input control on the pump or motor housing. The assembly contains the shoes and servo arm and shaft arrangement of the input controls. The servo arm couples to the pump cam. An indicator attached to the shaft thus indicates the cam position. Servo oil is fed to the shoes to balance the side force on the cam resulting from the shoes on the opposite side.

### DISASSEMBLY

1. Remove screws (2). Remove cover from pump.
2. Remove indicator (12). Remove retaining ring (4) and press the shaft assembly through the valve body.
3. Examine shoes (8) and (14) for contamination in balance pads or excessive scratching on faces. Note: the two shoes are not identical and must be installed in the proper position on reassembly.

### REWORK OF WEAR PARTS

| Description | Rework |
|---|---|
| Servo plate face | Fine stone to remove raised burrs & dings |
| Shear seal | Fine stone to remove raised burrs & dings. Note: grooves to supply balance pads must be present and adequate. |
| Control cover | Stone or lap inside face to remove raised burrs & dings. |

### PREPARATION FOR ASSEMBLY

All parts are to be inspected and be free of material defects, dirt, scratches or any foreign material.
All parts are to be cleaned with a suitable cleaning solvent and all cores and passages blown out with clean dry compressed air.
After cleaning and inspection, all parts are to be covered with a light film of oil and should be protected from dirt and excessive handling until assembled onto the unit. During assembly, lapped and ground surfaces should be kept lubricated and protected from nicks or surface damage.

### ASSEMBLY

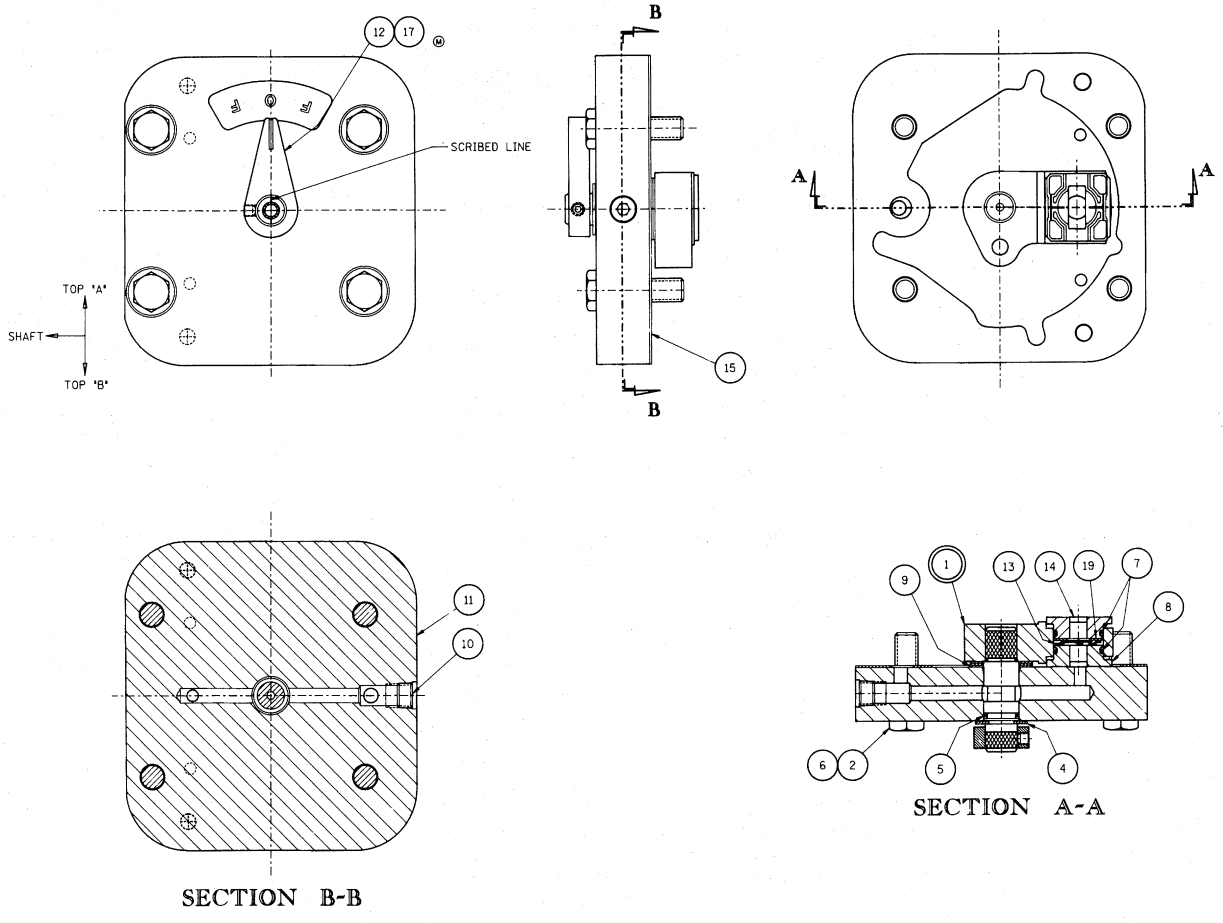
1. Apply pipe sealant and Install plug (10) in body. Torque to 100 in.-lb. (11.3 N•m)
2. Install O-ring (7) in groove of shear seal (8). Install shear seal with O-ring in the large hole on the servo link, on the servo shaft side. Be certain that the shear seal is sitting with the flange flush against the servo link surface.

> Note: The shear seal will fit in one position only. Otherwise one side will be held up by the lip of the servo link. Shear seal (8) must be installed to face against the cover plate (11). This shear seal differs from shear seal (14) in that the face surface is machined with two .094" (2.4 mm) radius scallops.

3. Install three thrust washers (9) over servo shaft and seat against the servo link.
4. Install O-ring (5) in the second groove from the end of the shaft, using installation tool T-1.
5. Install the servo shaft assembly into the cover plate (11).
6. Install retaining ring (4) into the groove of the servo shaft extending through the cover plate.
7. Place two spring washers (13), nested with the bent sections matching each other, into the large hole in the servo link.
8. Place washer (19) against the spring washers.
9. Install O-ring (7) into groove in the remaining shear seal (14). Note: This shear seal does not contain the two .094" (2.4 mm) radius scallops in the face. Place on top of washer (19). Position shear seal to match the lip on the servo link.
10. Place servo link against a solid object and press indicator (12) on the servo shaft end. Align the pointer line on the indicator with the scribed line across the shaft. When the pointer is towards the letter "O", the link should be centered between the dowel pin holes on the control cover. Install screw (17).
11. To mount on unit, slip servo arm between the two spacers extending from the servo stem and align control with housing dowels. Install control on pump with screws (2), new Nyltite washers (6), and gasket (15). Torque screws to 30 ft.-lb. (40.8 N•m).

**PARTS LIST**
*For stroke indicator*

| ITEM | DESCRIPTION | PT. NO. | QTY. |
|---|---|---|---|
| 1 | Servo shaft assy. | S13-48437 | 1 |
| 2 | Screw, hwhd. 3/8-16 x 1-1/4 | 353-25018 | 4 |
| 4 | Ring, WT 5100-50 | 356-65070 | 1 |
| 5 | O-ring, 70 S-1 ARP 013 | 671-00013 | 1 |
| 6 | Washer, Nyltite #37 | 631-45007 | 4 |
| 7 | O-ring, 70 S-1 ARP 017 | 671-00017 | 2 |
| 8 | Shear seal | 033-71371 | 1 |
| 9 | Thrust washer | 350-10103 | 3 |
| 10 | Hex flush plug 1/8” pipe | 431-90204 | 1 |
| 11 | Control cover | 033-53577 | 1 |
| 12 | Indicator | 033-70624 | 1 |
| 13 | Finger spring | 350-10067 | 2 |
| 14 | Shear seal | 033-70525 | 1 |
| 15 | Control cover gasket | 033-91058 | 1 |
| 17 | Soc. setscrew, 10-32 | 312-09032 | 1 |
| 19 | Thrust washer | 350-10064 | 1 |




**STROKE INDICATOR**
**S13-42064**

**PARTS LIST**

| CONTROL | POWDER METAL COVER PLATE *SEAL KIT | CAST IRON COVER PLATE **SEAL KIT | N/A |
|---|---|---|---|
| 102 | S23-02303-0 | S23-02303-0 | - |
| 2A2 | S23-02303-0 | S23-02303-0 | - |
| 2H2 | S23-02303-0 | S23-02303-0 | - |
| 4A2 | S23-02304-0 | S23-02304-0 | - |
| 4B2 | S23-02303-0 | S23-02303-0 | - |
| 4C2 | S23-02303-0 | S23-02303-0 | - |
| 5A2 | S23-02304-0 | S23-02304-0 | - |
| 5C2 | S23-02303-0 | S23-02303-0 | - |
| 602 | S23-02305-0 | S23-02305-0 | - |
| 6A2 | S23-02305-0 | S23-02305-0 | - |
| 6B2 | S23-02303-0 | S23-02303-0 | - |
| 6C2 | S23-02303-0 | S23-02303-0 | - |
| 8A/8C | - | S23-15156-0 | - |
| 9A/9C | - | S23-15157-0 | - |
| XX4 TLO | S23-02302-0 | S23-02303-0 | - |
| Reverse compensator XA5 | - | - | S23-05996-0 |

1. Add -4 for EPR and -5 for Viton Seals
* Powdered metal covers use “O” rings to seal between the control and the housing
** Cast iron use a gasket to seal between the control and housing
Note: All control seal kits contain both the “O” ring and gasket for either design.

## DEFINITION & UNIT

| | | |
|---|---|---|
| *displacement* | $in^3$/rev x 16.387 = $cm^3$/rev | $cm^3$/rev x 0.06102 = $in^3$/rev |
| *flow* | gpm x 3.78 = L/min | L/min x 0.2642 = gpm |
| *power* | hp x 0.7457 = kW | kW x 1.341 = hp |
| *torque* | lb-ft x 1.3567 = Nm | Nm x 0.7376 = lb-ft |
| *pressure* | $lbs/in^2$ (psi) x 0.06895 = bar<br>$lbs/in^2$ (psi) x 6.895 = kPa | bar x 14.50 = $lbs/in^2$ (psi)<br>kPa x 0.1450 = $lbs/in^2$ (psi) |
| *weight* | lb x 0.4536 = kg | kg x 2.205 = lbs |
| *force* | lb x 4.448 = N | N x 0.2248 = lbs |
| *volume* | $in^3$ x 16.387 = $cm^3$ | $cm^3$ x 0.06102 = $in^3$ |
| *area* | $in^2$ x 6.452 = $cm^2$ | $cm^2$ x 0.1550 = $in^2$ |
| *length* | in x 25.4= mm | mm x 0.03937 = in |
| *temperature* | $\frac{\text{degree F-32}}{1.8}$ = °C | 1.8 x °C+32 = ° F |
| *viscosity* | *c*St x 1.0 = $mm^2$/sec<br>SSU ≅ cSt x 4.25 + 14 | $mm^2$/sec x 1.0 = *c*St<br>20 cSt ≅ 99 SSU |

## FLUID POWER FORMULAS

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

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