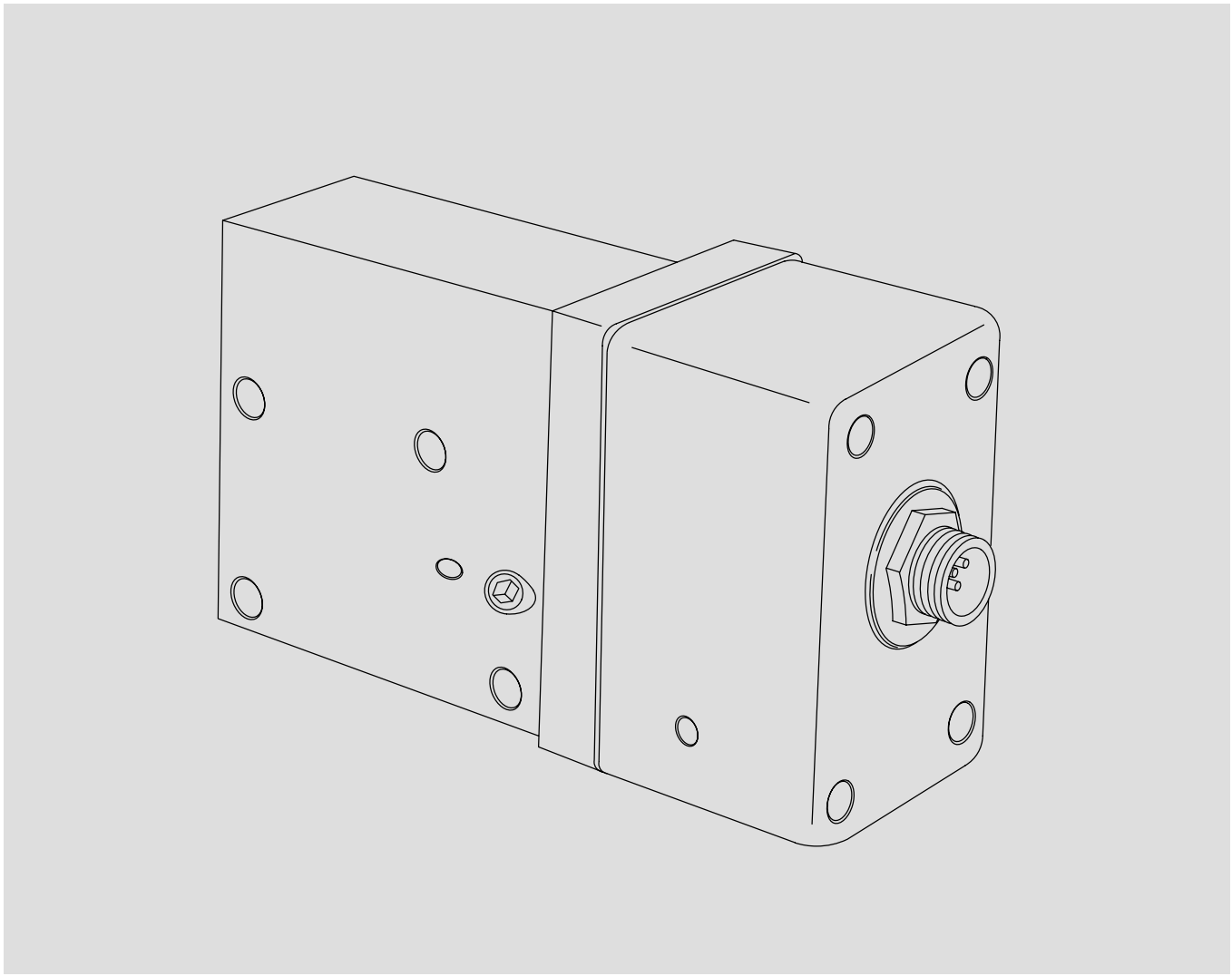
Overhaul Manual

Vickers®

Servo Valves

Two-Stage Servo Valves

SA4-03--***-1***
SA4-06--***-1***



Revised 9/1/87

I-3060-S

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Section I – Operating Characteristics

Type . . . . . Electrohydraulic two-stage servo valve
Operating Fluid . . . . . Clean hydraulic fluid
Filtration . . . . . 10 Micron
Type Mounting . . . . . Sub-plate, manifold
Mounting Position . . . . . Optional

Coil Resistance OHMs Per Coil (nominal)	Input Differential Current -ma	Deadband	Maximum Null Shift	Hysteresis	Power Required – watts (approx.)
20	400	.2% open loop with dither	.03%/°F	Less than 2%	3
25	360				
40	300				
100	175				
280	100				
2200	40				
5300	25				

Section II – Description

This manual contains operation, service and overhaul information for the SA4 Series Servo Valve. Units are identified on the nameplate. Figure 1 schematically illustrates the construction in cross-section.

Servo valves are comprised of a rectangular body containing four moving parts: a precision fitted pilot spool and sleeve, main spool and mechanical feedback linkage. Each valve uses a permanent magnet torque motor for pilot spool actuation.

Section III – Model Code

S A 4 – 0* – ** – * – 1***

1 2 3 4 5 6 7

1 Servo Valve

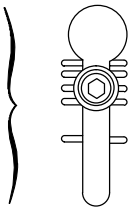
2 Type A – Two Stage Sliding Spool

3 4-way

4 03 – 3/8″ Nominal Pipe Size
06 – 3/4″ Nominal Pipe Size

5 Linkage Ratio

5.5 to 1
4.5 to 1
3.5 to 1
2.5 to 1
1.5 to 1



6 002 – 20 OHMS
003 – 25 OHMS
004 – 40 OHMS
010 – 100 OHMS
028 – 280 OHMS
220 – 2200 OHMS
530 – 5300 OHMS

7 Design and Modification

Section IV – Principles of Operation

A. System Control

In electrohydraulic servo valve systems, the control or command and feedback elements are electrical. As indicated in Figure 2, the command signal (which may be a tape control, punched card, dials, push button, etc.) dictates the operation of the servo valve to provide control of work as to sequence, direction, velocity, position, acceleration, and so on, or a combination of these. Feedback transducers (devices such as potentiometers, synchros, tachometers, accelerometers, etc.) can be used to measure results of the actual load motion in a closed loop hydraulic circuit. The electrical feedback signal can then be compared electrically with the command signal. If a difference between the feedback and command exists, the error current which results makes a correction to bring the system toward the desired command input.

B. Amplifier

The input command signal and the feedback signal of a servo system normally are both of very low power. They must be amplified, or increased in strength, to a level which is usable by the torque motor of the servo valve. This is done by the servo amplifier.

C. Servo Valve

The servo valve provides a flow proportional to the electrical current applied to it. The direction of flow is dictated by the polarity of the DC signal. This electrical signal can be the amplified command signal or the error signal as described above.

The SA4 Series servo valves consist of two stages: the pilot stage and the main stage. As shown in Figure1, the upper spool and sleeve comprise the pilot stage which controls the movements of the lower main stage spool. Hydraulic fluid is metered and directed to and from the work by the main stage. This is accomplished in the following manner:

When the electrical signal from the amplifier directs the torque motor to move the pilot spool, hydraulic fluid is metered to or from the 2A end of the main spool. Control pressure is always present against the 1A end area of the main spool. Since the 2A end area of the main spool is twice that of the effective area on the 1A end, the same pressure on both ends (or greater area of force on the 2A end) will cause the main spool to shift right. As the pilot moves to the right, fluid is permitted to drain back to tank from the 2A end and relieve pressure. When pressure on the 2A end of the main spool reduces to less than one-half the control pressure of the 1A end, the pressure at the 1A end moves the spool to the left. Fixed position of the main spool is achieved when the pressure in the 2A end is one-half the control pressure at the 1A end. Movement of the main spool is transmitted through the mechanical linkage to the pilot valve sleeve. The main spool continues to move until the pilot valve sleeve moves far enough to close off the flow of control fluid.

The main spool directs the flow to either pressure port “A” or “B” of the valve. Relationship of the spool to its stationary sleeve determines the amount of fluid metered to and from the motor or cylinder.

Independent control pressure can be supplied from a separate source such as a separate pump or from the supply pressure source using pressure reducing valves and accumulators. A separate source for the control pressure is preferred because:

1. It provides flexibility for trimming system to a fine point by careful adjustment of one pressure with another.

2. It permits separate filtration of control hydraulic fluid.

3. It is less power wasting.

4. The maximum control pressure preferred is 1000 PSI while the supply pressure may be as high as 3000 PSI.

5. It eliminates interaction of load fluctuation on pilot spool response in critical systems.

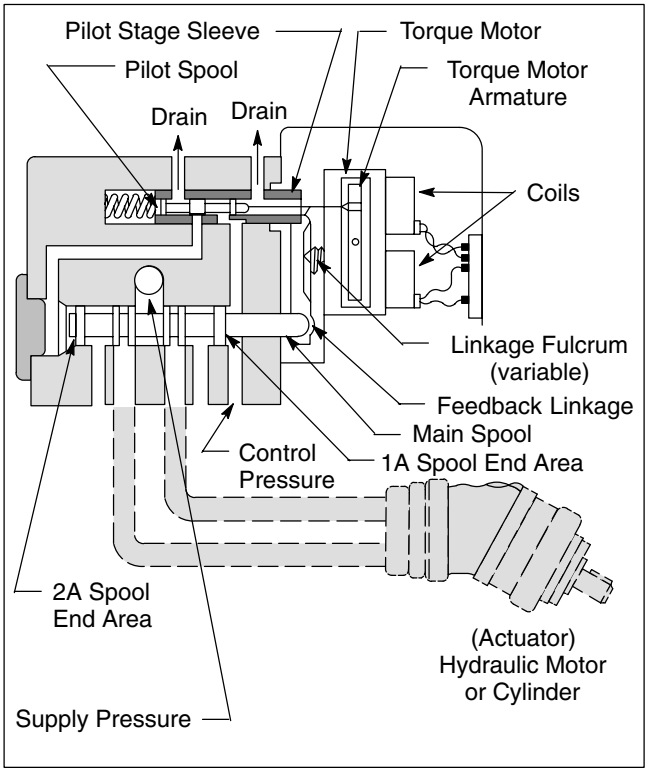


Figure 1. Servo Valve Schematic

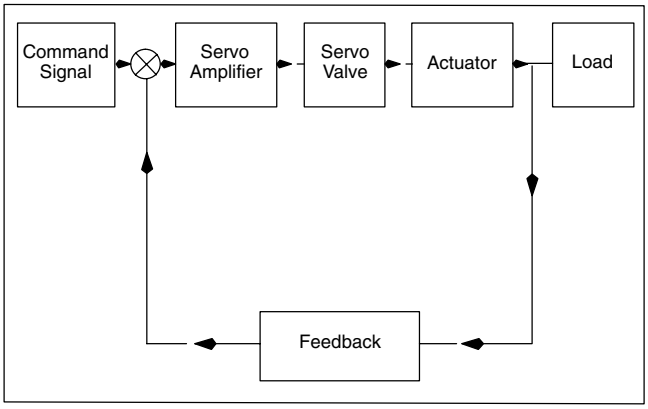


Figure 2. Servo Valve System Block Diagram

Section V – Installation

Installation drawing 501500 shows correct valve dimensions, port location, sub-plate mountings and other data. Vickers engineering personnel should be consulted to determine correct valve use and other assistance. Because of the extreme precision required of servo valve operation, extra precautions must be taken with the application of the valve to the circuit.

All piping should be thoroughly cleaned and pickled. Reservoirs should be carefully cleaned and flushed prior to addition of hydraulic fluid.

Full flow filters (10 micron) should be installed in both supply lines and control pressure lines. If desired, parallel filters can be installed with shut-off valves arranged so filters can be changed without interrupting system operation.

NOTE

Hydraulic fluid should be filtered to 10 microns while filling reservoir.

A. Flushing

Complete flushing of the hydraulic system will save considerable time in start-up and downtime of the servo system.

Before installing servo valve, flush the hydraulic system with clean fluid. A flushing plate (see Figure 3) can be purchased from any Vickers branch. It should be installed on the work face or mounted by means of a sub-plate to permit free return of hydraulic fluid from pressure to tank. Flush the system from one to two hours, then, replace the full flow filter cartridges and continue to flush. This procedure should be continued until filter elements and the bottom of the filter housing are free from contamination. After the system is clean, install the servo valve.

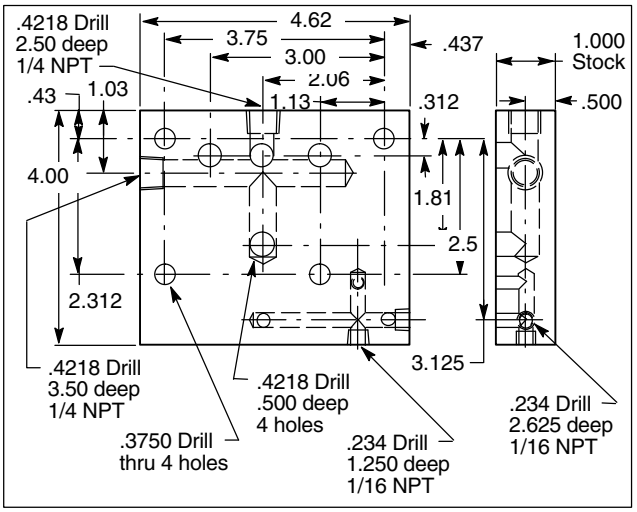


Figure 3. Flushing Plate (938714)

B. Mounting

Hydraulic connections between a servo valve and the actuator it controls can be made by a sub-plate or manifold, or the servo may be attached directly to a prepared, flat, ported face of the work unit. The sub-plate (SVGM2-03-10 or SVGM2-06-10) permits pipe connections with the work unit.

Figure 1. Schematic Sketch of Servo Valve

Manifolds (SVGM1-*-03-10, SVGM5-*-06-11 and SVGM6-*-06-10) allow direct manifolding of the SA4 series valves to any MF-2003-A thru MF-2020-A size hydraulic motor.

Manifolds may be obtained with three variations: (1) with cross line relief valves and variable orifice, (2) with cross line relief valves only and (3) with variable orifice only. In all applications the servo valve is attached by four mounting screws which should be tightened to the torque values specified in Table 1 in Section VI – Overhaul on page 7.

The mounting face of the servo valve has ten ports, each containing an O-ring. When the servo valve is mounted, the O-rings are compressed providing a leakproof installation.

C. Hydraulic Fluid Recommendations

Hydraulic fluids are required to perform the dual functions of lubrication and transmission of power. Thus, oil should be selected with care with the assistance of a reputable oil supplier. If fire resistant fluid is required, Vickers application engineering personnel must be consulted.

D. Electrical Connection

It is desirable to install milliammeters in series with the torque motor connections as shown in Figure 4. This will prove valuable for isolating electrical and hydraulic problems occurring during system trim and in troubleshooting electrical problems.

Electrical connections between the system and the torque motor should be checked to insure that they are in accordance with Figure 4.

When current through terminals “A” and “B” (Figure 4) is greater than current through terminals “C” and “D”, flow from Port “B” (FIgure 1) to the fluid motor or cylinder increases.

When the electrical system is turned on, current to the two coils should be balanced (1/2 input differential in each coil).

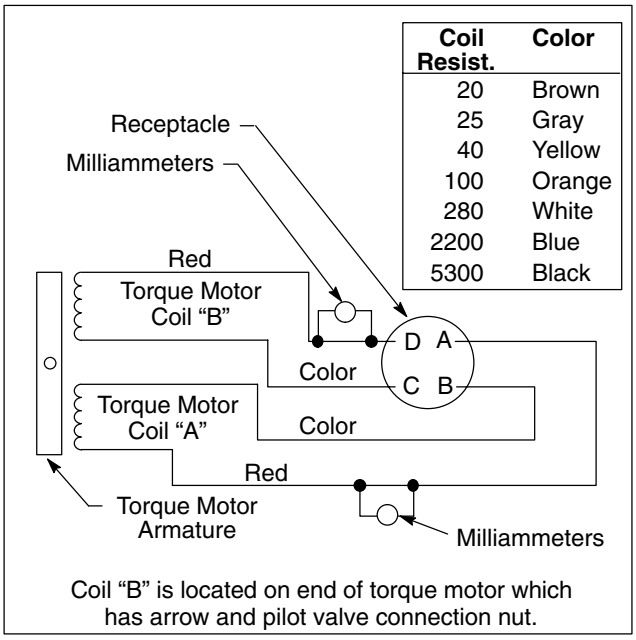


Figure 4. Wiring Diagram – Schematic View

E. Start-Up

After electrical connection is made, the hydraulic system can be started (with feedback devices disconnected). With balanced current in the coils, the actuator controlled by the servo valve should not move. If movement of the actuator in either direction is excessive at this stage, and the current to the torque motor coils is still balanced, the spool of the servo valve is probably not centered.

F. Null Adjustment

Null is accomplished by loosening set screw (32) then turning adjusting screw (33) clockwise to increase the flow out of Port A and counterclockwise to increase the flow out of Port B.

When sufficient adjustment cannot be made to properly center the valve, remove the torque motor cover and adjust the pilot spool with a 3/64 Allen wrench. In doing this, it should be remembered the torque motor is immersed in oil which will be released when the cover is loosened.

If the actuator (i.e., motor or cylinder) continues to move after the spool is properly centered, check the electrical signal shown in the milliammeters. If the current to the servo valve also varies or is unbalanced, the difficulty is probably in the electrical programming circuit. But if the milliammeters are showing a constant current without feedback connection and the actuator is still fluctuating erratically, the trouble is probably in the servo valve or elsewhere in the hydraulic system. If difficulty still exists after preliminary checking, the troubleshooting table on page 9 should help locate it.

G. Linkage Ratio

Linkage ratio is the relationship of pilot spool movement to main spool movement of the valve. This ratio is stamped into the nameplate of each unit. Linkage ratio is set at the factory based on information furnished with customers orders. Required flow, load pressure, available supply and control pressure should be specified. If this information is not furnished with the order, valves will be shipped with a 3.5 to 1 ratio. Adjustment, if necessary, must then be made in the field.

To adjust linkage ratio, (1) remove cover and torque motor, (2) loosen fulcrum screw with a 5/32 Allen wrench, (3) slide the fulcrum screw up or down in its slot. Ratio figures are stamped in the adaptor plate for reference in screw movement. If ratio is readjusted, have nameplate restamped.

H. Dither

The purpose of dither is to eliminate stiction and to increase the dirt tolerance within the valve. To accomplish this, it is necessary to keep the pilot spool moving within the deadband of the valve.

In every application, dither of 60-400 cycles must be applied to the pilot stage of the servo valve. Readily available 60-cycle current usually answers the dither requirement in the easiest and least expensive way.

Dither should be established as follows: Increase the amplitude of the dither until it can be felt at the output of the actuator. Then, slowly back down on the adjustment until no vibration can be felt on the actuator output.

Section VI – Overhaul

A. Disassembly

CAUTION

Before removing a unit or a part of a unit from a hydraulic circuit, be certain the unit concerned is not subject to hydraulic pressure or to an electrical power source.

Complete disassembly of the servo valve should be undertaken only at periodic intervals as recommended by the manufacturer or as determined by the application and operating conditions. Otherwise, a servo valve should not be disassembled further than necessary to correct a malfunction. Follow the sequence of index numbers shown in Figure 6 for disassembly.

When disassembling a servo valve, special attention should be given to identification of parts for proper reassembly. This is especially important for returning the valve spools, sleeves and other related parts in correct relationship to each other and to the block. The torque motor is a wet type so that removal of the cover results in the release of hydraulic fluid. Slightly oversize holes in the torque motor base permit proper readjustment of the torque motor as it is secured to the servo body. Attention also must be given to mating port holes mountings and gaskets on the bottom face of the valve block.

CAUTION

Never use an air hose on or near a hydraulic device because of water and dirt in the air stream.

Check the valve spools and block bores for roughness or scratches. Slight scratches and abrasions can be removed with crocus cloth or light lapping. Do not round off sharp edges of valve spool lands. Coat the spools with hydraulic fluid and test in the block bore for freedom of movement.

A malfunction of the torque motor can be checked by energizing with proper current and measuring armature deflection. Maximum current should give .020 movement of the armature in each direction. If this deflection does not occur, a continuity check of the coils should be made with a volt-ohmmeter. If the torque motor or any parts on the pilot spool linkage appear to be damaged, they can be replaced with new parts.

B. Reassembly

Before reassembly of the servo valve, coat all parts with hydraulic fluid and replace all seals and gasket.

For proper reassembly, an alignment tool (Figure 5) must be used. This tool can be procured from any Vickers branch. It is the only special tool required.

C. Spool Centering

Assemble sleeve sub-assembly (36) flush with body (37) at the adapter end (13), then, assemble torque motor so hole which normally receives the threaded end of the pilot spool is aligned with the threaded end of the alignment tool.

NOTE

Alignment tool must be clean before using.

Tighten down the torque motor and remove the alignment tool. Assemble the pilot spool to the torque motor. Install the valve on the system and adjust the pilot spool for center at the torque motor armature nut with a 3/64 Allen wrench. Replace the cover and trim if necessary as outlined in null adjustment paragraph, page 7.

Reassembly is in reverse order of disassembly. Follow index numbers of Figure 6 in reverse order.

Model Number	Torque lbf. in.
SA4-03-**–**–10, 11, 12	35 – 40
SA4-03-**–**–13, 14, 15	80 – 85
SA4-06-**–**–10, 11	35 – 40
SA4-06-**–**–12, 13	80 – 85

Table 1. Mounting Bolt Torque

D. Product Life

The longevity of these products is dependent upon environment, duty cycle, operating parameters and system cleanliness. Since these parameters vary from application to application, the ultimate user must determine and establish the periodic maintenance required to maximize life and detect potential component failure.

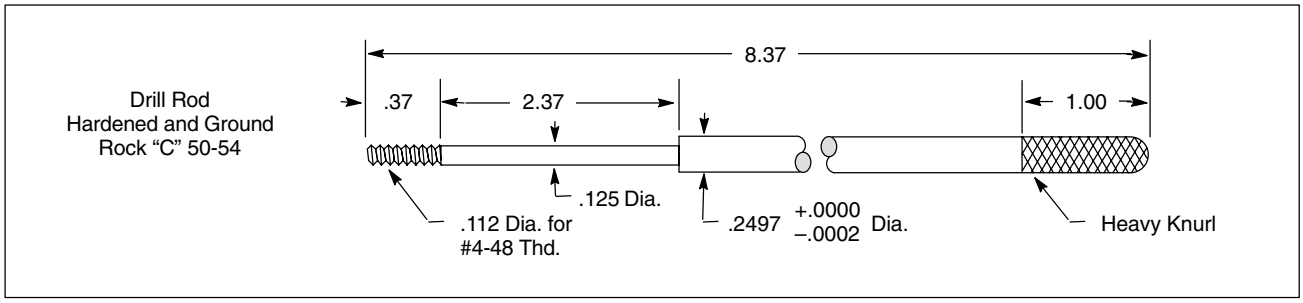


Figure 5. Alignment Tool (938710)

E. Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
No load movement	Insufficient control pressure or supply pressure.	Check the control pressure or supply pressure – the gage installation should be close to the servo valve.
	Improper or poor electrical connections.	With the amplifier or signal source turned off, check continuity with an ohmmeter for cold solder joints on the electrical connectors, broken leads and for improper pin wiring.
	Flow ports blocked.	Check for proper manifolding (O-rings) and for obstructions or improper piping of the hydraulic lines.
	Servo valve mounting bolts too tight.	Loosen the four servo valve mounting bolts and adjust to the values specified in Section VI – Overhaul.
	Amplifier or signal source inoperative.	Install milliammeters between the torque motor and amplifier or signal source, one in series with line “A” and the other in series with line “D”, and check for the proper differential currents.
	Torque motor inoperative.	With the amplifier or signal source turned off, check the torque motor coils for either an open or shorted condition by placing an ohmmeter across pins “A” and “B” of the electrical connector for one coil and across pins “C” and “D” for the other.
Load movement in only one direction	Pilot spool not centered.	Recenter pilot spool. Refer to page 8.
	One torque motor coil inoperative.	With the amplifier or signal source turned off, check the torque motor coils for either an open or shorted condition by placing an ohmmeter across pins “A” and “B” of the electrical connector for one coil and across pins “C” and “D” for the other.
	Improper or poor electrical conditions.	Install milliammeters between the torque motor and amplifier or signal source, one in series with line “A” and the other in series with line “D”, and check for the proper differential currents.
	Insufficient control pressure.	Check the control pressure – the gage installation should be close to the servo valve.
	Flow ports blocked.	Check for proper manifolding (O-rings) and for obstructions or improper piping of the hydraulic lines.
Movement of load in both directions, but maximum load movement obtainable in only one direction.	Pilot spool not centered.	Recenter pilot spool. Refer to page 8.
	Amplifier or signal source null shift.	Install milliammeters between the torque motor and amplifier or signal source, one in series with line “A” and the other in series with line “D”, and check for the proper differential currents. Refer to operating characteristics.
	Main sleeve too far out of adjustment.	Refer to spool centering adjustment page 8 then null adjustment page 7.
Erratic load movement	Contamination.	Install the proper filter required. Clean the system components, and thoroughly flush the system.

TROUBLE	PROBABLE CAUSE	REMEDY
Erratic load movement (cont'd.)	Erratic input signal from amplifier or signal source.	Check the amplifier or signal source for stability and check the input signal to the torque motor for freedom from hash and pick-up. Shield the input cables wherever required.
	Servo valve mounting bolts too tight.	Loosen the four servo valve mounting bolts and tighten to the values specified in Section VI – Overhaul.
Uncontrolled load movement	Insufficient control pressure.	Check the control pressure. The gage installation should be close to the servo valve.
	Amplifier or signal source defective or inoperative.	Install milliammeters between the torque motor and amplifier or signal source, one in series with line "A" and the other in series with line "D", and check for the proper differential currents. Refer to differential currents as specified in operating characteristics for full deflection of specific torque motor.
	Torque motor defective or inoperative.	With the amplifier or signal source turned off, check the torque motor coils for either an open or shorted condition by placing an ohmmeter across pins "A" and "B" of the electrical connector for one coil and across pins "C" and "D" for the other. Check all four pins to ground.
	Servo valve mounting bolts too tight.	Loosen the four servo valve mounting bolts and tighten to the values specified in Section VI – Overhaul.
Load movement in the wrong or opposite direction	Torque motor wiring incorrect.	Reverse input polarity or switch leads "A" and "D" to the torque motor electrical connector.
	Amplifier, signal source current polarity or wiring incorrect.	Reverse input polarity or switch leads "A" and "D" to the torque motor electrical connector.
External leakage out of cover around cover bolts	Copper gasket defective.	Replace gasket.
External leakage out of cover around plug electrical connector	Defective O-ring seal.	Replace O-ring.
	Connector pin not in locator hole.	Relocate plug in mounting hole.
External leakage between cover and adapter plate	Defective adapter O-ring seal.	Replace O-ring.
External leakage between valve body and adapter plate	Defective gasket in bath-tub shape opening.	Replace gasket.
External leakage from end cap of main spool bore	Defective O-ring.	Replace O-ring.
External leakage between valve body and sub-plate	Blown O-ring.	Replace O-ring.
External leakage from bore plugs (pipe plugs)	Plugs not tight or imperfect threads.	Replace plugs.
Extreme external leakage from cover	Drain line restricted.	Check line to insure free drain to tank.

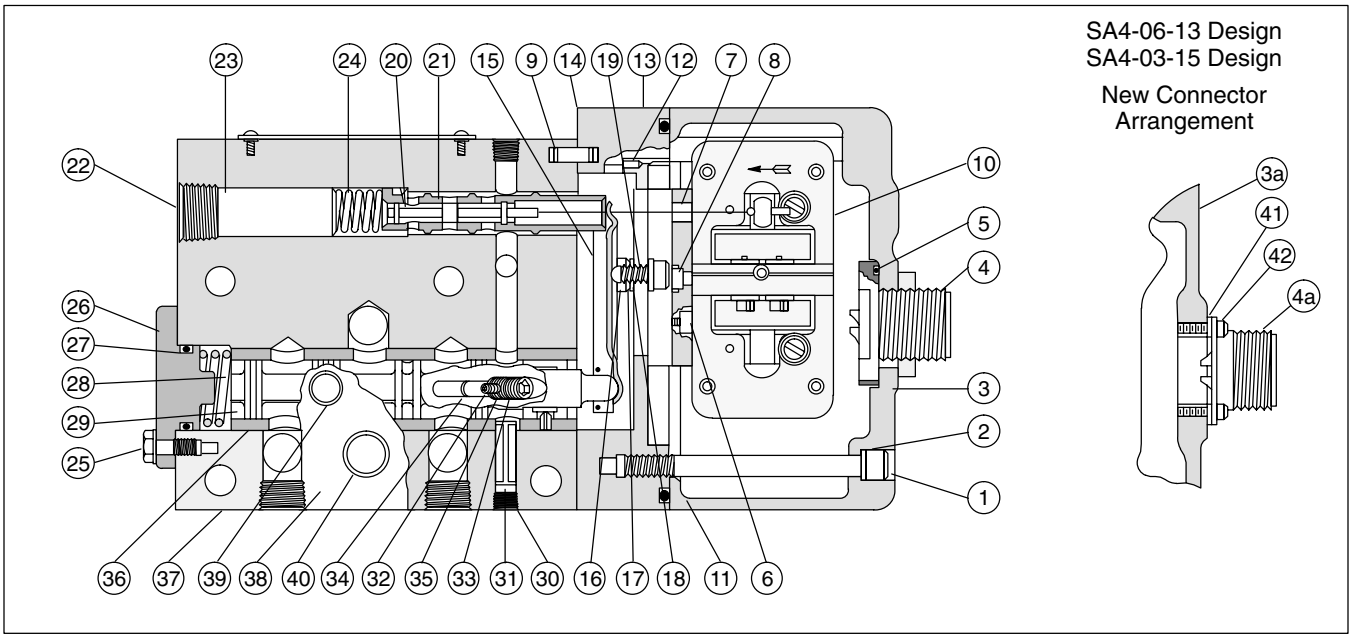


Figure 6. Servo Valve Assembly – Cross Sectional View

Code	Part No.	Name	SA4-03-**-***-10	SA4-03-**-***-11	SA4-03-**-***-13	SA4-03-**-***-14	SA4-03-**-***-15	SA4-06-**-***-10	SA4-06-**-***-11	SA4-06-**-***-12	SA4-06-**-***-13
1	10933	Screw	4	4	4	4	4	4	4	4	4
* 2	48170	Gasket	4	4	4	4	4	4	4	4	4
3	223051	Cover	1	1	1	1		1	1	1	
3a	424687	Cover					1				1
4	177917	Receptacle	1	1	1	1		1	1	1	
4a	243233	Receptacle					1				1
* 5	230666	O-ring	1	1	1	1		1	1	1	
6	125792	Screw	4	4	4	4	4	4	4	4	4
7	223049	Mtng. Plate	1	1	1	1	1	1	1	1	1
8	126017	Screw	2	2	2	2	2	2	2	2	2
9	226816	Roll Pin	1	1	1	1	1	1	1	1	1
10	319237	Torque Motor 20 OHM	1	1	1	1	1	1	1	1	1
	290994	25 OHM	1	1	1	1	1	1	1	1	1
	212619	40 OHM	1	1	1	1	1	1	1	1	1
	285329	100 OHM	1	1	1	1	1	1	1	1	1
	207691	280 OHM	1	1	1	1	1	1	1	1	1
	207692	2200 OHM	1	1	1	1	1	1	1	1	1
	211458	5300 OHM	1	1	1	1	1	1	1	1	1
*11	154099	O-ring	1	1	1	1	1	1	1	1	1
12	8077	Screw	6	6	6	6	6	6	6	6	6
13	223052	Adapter Plate	1	1	1	1	1	1	1	1	1
*14	224685	Gasket	1	1	1	1	1	1	1	1	1
15	936505	Beam S.A.	1	1	1	1	1	1	1	1	1
16	223926	Nut	1	1	1	1	1	1	1	1	1
17	6455	Lockwasher	1	1	1	1	1	1	1	1	1
18	73826	Washer	2	2	2	2	2	2	2	2	2
19	223662	Screw	1	1	1	1	1	1	1	1	1
20	223047	Pilot Spool S.A.	1	1	1	1	1	1	1	1	1
21	214319	Pilot Spool Slv.	1	1	1	1	1	1	1	1	1
22	7076	Pipe Plug	1	1	1	1	1	1	1	1	1

Code	Part No.	Name	SA4-03-**-***-10	SA4-03-**-***-11	SA4-03-**-***-13	SA4-03-**-***-14	SA4-03-**-***-15	SA4-06-**-***-10	SA4-06-**-***-11	SA4-06-**-***-12	SA4-06-**-***-13
23	225199	Plug	1	1	1	1	1	1	1	1	1
24	223055	Spring	1	1	1	1	1	1	1	1	1
25	177850	Screw	3	3	3	3	3	3	3	3	3
26	177713	Plug	1	1	1	1	1	1	1	1	1
*27	199812	O-ring	1	1	1	1	1	1	1	1	1
28	223056	Spring	1	1	1	1	1	1	1	1	1
29	229570	Spool						1	1	1	1
	220215	Spool	1	1	1	1	1				
30	7074	Pipe Plug	2	2	2	2	2	2	2	2	2
31	164056	Roll Pin	1	1	1	1	1	1	1	1	1
32	158577	Set Screw	1	1	1	1	1	1	1	1	1
33	223045	Adj. Screw	1	1	1	1	1	1	1	1	1
*34	187681	O-ring	1	1	1	1	1	1	1	1	1
35	223046	Plug	1	1	1	1	1	1	1	1	1
36	936506	Sleeve S.A.						1			
	936507	Sleeve S.A.		1							
	936508	Sleeve S.A.	1								
	938796	Sleeve S.A.							1	1	1
	938797	Sleeve S.A.			1	1	1				
37	229568	Body						1	1		
	231623	Body		1	1						
	223053	Body	1								
	249754	Body								1	
	249755	Body				1	1				
38	227551	Plate						1	1		
	178993	Plate	1	1	1						
*39	154005	O-ring	4	4	4	4	4	4	4	4	4
*40	175942	O-ring				6	6	6	6	6	6
	173792	O-ring	6	6	6						
*41	235068	Gasket					1				
42	215396	Screws					4				

* Included in Seal Kit 919159