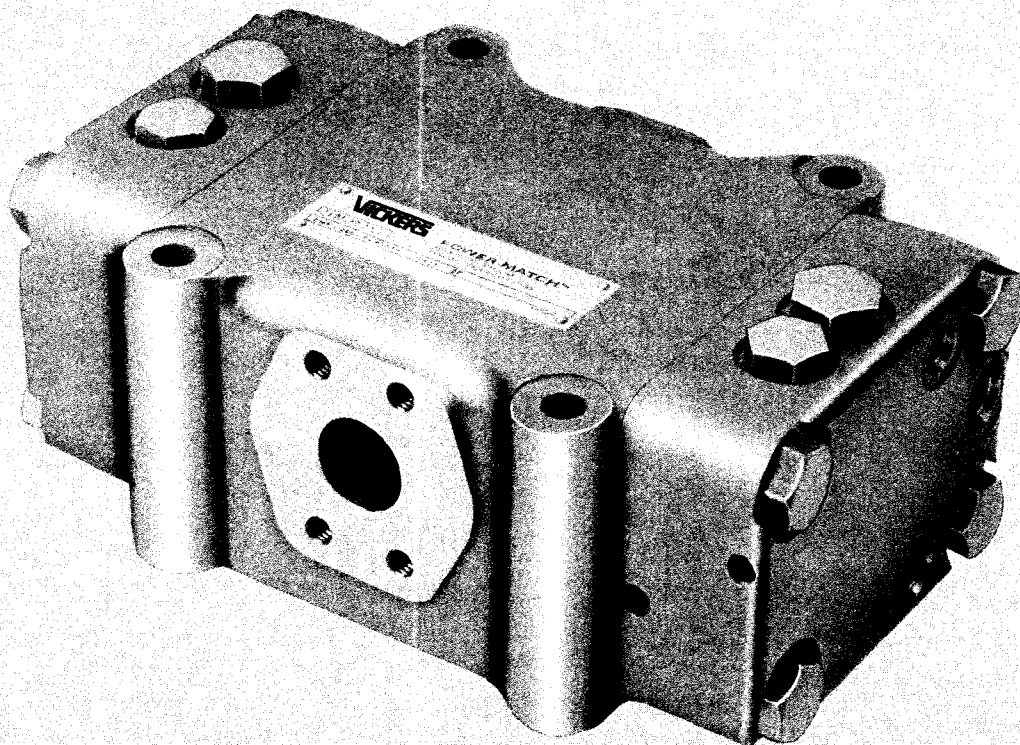


CMX Directional Valves

CMX 160, 250, 400, 630



Vickers Incorporated
A TRINOVA Company
5445 Corporate Drive
P.O. Box 302
Troy, Michigan 48007-0302
U.S.A.

TABLE OF CONTENTS

SECTION		PAGE
I	INTRODUCTION	
	A. Purpose of Manual	1
	B. General Information	1
II	DESCRIPTION	
	A. General Construction	1
	B. Mounting	2
	C. Valve Function	2
	D. Control Type and Application	2
III	PRINCIPLES OF OPERATION	
	A. General	4
	B. POWER MATCH™ Feature	4
	C. Operation of Valve Elements	4
	Meter-In Element	4
	Meter-Out Element	5
	Meter-Out Poppet Variations	5
	Relief Valve Element	5
	Transient (Fast Rise) Pressure Operation	6
	Relief Valve Element (CMX160)	6
	D. Valve Operation	6
	General	6
	Meter-In/Meter-Out Phasing	6
	Driving a Load	7
	Lowering a Load	7
	Neutral Position	8
	Pump Standby Condition	8
IV	INSTALLATION & OPERATING INSTRUCTIONS	
	A. Installation Drawings	8
	B. Mounting	8
	C. Hydraulic Tubing	8
	D. Hydraulic Fluid Recommendations	8
	General Data	8
	Cleanliness	8
	Sound Level	9
	E. Overload Protection	9
V	SERVICE & MAINTENANCE	
	A. Service Tools	9
	Special Tools	9
	B. Inspection	10
	C. Adding Fluid to the System	10
	D. Replacement Parts	10
	E. Trouble Shooting	10
VI	OVERHAUL	
	A. General Information	11
	B. Disassembly of Relief Valve Parts from End Covers	11
	C. Removal of End Covers and Internal Body Parts	11
	D. Inspection, Repair, and Replacement	19
	E. Assembly	19
VII	TEST PROCEDURE	
	A. General	21
	B. Test Stand	21
	C. On Vehicle Test	24

Section I - INTRODUCTION

A. PURPOSE OF MANUAL

This manual has been prepared to assist users of Vickers CMX Series high pressure load sensing directional valve for properly maintaining and repairing their units. In the sections that follow, features of the valve are discussed and instructions are given for proper installation, maintenance and overhaul.

B. GENERAL INFORMATION

1. Related Publications - Service parts information and installation dimensions are not contained in this manual. The parts and installation drawings listed in Table 1 are available

MODEL	PARTS DRAWING	INSTALLATION DRAWING
CMX160	M-2407-S	593321
CMX250	M-2405-S	593393
CMX400	M-2406-S	583396
CMX630	M-2408-S	626438

Table 1. Available Parts & Installation Drawings

2. Model Codes - The many variations within a basic model series are covered by variables in the model code. Table 2 is a complete breakdown of the model code covering these units. Service inquiries should always include the complete model code number as stamped on the nameplate.

Section II - DESCRIPTION

A. GENERAL CONSTRUCTION

All CMX series valves are made in three sections; a body and two end covers. CMX250, CMX400 and CMX630 main body section consists of machined bores for the installation of a meter-in spool, two meter-out poppet assemblies, two load drop checks, two anti cavitation check valves and two filter/main orifice assemblies. Each end cover section consists of a

filter/accumulator orifice assembly and a port relief valve. See Figure 1.

The CMX160 valve is basically constructed the same as other models except filter assemblies do not exist in the body or end covers. It also has a different port relief arrangement in the end covers. See Figure 1a.

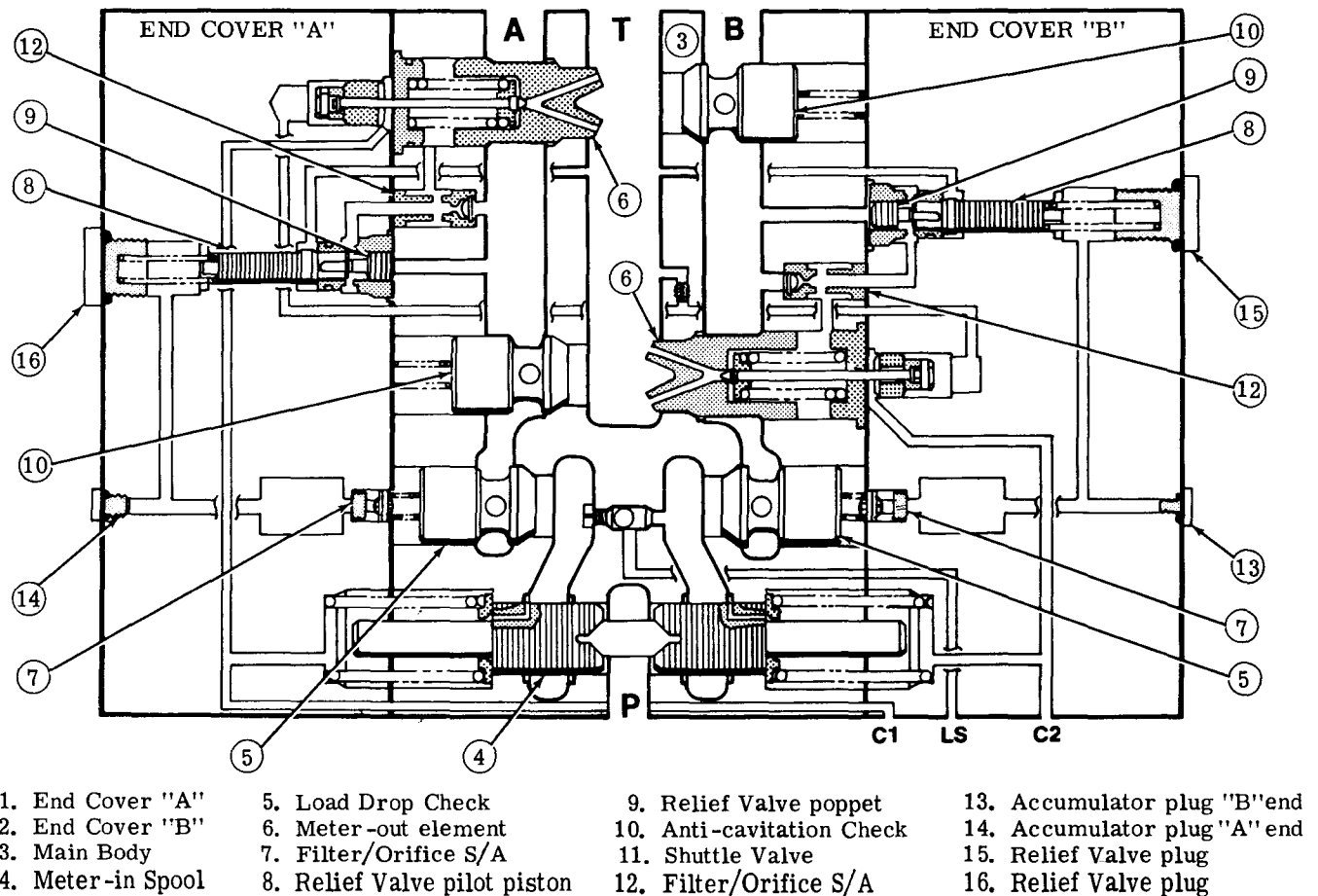


Figure 1. Standard (S) CMX250, 400, & 630 Valve Pictorial Schematic Showing Basic Valve Sections.

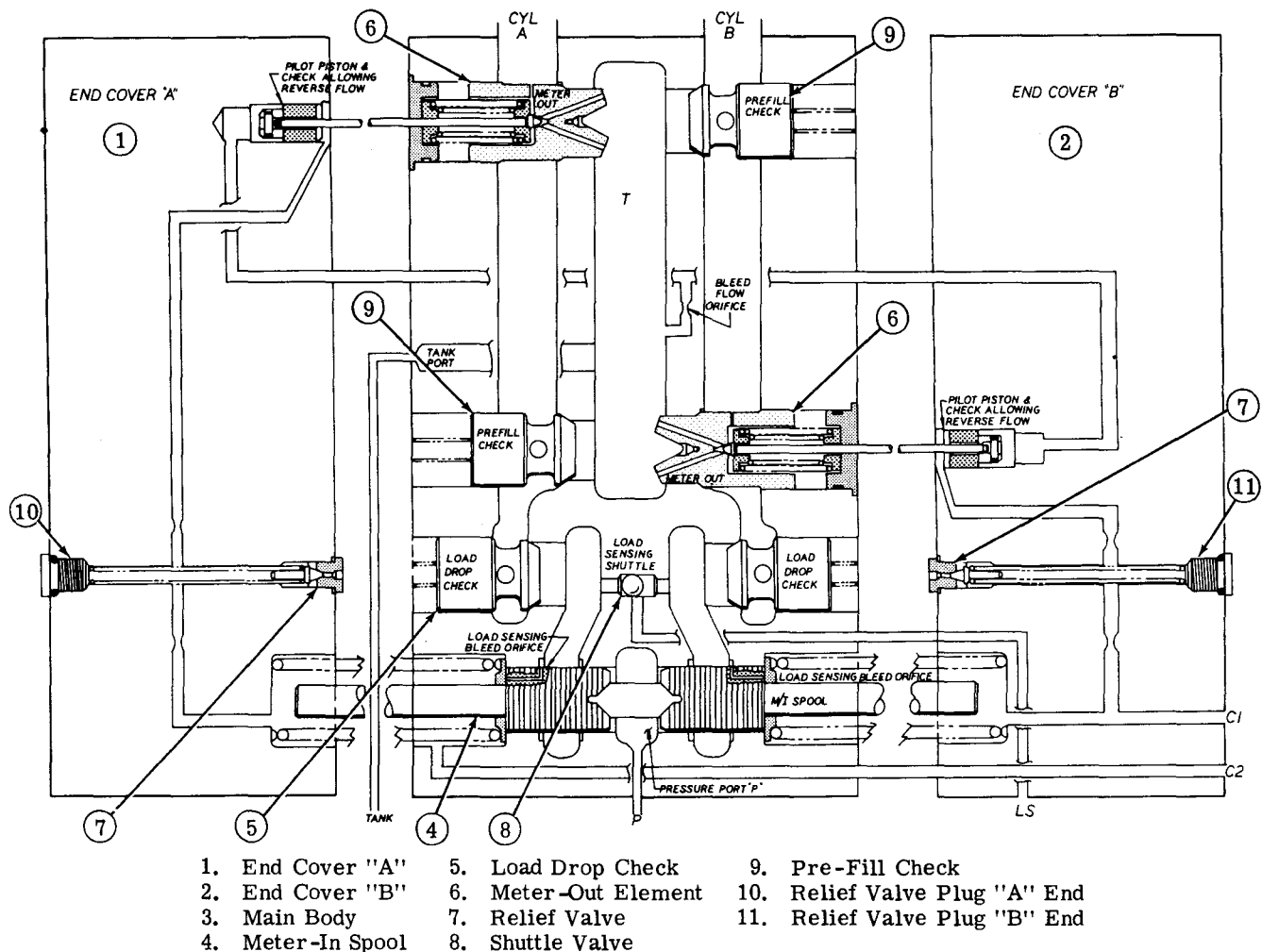


Figure 1a. Standard (S) CMX160 Valve Schematic Showing Basic Sections.

B. MOUNTING

The valve is designed to be actuator or manifold mounted. The only external full flow high pressure line in the system connects the pump outlet to the CMX valve inlet. Return flow from the valve is carried by a low pressure line. A 6000 PSI SAE split flange connection is used at the pressure port. The tank port is a low pressure split flange connection. Two command pilot pressure lines are connected to SAE straight thread ports at the "B" cover end. A smaller SAE straight thread connection port provides load sensing feedback pressure to the pump control. The "A" & "B" actuator ports are located on the mounting surface of the valve. Four screws retain the valve to the actuator manifold. See Figure 2 and 3.

C. VALVE FUNCTION

The CMX valve function is actuated by a hydraulic operated controller (HRC valve). See Figure 4.

Multiple CMX valves can be supplied by connecting their inlets in parallel to pump discharge. Return lines can also be connected through shuttle valves. See Figure 5. This allows the highest feedback signal to be directed to the pump load sensing control.

D. CONTROL TYPE & APPLICATION

This manual discusses the standard (S) control version of the CMX valve series.

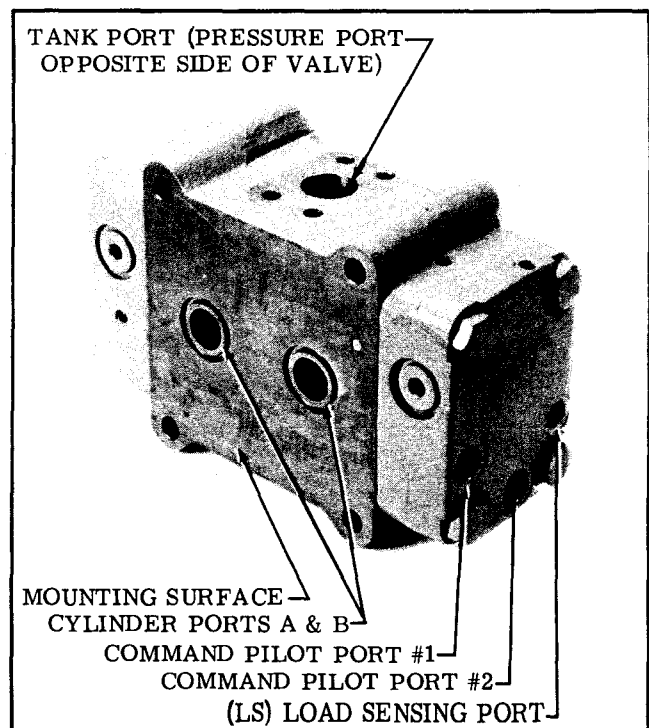


Figure 2. CMX250 Mounting Surface & Port Locations.

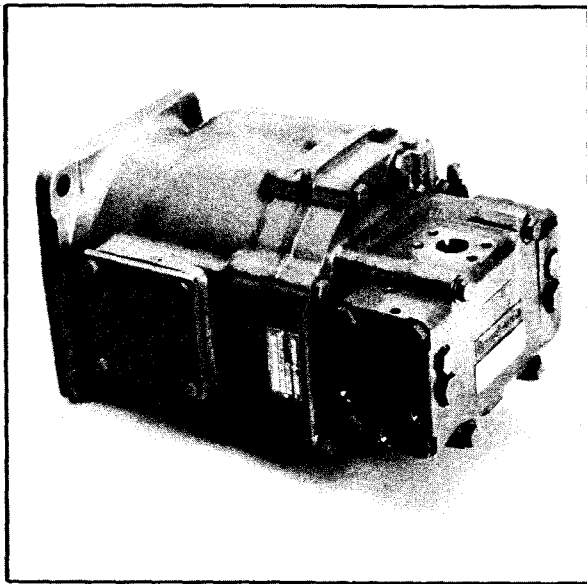


Figure 3. Actuator Mounting to a Motor.

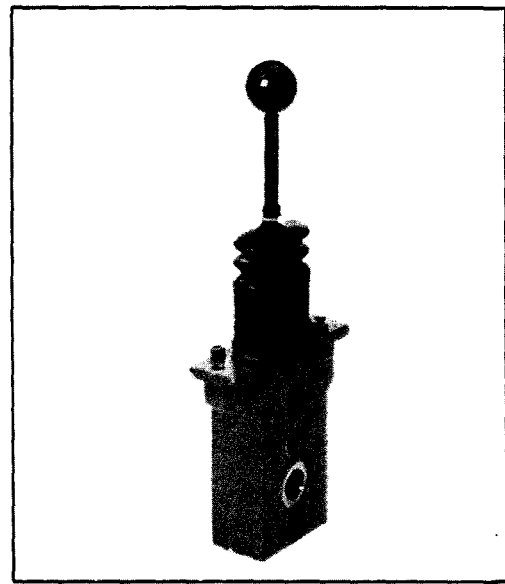


Figure 4. Single Function Hydraulic Remote Control Valve (HRC).

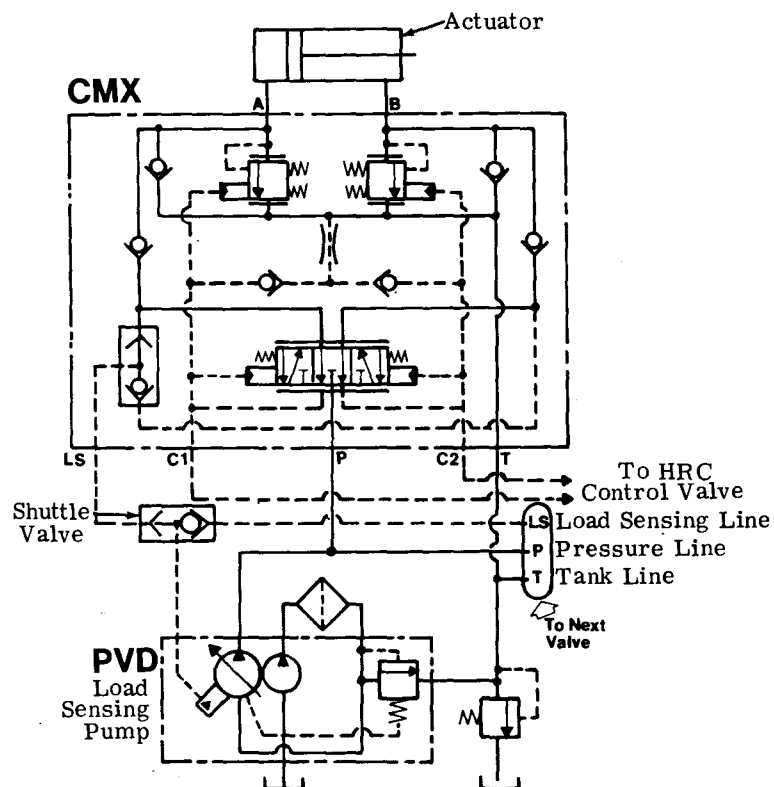


Figure 5. Power Match™ System.

MODEL CODE BREAKDOWN

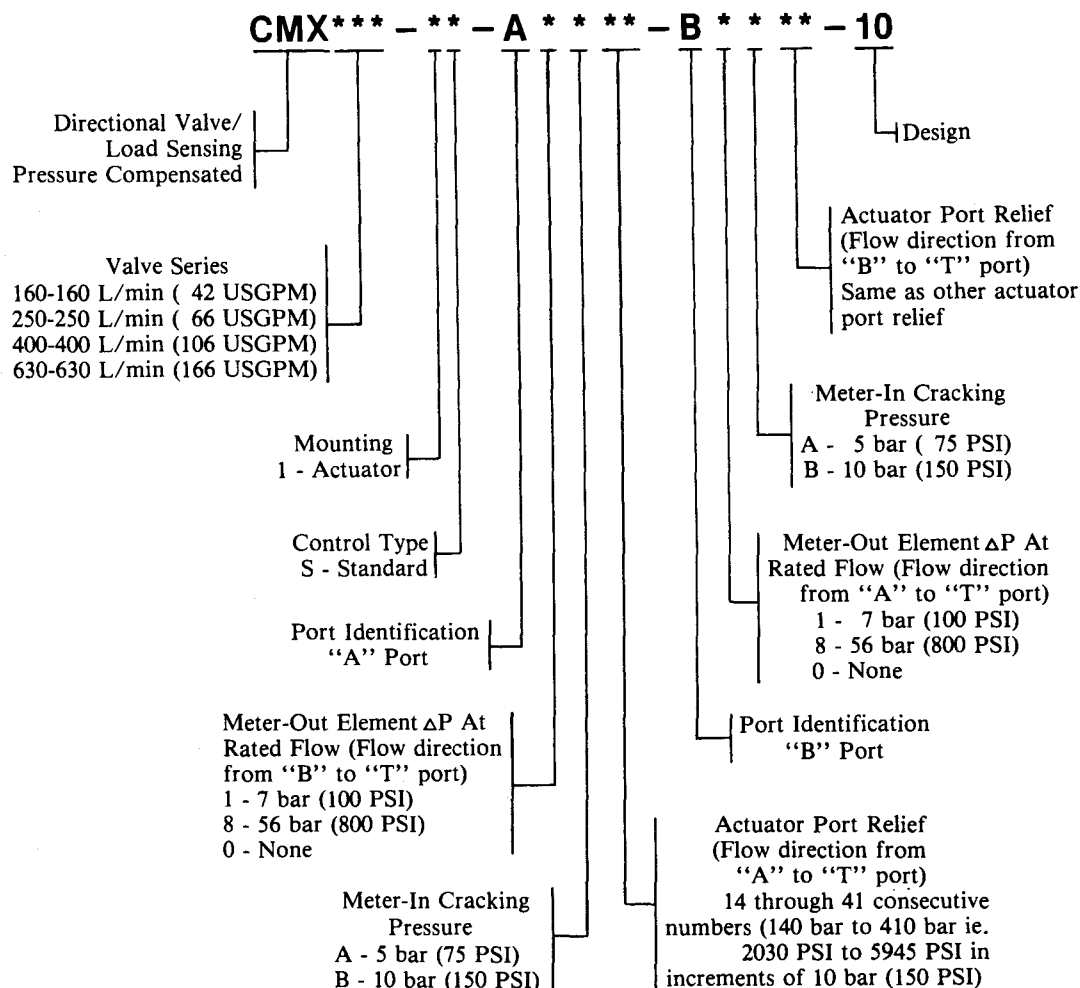


Table 2. Model Code Breakdown

Section III - PRINCIPLES OF OPERATION

A. GENERAL

CMX valve sizes and flow ratings are shown in Table 3. A load sensing system, comprised of the CMX valve in conjunction with a PVD pump and a HRC hydraulic controller has been named POWER MATCH™. In a POWER MATCH™ system, pump outlet power matches that required by the load. The CMX valve was designed to operate with some back pressure present at the tank port. The basic POWER MATCH™ circuit is shown in Figure 5.

MODEL	RATED FLOW		RATED INLET PRESSURE	
	L/min	USGPM	bar	PSI
CMX160	160	42	350	5075
CMX250	250	66		
CMX400	400	106		
CMX630	630	166		

Table 3. CMX Valve Size and Pressure Ratings

B. POWER MATCH™ FEATURE

1. The POWER MATCH™ system in Figure 5 is capable of maintaining precise control for both driven and overrunning loads.
2. It provides relief valve protection against over pressure for all operating modes.
3. In applications where the CMX valve is mounted on an actuating cylinder, check valves prevent the load from dropping if an external line ruptures.

4. Anti-cavitation check valves provide free flow from tank to either the "A" or "B" ports. This is required to prevent cavitation when the meter-in spool is blocked and the meter-out circuit is lowering a load.

C. OPERATION OF VALVE ELEMENTS

METER-IN ELEMENT (Refer to Figure 6 during the following explanation.)

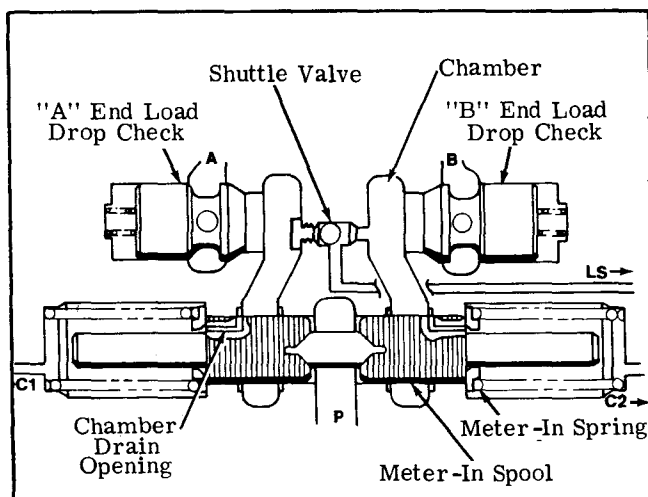


Figure 6. Meter-In Element in Neutral.

The meter-in spool is shown in the center position. Command pressure is applied to either C1 or C2 and directs flow to the desired actuator port. During this explanation, assume command pressure is applied to C1. When command pressure reaches a level that overrides meter-in spring force, the meter-in spool moves to the right. Movement of the spool will close the chamber drain opening through the spool and open pressure to the load drop check and shuttle valve. The shuttle valve ball then shifts to the left, allowing pressure to the load sensing feedback port (LS). Pump outlet pressure (P) will be approximately 14 bar (203 PSI) higher than the load sensing feedback pressure at (LS). By varying pilot command pressure at C1, the meter-in spool will modulate flow to cylinder "B" port and precise metering of flow to the load can be obtained.

In a load sensing system, if command pressure at C1 is reduced, spring force will center the meter-in spool and the load sensing pressure will decay through the chamber drain opening in the spool. This allows pump outlet pressure to reduce to standby pressure.

METER-OUT ELEMENT (Refer to Figure 7 during the following explanation.)

Essentially, the CMX meter-out element is a variable orifice between one of the actuating ports and the reservoir. The meter-out element is used to restrict exhaust flow from an actuator (motor or cylinder). As flow is restricted, the speed of the actuator slows down. The meter-out element functions as a simple bleed servo and is controlled by command pilot pressure at C1. Command pilot pressure causes the piston to move and the stem being connected to the piston automatically follows. This opens the left side of the meter-out poppet to the reservoir. Pressure then lowers in the spring chamber and actuator port pressure causes the poppet to shift to the left, allowing more oil into the reservoir. When command pilot pressure decreases at C1, the piston and stem move under the influence of the spring in the opposite direction. This causes the meter-out poppet to start restricting flow; consequently, less oil is ported into the reservoir. When the meter-out poppet bottoms against its seat in the body, exhaust oil flow ceases to the reservoir and actuator movement stops.

METER-OUT POPPET VARIATIONS

Two different meter-out poppets are available. One is designed with a wide notch while the other has a narrow notch. The wide notched poppet provides a lower differential pressure (7 bar, 100 PSI) between the tank port and the cylinder ports at rated flow. This condition provides better control when lowering a smaller load. The narrow notched poppet provides a higher differential pressure (56 bar, 800 PSI) between the tank port and cylinder ports at rated flow. This condition provides better control when lowering a heavy load.

RELIEF VALVE ELEMENT (Refer to Figure 8 during the following explanation.)

The relief valve element in conjunction with the meter-out element has the dual function of controlling maximum actuator port pressure and limiting pressure overshoots.

The area of the relief valve poppet is slightly larger than the relief valve piston. As actuator port pressure rises, it acts on the area difference and causes the piston and poppet to move against the relief valve spring force. This opens the left side of the meter-out poppet to the reservoir. Consequently, pressure in the meter-out poppet spring chamber drops. Actuator port pressure then causes the meter-out poppet to move left, opening the actuator port to the reservoir. As flow to the reservoir is obtained, the actuator port pressure is relieved.

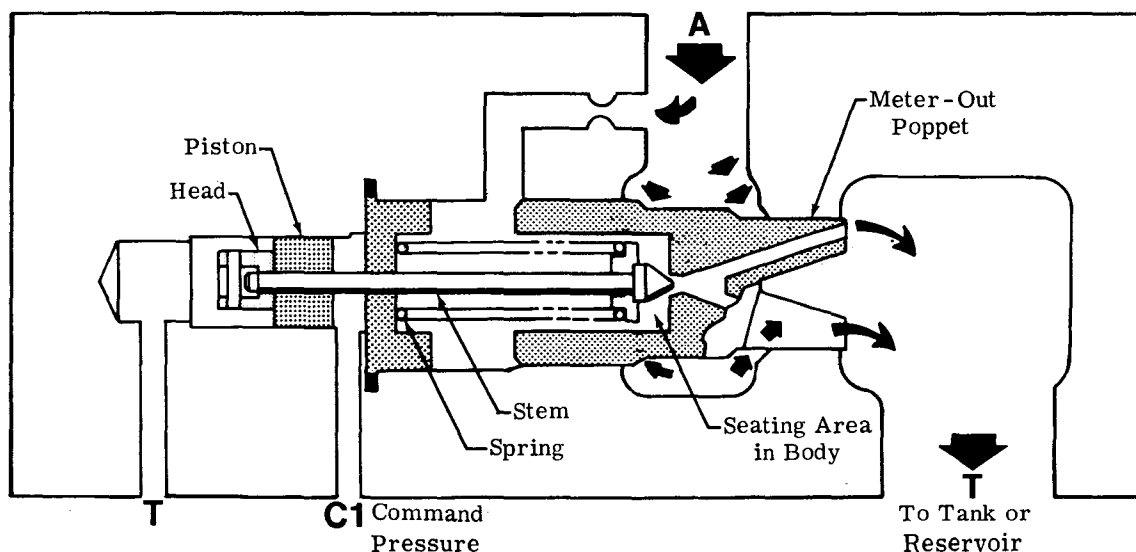


Figure 7. Meter-Out Element.

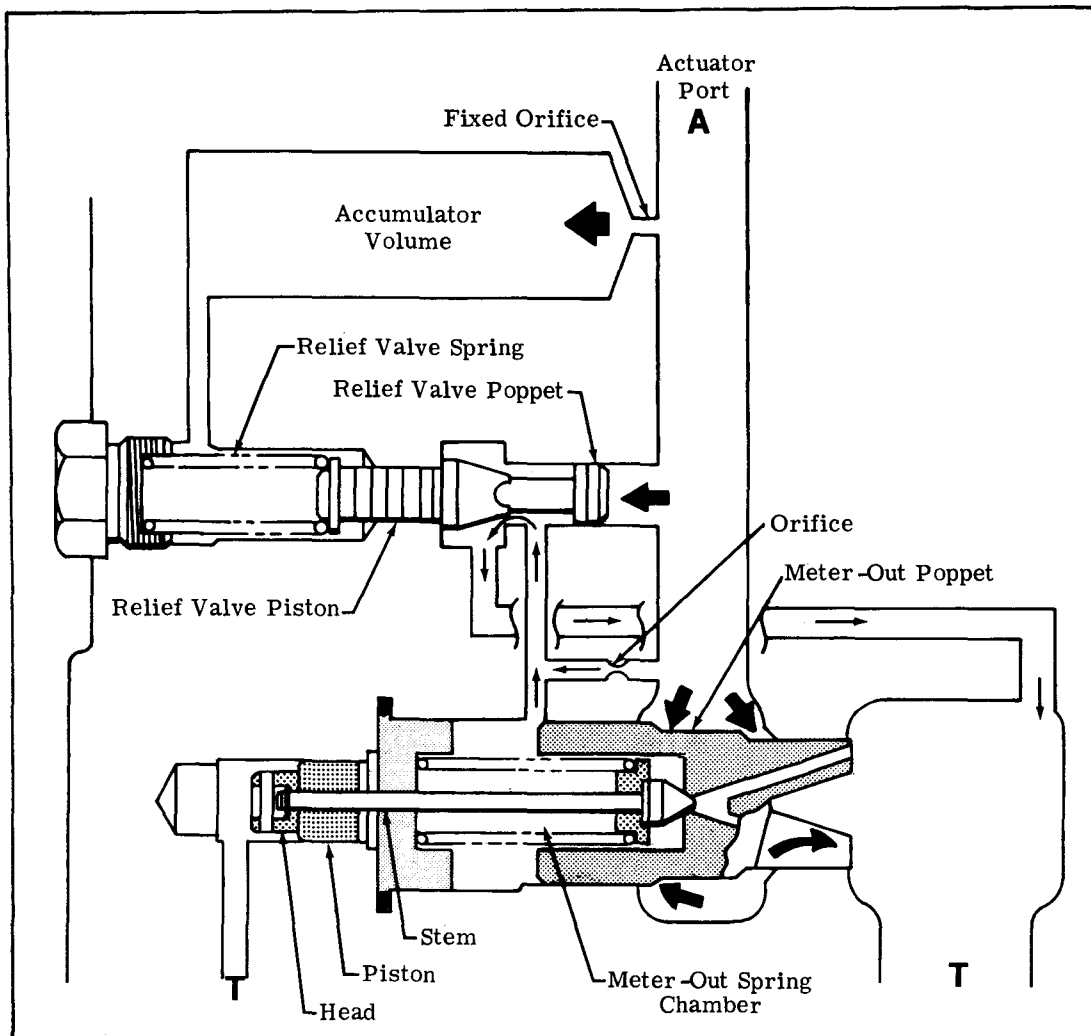


Figure 8. Relief Valve Element (CMX250, 400 & 630 Models).

TRANSIENT (FAST RISE) PRESSURE OPERATION (Refer to Figure 8.)

This feature is available on the CMX250, CMX400 and CMX630 models but does not exist on CMX160 models. When a fast rise in actuator port pressure is felt at the relief valve poppet but not at the relief valve piston, due to the time it takes for the accumulator volume to be pressurized through the fixed orifice, the relief valve poppet moves the relief valve piston against the spring at a lower pressure setting. This opens the left side of the meter-out poppet to the reservoir before it would normally open. The fast rise in pressure is therefore prevented from causing overshoot. Pressure overshoots are not desirable because they can cause fatigue of system components and reduce the life expectancy of the system.

RELIEF VALVE ELEMENT (CMX160) (Refer to Figure 8a during the following explanation.)

The CMX relief valve element controls maximum actuator port pressure but does not limit pressure overshoots as well as the CMX250, 400 and 630 models. Unlike other models, the CMX160 relief valve incorporates a poppet/seat design.

When actuator port pressure overcomes relief valve spring force, the poppet moves off the seat. Actuator port pressure is then released to the meter-out piston area and causes the piston to shift left. Since the servo stem is connected to the piston, the

stem also shifts to the left and opens actuator flow to the reservoir. As flow to the reservoir is obtained, actuator port pressure is relieved.

D. VALVE OPERATION

GENERAL

The CMX valve system has three basic operational features. These features are called meter-in, meter-out and neutral. The meter-in feature is used to drive a load while the meter-out feature is used to lower a load. The neutral feature is used to hold a load in a desired position.

METER-IN/METER-OUT PHASING

When the "A" type meter-in spring is used, the meter-in element will begin to open at a command pilot pressure of 5 bar (75 PSI) and be fully open at 15.5 bar (225 PSI). If a "B" type meter-in spring is used, the meter-in element will begin to open at 10 bar (150 PSI) and be fully open at 21 bar (300 PSI).

Normally the meter-out element will begin to open at a command pilot pressure of 3.5 bar (50 PSI) and be fully open at 14 bar (200 PSI).

The CMX valve meter-in/meter-out pressures can be tailored to meet almost any requirement of the system by changing

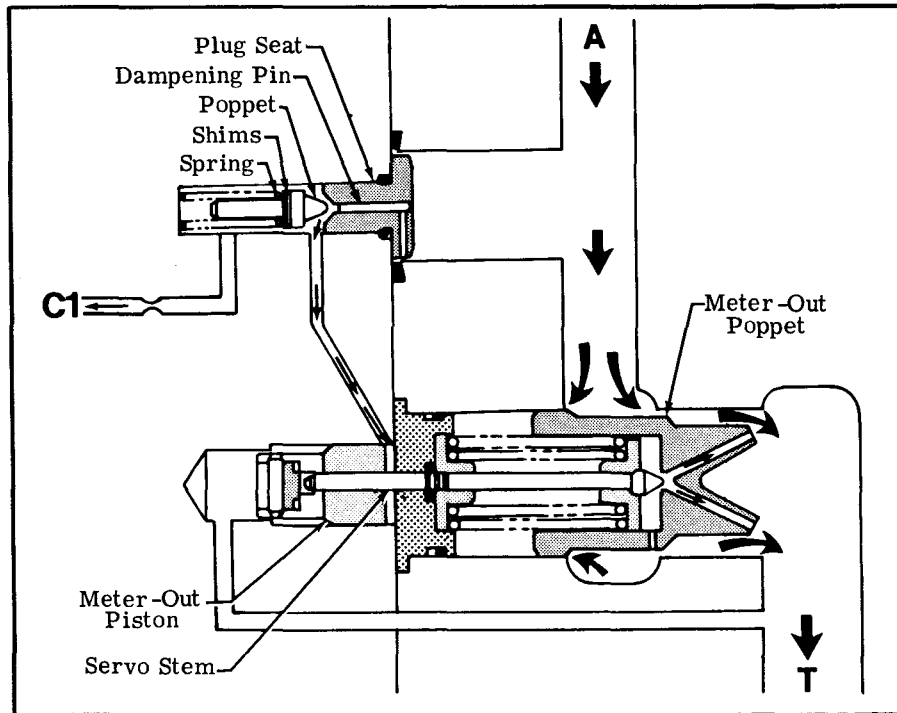


Figure 8a. Relief Valve Element (CMX160).

spring force and meter-out poppet configurations. Consult your Vickers representative for further information concerning the capabilities of this valve sub-system.

DRIVING A LOAD

Figure 9 illustrates meter-in/meter-out operation when driving a load. Pressurized oil from the pump is admitted through the meter-in spool to the load drop check valve. The load drop check opens and oil pressurizes actuator port "B" and the rod end of the cylinder. Oil from the other end of the cylinder is returned to the "A" actuator port and flows to tank (reservoir) through the meter-out element. Velocity of the oil and subsequent movement of the cylinder is controlled by the command pressure at C1.

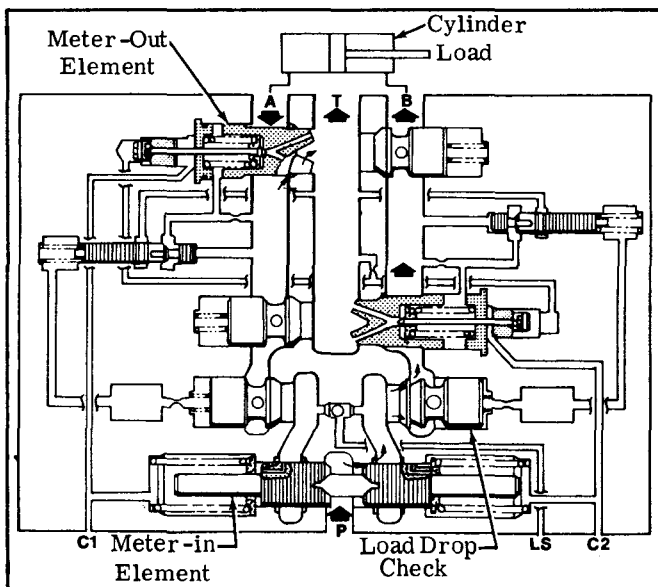


Figure 9. Driving a Load.

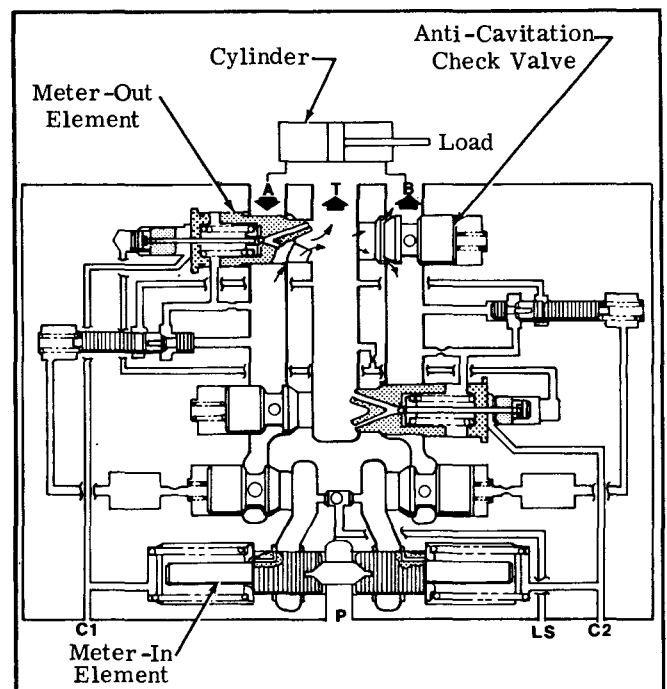


Figure 10. Lowering a Load.

LOWERING A LOAD

Figure 10 represents the condition when sufficient command pilot pressure is applied at C1 to partially open the meter-out element of actuator port "A". Preload springs keep the meter-in spool in the center blocked condition. The load forces the cylinder to the left. The "B" actuator port anti-cavitation check valve opens, allowing the rod side of the cylinder to fill with fluid. Return fluid flows to tank over the meter-out poppet which acts as a back pressure valve. Velocity of the cylinder can be controlled by varying control pressure at C1.

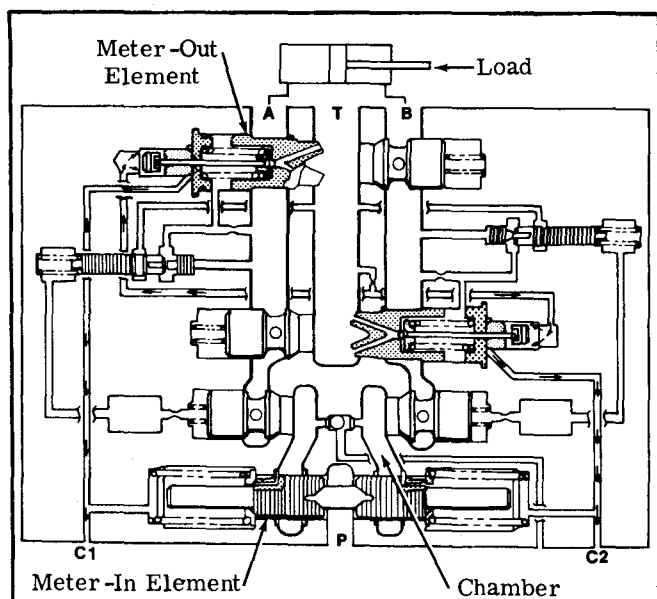


Figure 11. Neutral/Standby

Section IV - INSTALLATION & OPERATING INSTRUCTIONS

A. INSTALLATION DRAWINGS

The installation drawings listed in Table 1 will show installation dimensions and port locations.

B. MOUNTING

The CMX valve is actuator or manifold mounted. A CMX mounted to a MFD motor is shown in Figure 3.

Pressure lines are connected to the PVD pump and hydraulic controller. This CMX/PVD/HRC combination is called POWER MATCH™ system and is shown in Figure 5.

All unit connections are compatible with standard SAE fittings with "O" ring seals. DO NOT over tighten SAE fittings. Fittings should be tightened to a firm metal contact and not over torqued.

C. HYDRAULIC TUBING

1. In a new or contaminated system, all tubing must be thoroughly cleaned before installation to remove dirt, rust and scale. Recommended methods of cleaning are sandblasting, wire brushing, pickling, and power flushing with clean solvent to remove loose particles.

NOTE

For information on pickling, refer to instruction sheet 1221-S.

2. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended minimum radius for bends is three times the inside diameter of the tube. In high pressure systems (5000 PSI and above), use steel elbows instead of bending tubing to increase circuit life and reliability.

NEUTRAL POSITION

Figure 11 illustrates the neutral/standby condition. When the CMX is in the neutral position, and actuator port pressure is below the relief valve setting, a load can be held stationary in one position. To keep the CMX valve in the neutral condition, the command pilot pressure at C1 or C2 must be below 3.5 bar (50 PSI). When command pilot pressure is below 3.5 bar (50 PSI), the meter-in spool is centered and the meter-out element is blocked. Figure 11 shows the valve in center/neutral position.

PUMP STANDBY CONDITION

When the meter-in spool is in center position, the chamber drain opening through the spool allows pressure in the chamber to decay to atmospheric pressure. The pump control senses this pressure and causes the yoke to stroke to zero flow at a pressure of approximately 14 bar (200 PSI). The pump will stay in the neutral (standby) condition until a demand from the hydraulic controller (HRC) is again felt at C1 or C2.

D. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of oil assures satisfactory life and operation of system components with particular emphasis on hydraulic valves. Any oil selected for use with valves is acceptable for use with pumps or motors. Data sheet M-2950-S for oil selection is available from

Vickers Technical Publications, Troy, MI. Oil recommendations noted in the data sheet are based on our experience in industry as a hydraulic component manufacturer. Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Vickers sales representative.

CLEANLINESS

Observe the following precautions to insure the hydraulic system is clean:

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.

2. Filter each change of oil to prevent introduction of contaminants into the system.

3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.

4. Provide continuous protection of system from entry of airborne contamination by sealing the system and/or by proper filtration of the air.

5. During usage, proper oil filling and servicing of filter, breathers, reservoirs, etc. cannot be over emphasized.

6. Proper system and reservoir design will insure that aeration of the oil will be kept to a minimum.

SOUND LEVEL

Noise is only indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels. Some of the major factors affecting the fluid conditions that cause the loudest noises in a hydraulic system are:

1. Very high viscosities at start-up temperatures can cause pump noises due to cavitation.
2. Running with a moderately high viscosity fluid will impede the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir, before recycling through the system.

3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similar to cavitation.

E. OVERLOAD PROTECTION

The actuator port relief function is controlled by the CMX internal relief valves. Refer to section III, C, RELIEF VALVE ELEMENT, for more information. A system relief valve is required to prevent excessive pressure build up if a control malfunctions.

Section V - SERVICE AND MAINTENANCE

A. SERVICE TOOLS

The following standard tools are suggested for proper assembly:

1. Needle nose pliers
2. Ball peen hammer
3. Adjustable wrench (8 inch)
4. Torque wrench (500 lb.ft. maximum)
5. Torque wrench (200 lb.ft. maximum)
6. Standard socket to one (1) inch diameter
7. Ratchet ($\frac{1}{2}$ inch drive)

8. Hex wrenches ($\frac{3}{32}$ ", $\frac{1}{16}$ ", $\frac{1}{8}$ ", & $\frac{3}{8}$ ")
9. Marking pencil
10. Viscosity improver (STP or equivalent)
11. Vise grip pliers
12. Pencil magnet

SPECIAL TOOLS

The following special tools are required to service the CMX valve series:

1. Spring compressor assembly tool (optional). See Figure 12
2. Guide pins (Order two additional end cover screws as noted in parts drawing per Table 1. Cut the heads off and slot screw end for a screwdriver. Guide pins will be used during removal and installation of end covers.)
3. One $\frac{1}{4}$ "-20 screw or stud, approx. 3 inch long (for CMX400 & CMX630 only)
4. One brass or nylon rod ($\frac{1}{4}$ " \times 6")
5. One brass or nylon rod ($\frac{1}{2}$ " \times 8")

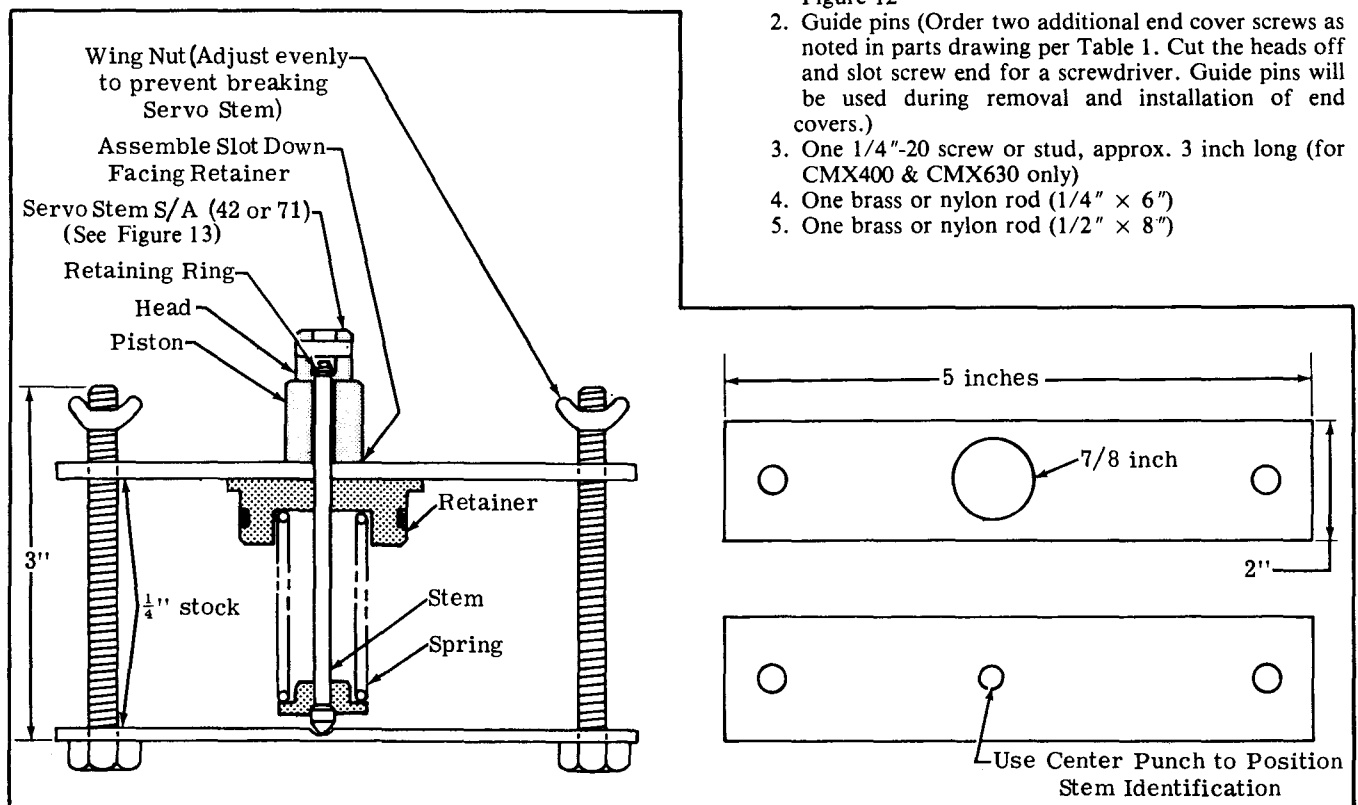


Figure 12. Servo Stem Spring Compression Tool.

B. INSPECTION

Periodic inspection of valve/system operation, oil condition and pressure connections saves time resulting in fewer breakdowns and unnecessary part replacement. Major areas of concern are as follows:

1. All hydraulic connections must be tight. Loose connections not only allow leakage, but also permit air to be drawn into the hydraulic system. Air in the system causes noisy and erratic operation.
2. System filters and reservoir should be checked periodically for foreign particles. If excessive contamination is found, the system should be drained and cleaned. New system filters should be installed into the system.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to a system, it should be pumped through a twenty-five micron absolute filter. If such an oil filter is not available or feasible to use, a wire screen (200 mesh or better) can be substituted. It is important that the fluid

be clean and free from all foreign substances. A dirty system can cause improper operation and excessive wear to hydraulic components.

D. REPLACEMENT PARTS

Reliable operation throughout the specified operating range is assured only if genuine Vickers parts are used. Sophisticated design processes and material are used in the manufacture of our parts. Substitutes may result in early failure. Part numbers are shown in the parts drawings listed in Table 1.

E. TROUBLE-SHOOTING

Table 4 lists the difficulties which may be experienced with the unit and/or hydraulic system. It indicates the cause and possible remedy for each of the troubles listed. It should always be remembered that pressure and flow rate are factors which are usually dependent upon each other. Adequate pressure gauge equipment and a thorough understanding of the operation of the complete hydraulic system is essential to diagnose improper operation.

Operating Condition	Possible Problem Areas
A. Raising Load	
1. No response	a. No command pilot pressure from HRC b. Relief valve piston stuck open c. Meter-out stem jammed d. Meter-in spool stuck e. Meter-out poppet hung open
2. Poor low speed control; jerky start	a. HRC piston binding or stuck b. Binding meter-in spool c. Broken Meter-in spring
3. Top speed too low	a. Insufficient ΔP across meter-in spool b. Binding meter-in spool c. HRC/CMX matching problem d. Insufficient pilot pressure ΔP between C1 & C2 ports
4. Unstable	a. Pump failure b. Binding meter-in spool c. Unstable HRC or pump pressure
B. Lowering Load	
1. No response	a. No command pilot pressure from HRC b. Broken meter-out stem c. Binding meter-out poppet d. Lost or missing retaining ring in meter-out section
2. Poor low speed control; jerky start	a. HRC/CMX matching problem b. Broken meter-out spring c. Binding meter-out piston in servo stem
3. Lowering speed is uncontrollable	a. Broken meter-out stem b. HRC piston binding or stuck in open position c. Meter-out poppet stuck open

Operating Condition	Possible Problem Areas
4. Max. speed too high	a. Due to high pressure resulting from heavy load. Operator control is required. b. Incorrect selection of meter-out poppet (install wide notched poppet).
5. Max. speed too low	a. Jammed meter-out piston or poppet b. HRC/CMX matching problem c. Incorrect selection of meter-out poppet (install narrow notched poppet).
6. Unstable	a. Binding meter-out piston or poppet
7. Harsh stop; severe jolt	a. Binding relief valve balance piston b. Binding meter-out piston or poppet
C. Holding Load	
1. Slow downward drift	a. Load drop check valve not seating properly b. Relief valve has too much leakage
2. Rapid downward drift	a. Load drop check cracked or defective seating area in body b. Relief valve balance piston binding
D. External Leakage	a. Damaged or missing seals b. Cracked body or end cover c. Mating surfaces between body and end covers are not flat d. Burrs on mating surfaces e. Screws not torqued to specifications

Table 4. POWER MATCH™ System Trouble Shooting Chart

Section VI - OVERHAUL

A. GENERAL INFORMATION

CAUTION

Block vehicle if it is on a slope to prevent uncontrolled movement.

CAUTION

Before breaking a circuit connection, make certain that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators, and block any load whose movement could generate pressure.

1. Drain oil from the vehicle hydraulic system. Use new clean oil when restoring the unit to service.

2. Before breaking a circuit connection, hose off or otherwise clean the outside of the unit thoroughly to prevent entry of dirt into the system.

3. Remove the CMX valve from the vehicle. Cap or plug all ports and disconnected hydraulic lines.

CAUTION

Absolute cleanliness is essential when working on a hydraulic system. Always work in a clean area. The presence of dirt and foreign materials in the system can result in serious damage or inadequate operation.

NOTE

Repair of the CMX valve will generally not require disassembly to the extent described here. The sequence can also be used as a guide for partial disassembly. In general, disassembly is accomplished in the item number sequence shown in Figure 13. Special procedures are included in the following steps.

NOTE

Discard and replace all "O" rings and back-up rings that are removed during disassembly.

B. DISASSEMBLY OF RELIEF VALVE PARTS FROM END COVERS

CAUTION

During disassembly, particular attention should be made to identification of parts for assembly. DO NOT mix parts from each end of the body. Make sure all poppets and bores are marked at disassembly. Poppets develop a wear pattern and may leak if placed in a different bore.

NOTE

The following steps (1 through 6) pertain to CMX250, CMX400 and CMX630 models only. Refer to Figure 13.

1. Use a 3/8 inch hex key to remove plug (2) and "O" ring (3) from side of end cover "A" (33).

2. Remove parts (9 through 14) on opposite side of end cover "A" (33). A needle nose pliers may be needed to remove cylinder relief piston (13) and pin (14).

3. Locate a 1/4" x 6" brass or nylon rod (noted in special tool section) and insert it into empty bore that was created in step 2.

4. Tap on rod to remove parts (4 through 8) from end cover "A" (33).

5. Remove plug (15) and "O" ring (16) from end cover "A".

6. Remove parts (17 through 31) from end cover "B" (61) in same manner as described in steps 1 through 5. Keep these parts separate.

NOTE

The following steps (7 and 8) pertain to CMX160 models only. Refer to Figure 13a.

7. Remove plug (a) and "O" ring (b) from end cover "A" (33) as shown in Figure 13a. Then remove spring (c), poppet (d) and shims (e).

8. Repeat step 7 and remove relief valve parts (a through e) from end cover "B" (62). Keep these parts separate from end cover "A" parts.

C. REMOVAL OF END COVERS AND INTERNAL BODY PARTS (Refer to Figure 13)

1. Remove two of the four screws (32) located at end cover "A" (33). Install two guide pins (noted in special tool section) into the screw holes. Loosen the two remaining screws (32) and allow fluid to drain from valve opening. Finish removing end cover "A" (33) from body (84) exposing the internal parts.

NOTE

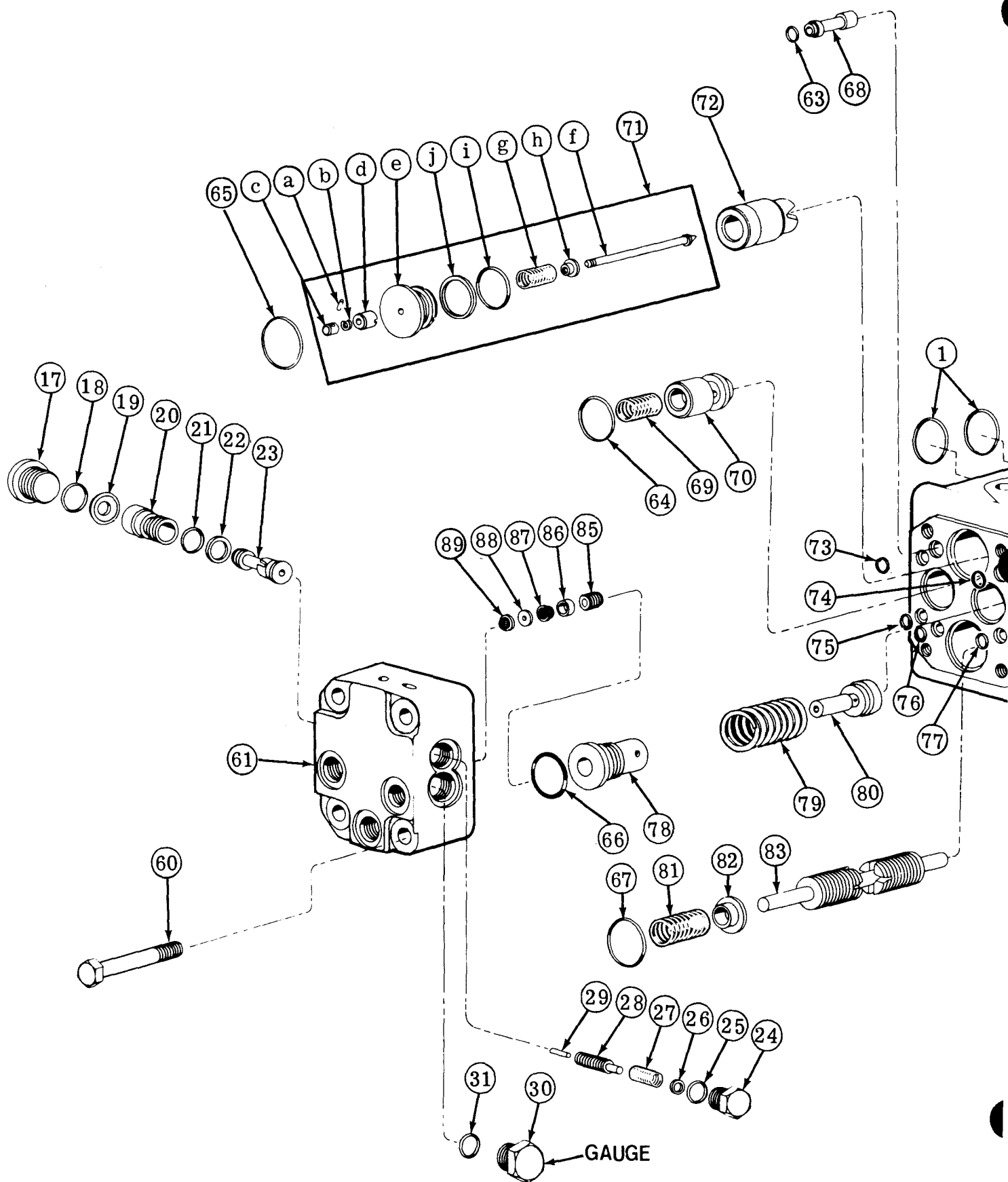
The following step (2) pertains to CMX160 models only. Refer to Figure 13a.

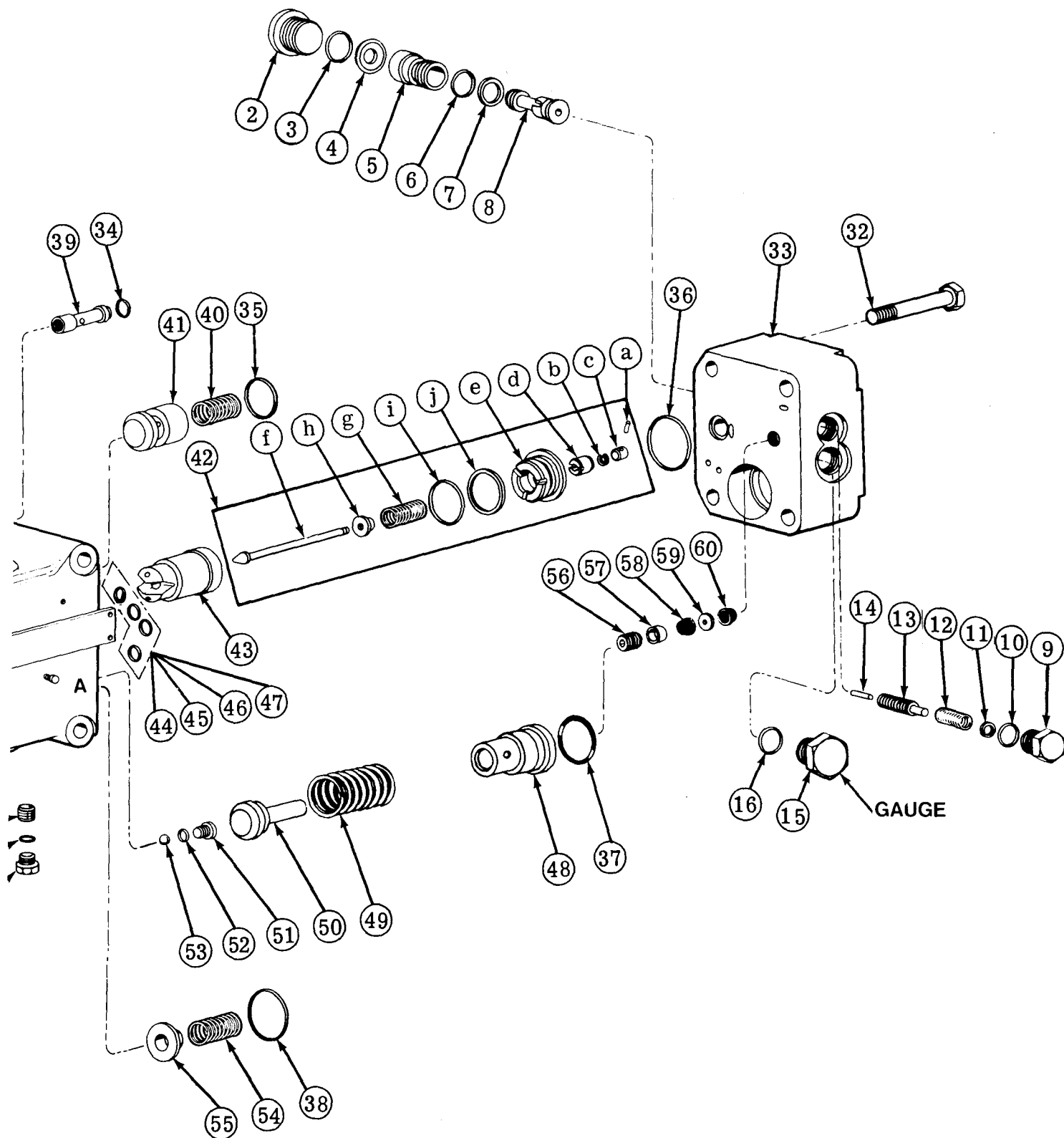
2. Use a 2 millimeter wrench and remove relief valve seat (f) and "O" ring (g) from end cover "A" (33) face. Remove pin (h) from seat (f).

3. Remove and discard "O" rings (34 through 38) and (44 through 47) from body (84) face. (NOTE: "O" rings (34, 44, 45 & 46) do not exist in CMX160 models.)

4. Remove filter/main orifice S/A (39) from body (84). Use a small magnet or hooked tool for removal. (NOTE: Filter/main orifice S/A (39) does not exist on CMX160 models. See Figure 13a.)

5. Remove spring (40) and poppet (41) from body (84). Mark the body bore and poppet to prevent assembly into wrong bore.





Item Number	Description	Source Code	Qty.	Item Number	Description	Source Code	Qty.
	CMX160	A		44	"O" Ring	B,C,D	1
	CMX250	B		45	"O" Ring	B,C,D	1
	CMX400	C		46	"O" Ring	B,C,D	1
	CMX630	D		47	"O" Ring		1
		Usable on code		48	Retainer		1
				49	Spring		1
				50	Poppet		1
				51	Plug		1
				52	"O" Ring		1
1	"O" Ring		1	53	Ball		1
2	Plug	B,C,D	1	54	Spring		1
3	"O" Ring	B,C,D	1	55	Spring Retainer		1
4	Spring Washer	B,C,D	1	56	Hollow Screw	B,C,D	1
5	Sleeve	B,C,D	1	57	Spacer	B,C,D	1
6	"O" Ring	B,C,D	1	58	Filter/Main Orifice	B,C,D	1
7	Back-Up Ring	B,C,D	1	59	Orifice Plate	B,C,D	1
8	Poppet	B,C,D	1	60	Filter/Main Orifice	B,C,D	1
9	Plug	B,C,D	1	61	Screw		4
10	"O" Ring	B,C,D	1	62	End Cover		1
11	Shim	B,C,D	A/R	63 - 67	"O" Ring		1
12	Spring	B,C,D	1	68	Filter/Main Orifice	B,C,D	1
13	Piston	B,C,D	1	69	Spring		1
14	Pin	B,C,D	1	70	Poppet		1
15	Plug	B,C,D	1	71	Servo Stem S/A		1
16	"O" Ring	B,C,D	1	71a	Pin		1
17	Plug	B,C,D	1	71b	Retaining Ring		1
18	"O" Ring	B,C,D	1	71c	Head		1
19	Spring Washer	B,C,D	1	71d	Piston		1
20	Sleeve	B,C,D	1	71e	Retainer		1
21	"O" Ring	B,C,D	1	71f	Stem		1
22	Back-Up Ring	B,C,D	1	71g	Spring		1
23	Poppet	B,C,D	1	71h	Spring Retainer		1
24	Plug	B,C,D	1	71i	"O" Ring		1
25	"O" Ring	B,C,D	1	71j	Back-Up Ring		1
26	Shim	B,C,D	A/R	72	Meter-Out Poppet		1
27	Spring	B,C,D	1	73	"O" Ring		1
28	Piston	B,C,D	1	74	"O" Ring	B,C,D	1
29	Pin	B,C,D	1	75	"O" Ring	B,C,D	1
30	Plug	B,C,D	1	76	"O" Ring		1
31	"O" Ring	B,C,D	1	77	"O" Ring		1
32	Screw		4	78	Retainer		1
33	End Cover		1	79	Spring		1
34	"O" Ring	B,C,D	1	80	Poppet		1
35 38	"O" Ring		1	81	Spring		1
39	Filter/Main Orifice		1	82	Spring Retainer		1
40	Spring		1	83	Meter-In Spool		1
41	Poppet		1	84	Body		1
42	Servo Stem S/A		1	85	Hollow Screw	B,C,D	1
42a	Pin		1	86	Spacer	B,C,D	1
42b	Retaining Ring		1	87	Filter/Main Orifice	B,C,D	1
42c	Head		1	88	Orifice Plate	B,C,D	1
42d	Piston		1	89	Filter/Main Orifice	B,C,D	1
42e	Retainer		1	90	Plug		1
42f	Stem		1	91	"O" Ring		1
42g	Spring		1	92	Orifice Plug		1
42h	Spring Retainer		1				
42i	"O" Ring		1				
42j	Back-Up Ring		1				
43	Meter-Out Poppet		1				

NOTE

Where "Usable on Code" is blank, the part is used on all units tabulated. When codes are shown, use with indicated units.

Figure 13. Part Nomenclature

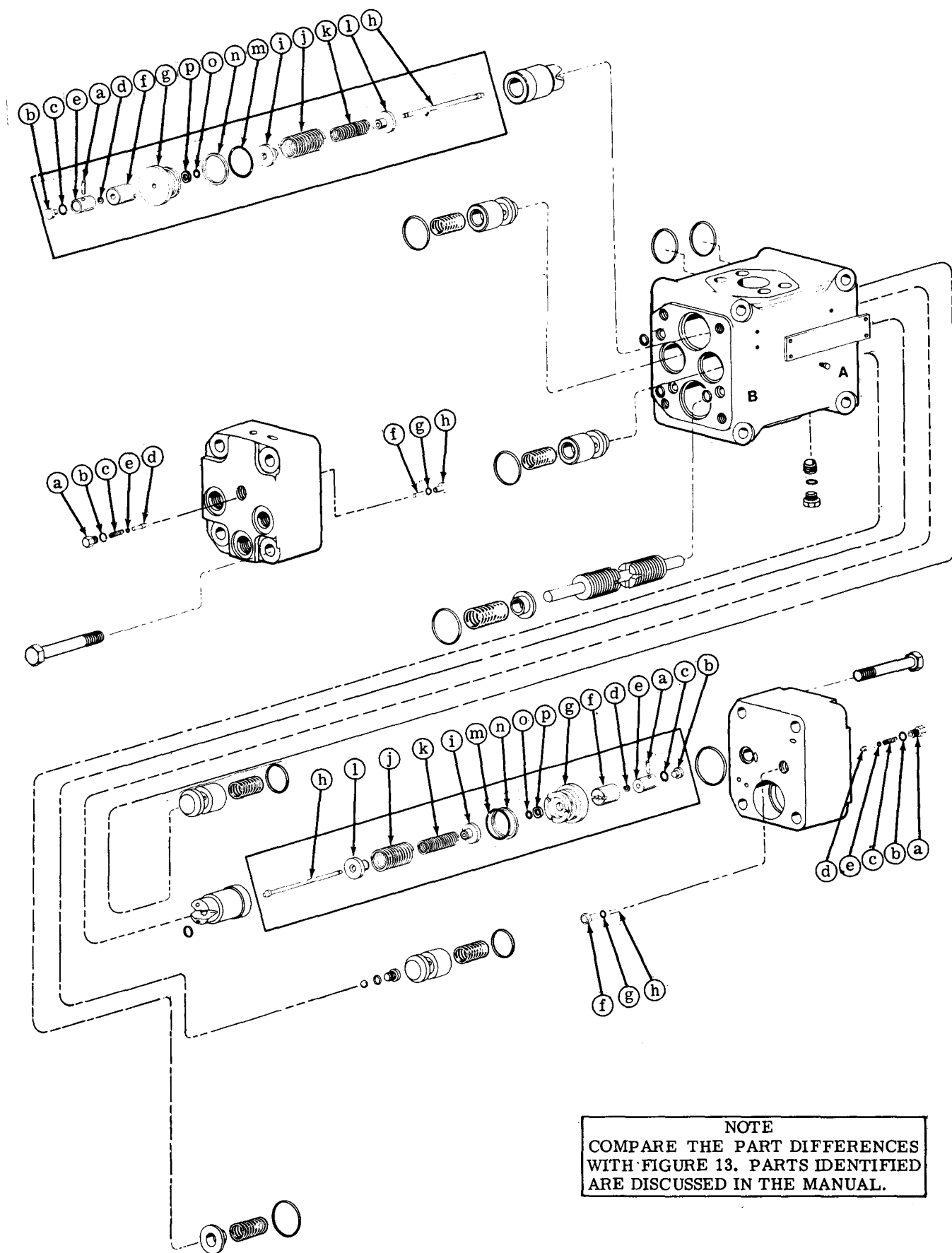


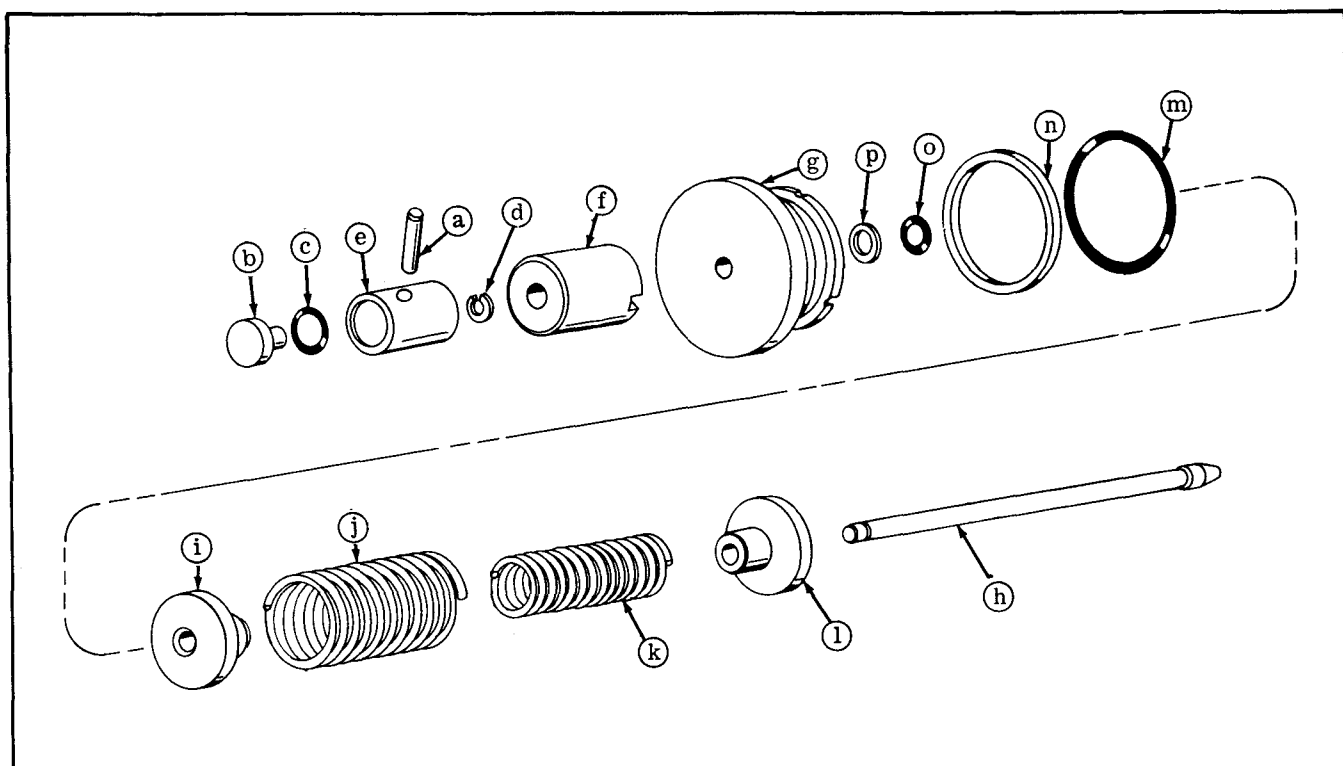
Figure 13a. Exploded View, CMX160 Model.

Index Letter Number	Description	Qty.	Index Letter Number	Description	Qty.
42	Servo Stem S/A	1	71f	Piston	1
42a	Pin	1	71g	Retainer	1
42b	Plug	1	71h	Stem	1
42c	"O" Ring	1	71i	Spring Retainer	1
42d	Retaining Ring	1	71j	Spring (Outer)	1
42e	Head	1	71k	Spring (Inner)	1
42f	Piston	1	71l	Spring Retainer	1
42g	Retainer	1	71m	"O" Ring	1
42h	Stem	1	71n	Back-Up Ring	1
42i	Spring Retainer	1	71o	"O" Ring	1
42j	Spring (Outer)	1	71p	Sealing Ring	1
42k	Spring (Inner)	1			
42l	Spring Retainer	1		Relief Valve Parts	
42m	"O" Ring	1			
42n	Back-Up Ring	1	a	Plug	2
42o	"O" Ring	1	b	"O" Ring	2
42p	Sealing Ring	1	c	Spring	2
71	Servo Stem S/A	1	d	Poppet	2
71a	Pin	1	e	Shims	A/R
71b	Plug	1	f	Seat	2
71c	"O" Ring	1	g	"O" Ring	2
71d	Retaining Ring	1	h	Pin	2
71e	Head	1			

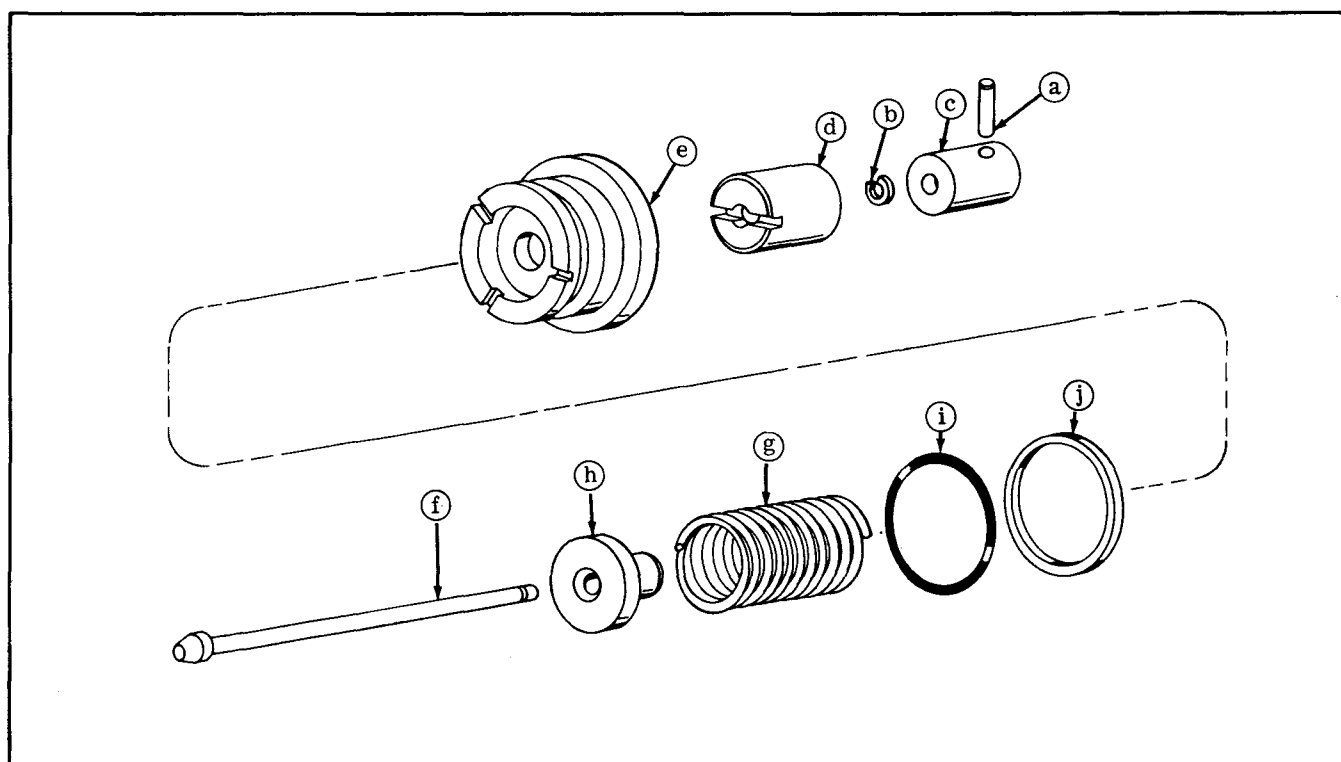
Figure 13a. Part Tabulation (CMX160)

CMX160	CMX250, 400, 630
1. Place head (e) in V-block and remove pin (a).	1. Place head (c) in V-block and remove pin (a).
2. Place servo stem S/A on spring compression tool as shown in Figure 12. Tighten wing nuts evenly to compress springs (j and k).	2. Place servo stem S/A on spring compression tool as shown in Figure 12. Tighten wing nuts evenly to compress spring (g).
3. Take a plastic hammer and tap on bottom of tool to dislodge plug (b) from head (e).	3. Remove retaining ring (b) from stem (f).
4. Remove plug (b) and "O" ring (c) from head (e).	4. Remove head (c) and piston (d) from stem (f).
5. Remove retaining ring (d) from stem (h).	5. Loosen wing nuts and remove remaining parts from tool.
6. Remove head (e) and piston (f) from stem (h).	6. Remove retainer (e), spring (g) and spring retainer (h) from stem (f).
7. Loosen wing nuts and remove remaining parts from tool.	7. Remove "O" ring (i) and back-up ring (j) from retainer (e).
8. Remove retainer (g), spring retainer (i), outer spring (j), inner spring (k) and spring retainer (l) from stem (h).	
9. Remove "O" ring (m), back-up ring (n), "O" ring (o) and sealing ring (p) from retainer (g).	
	NOTE Assemble servo stem S/A in reverse order of disassembly.

Figure 13b. Servo Stem S/A (42 or 71) Disassembly Instructions



CMX160



CMX250, 400 & 630

Figure 13b. Stem Servo S/A (42 or 71).

NOTE

The following step (6) pertains to CMX160 and CMX250 models only. Refer to Figure 13.

6. Remove spring (49) and poppet (50) from body (84). Mark the poppet and body bore. (NOTE: Poppet (50) will look like poppet (41). Retainer (48) does not exist in CMX160 and CMX250 models.)

NOTE

The following step (7) pertains to CMX400 and CMX630 models only. Refer to Figure 13.

7. Thread a 1/4"-20 screw (noted in special tool section) through retainer (48) and into poppet (50). Grip the screw end with pliers and remove poppet (50), spring (49) and retainer (48) from body (84). Mark the poppet and body bore.

8. Remove plug (51), "O" ring (52) and shuttle ball (53) located below poppet (50). A pencil magnet may be helpful for removing the ball.

9. Remove meter-out spring (54) and spring retainer (55) from meter-in spool (83).

NOTE

The following step (10) pertains to CMX250, CMX400 and CMX630 models only. Refer to Figure 13.

10. Remove filter assembly from end cover "A" (33) as follows:

a. Use a 1/16 inch hex key and remove hollow screw (56).

b. Remove parts (57 through 60). A pencil magnet may be helpful. Be careful not to damage filter screens (58 and 60).

NOTE

Set aside all parts that were removed from "A" end of valve and keep them separate from "B" end parts during inspection.

11. Remove two of the four screws (61) from end cover "B" (62). Install two guide pins into the screw holes. Loosen the remaining two screws (61) and allow fluid to drain from valve opening. Remove end cover "B" from body (84) exposing internal parts.

NOTE

The following step (12) pertains to CMX160 models only. Refer to Figure 13a.

12. Use a 2 millimeter wrench and remove seat (f) and "O" ring (g) from end cover "B" (62) face. Remove pin (h) from seat (f).

13. Remove and discard "O" rings (63 through 67) and (72 through 76) from body face. (NOTE: "O" rings (63, 74 & 75) do not exist in CMX160 models.)

14. Remove filter/main orifice S/A (68) from body. Use a small magnet or hooked tool for removal. (NOTE: Filter/main orifice S/A (68) does not exist in CMX160 models. See Figure 13.)

15. Remove spring (69) and poppet (70) from body bore. Mark the poppet and body bore.

16. Disassemble servo stem S/A (71) and (42) from body (84) by performing the following steps:

a. Insert a 1/2" x 8" brass or nylon rod (noted in special tool section) into empty bore ("A" end of body) opposite servo stem S/A (71).

b. Press the rod against meter-out poppet (72) to compress spring (71g). At the same time, tap meter-out poppet (72) and servo stem S/A (71) from body bore ("B" end of body).

c. Insert the rod into empty bore ("B" end of body) opposite servo stem S/A (42). Remove servo stem S/A (42) and meter-out poppet (43) in same manner as described in step (b).

d. Remove and discard "O" rings (71i & 42i) and back-up rings (71j & 42j) from retainers (71e & 42e).

NOTE

If inspection reveals servo stem S/A (71 or 42) requires disassembly, refer to Figure 13b for instructions.

NOTE

The following step (17) pertains to CMX400 and CMX630 models only. Refer to Figure 13.

17. Thread a 1/4"-20 screw through retainer (78) and into poppet (80). Grip the screw end with pliers and pull poppet (80), spring (79) and retainer (78) from "B" end of body. Mark the poppet and body bore.

NOTE

The following step (18) pertains to CMX160 and CMX250 models only. Refer to Figure 13.

18. Remove spring (79) and poppet (80) from "B" end of body. (NOTE: Poppet (80) will look like poppet (70). Retainer (78) does not exist.) Mark the poppet and body bore.

19. Remove meter-in spring (81) and spring retainer (82) from meter-in spool (83). Then remove meter-in spool (83) from body.

NOTE

The following steps (20, 21 & 22) pertain to CMX250, CMX400 and CMX630 models only. Refer to Figure 13.

20. Remove the filter assembly from end cover "B" as follows.

a. With a 1/16 inch hex key, remove hollow screw (85).

b. Remove parts (86 through 89). Be careful not to damage filter screens (87 and 89).

21. Remove plug and "O" ring (90 and 91) from body. Discard the "O" ring.

22. DO NOT remove orifice plug (92) from body unless inspection reveals it necessary. If required, remove orifice plug with a 3/32 inch hex key.

D. INSPECTION, REPAIR, AND REPLACEMENT

NOTE

All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of parts makes this requirement very important. Clean all removed parts using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning, but it must be filtered to remove water and contamination. Clean compressed air is particularly useful in cleaning end covers, valve body passages and orifices.

NOTE

Replace all parts that do not meet the following specifications.

1. Inspect all parts for wear, erosion and/or seizure.
2. Inspect all springs for parallelism. Spring ends must be parallel within 3°. Replace springs if worn or deformed.
3. Inspect all poppets for heavy wear patterns on the outside diameter of the poppet. Also, check poppet for the proper seating pattern. If the seating pattern is broken, check the main body bore and seat for erosion. If body is eroded beyond repair, replace the valve. Poppets must move freely within their respective bores and have a close fit. If scratches are evident on the outside of the poppet, clean up with crocus cloth or 500 grit paper. If scratches are deep enough to cause heavy leakage, replace the poppet. Check the bore for identical scratches. Make sure scratches are not greater than 0.001 inches deep. If a poppet is replaced within the body, it must be seated to prevent excessive leakage. To seat a poppet, install the poppet in the bore and then insert a brass rod within the poppet and tap with a small hammer. The poppet will develop a ring around its contact point with the seat. This ring indicates a good sealing match between the poppet and seat. If the ring is not complete, recheck the seating area of the bore for distortion or erosion. Each poppet must seat properly within the bore for the valve to function with minimum leakage.
4. Check the meter-in spool for burrs and/or scratches. Clean up with an India stone. Do not stone sharp edges of the spool. Make sure the spool moves freely within the bore after clean up.
5. Inspect filter screens for torn or broken out places in the screen. Replace if defective.
6. If inspection reveals the servo stem S/A requires disassembly, refer to Figure 13b disassembly instructions. During valve assembly, the servo piston must move freely within the end cover. Make sure the stem is not bent and the point of contact of the stem within the meter-out poppet is clean and free from burrs.
7. Check all plugs and screws for broken threads and rounded corners. Replace parts that are defective.

E. ASSEMBLY

1. Obtain a seal kit for the unit being assembled. Refer to parts drawing for seal kit information. See Table 1.

NOTE

Cover the assembly area with clean Kraft paper to prevent contamination of parts. Lubricate parts at assembly with system fluid. Use a viscosity improver, STP or equivalent for lubrication of seals. Assembly will be in reverse part number sequence as noted in Figure 13. Special procedures are included in the following steps.

NOTE

The following steps (2 through 5) pertain to CMX250, CMX400 and CMX630 models only. Refer to Figure 13.

2. Install orifice plug (92) into body (84) if previously removed.
3. Install "O" ring (91) on plug (90). Thread the plug into body (84) and torque to 12.1-12.4 N.m (107-110 lb.in.).
4. Assemble parts (89 through 86) into end cover "B" (62). Orient the filter screens as shown in Figure 13.
5. Thread hollow screw (85) into end cover "B" and secure.
6. Assemble meter-in spool (83) into body bore at "B" end of body (84).
7. Assemble spring retainer (82) and spring (81) over the end of meter-in spool (83).

NOTE

The following step (8) pertains to CMX400 and CMX630 models only.

8. Insert poppet (80) on spring (79) and then insert into retainer (78). Lubricate and install complete poppet assembly into "B" end of body (84). Use the end cover and screws to seat poppet assembly within the body bore. Tighten the end cover evenly during this operation. Remove cover and screws.

NOTE

The following step (9) pertains to CMX160 and CMX250 models only.

9. Install poppet (80) into body bore and then install spring (79) into the poppet. (NOTE: Retainer (78) does not exist in CMX160 or CMX250 models.)
10. Install meter-out poppet (72) into its correct bore on the "B" side of body (84).
11. If servo stem S/A (71) was completely disassembled, assemble it in reverse order of Figure 13b instructions. Install back-up ring (71j) and "O" ring (71i) on retainer (71e). See Figure 13 for correct seal position. Lubricate and insert complete servo stem S/A (71) into the meter-out bore.

CAUTION

DO NOT FORCE servo stem S/A (71) into body bore. The retainer (71e) MUST be assembled straight into the bore to prevent stem damage. The servo stem S/A will be seated in place during end cover installation as described in step 18.

12. Install poppet (70) and spring (69) into correct bore on "B" side of body.

13. Install filter/main orifice S/A (68) into "B" side of body. Filter screen of S/A will be pointed into body. (NOTE: Part (68) does not exist in CMX160 models.)

14. Install "O" rings (77 through 73 and 67 through 63) on "B" end body face. (NOTE: "O" rings (63, 74 & 75) do not exist in CMX160 models.)

NOTE

The following steps (15 and 16) pertain to CMX160 models only. Refer to Figure 13a.

15. Assemble relief valve parts (e through a) into end cover "B" as shown. Torque plug (a) to 20-22 N.m (177-193 lb.in.).

16. Lubricate seat (f) threads. Assemble "O" ring (g) on seat (f). Coat pin (h) with petroleum jelly. Insert pin (h) into seat (f). Thread seat (f) into end cover "B" face. Torque seat (f) to 11.7-12.7 N.m (104-112 lb.in.).

17. Install two guide pins into "B" end of body and secure.

18. Install the "B" end cover (62) over the guide pins. Slide the end cover towards the body slowly. Be careful when contact is made with the servo stem piston (71d). Make sure the piston is aligned with the end cover bore. Move the cover up against the body. Install the two remaining screws (61) and thread them hand tight. Remove the two guide pins and install the other two screws. Torque the cover screws evenly to values shown in Table 5.

MODEL	Torque Plug to:	
	N.m	lb. ft.
CMX250	75-83	55-61
CMX400		
CMX630	113-124	83-91

Table 5. End Cover Retaining Screw Torque

NOTE

The following steps (19, 20 & 21) pertain to CMX250, CMX400 and CMX630 models only. Refer to Figure 13.

19. Install "O" ring (31) on plug (30) and thread plug into end cover "B". Torque plug (30) to values shown in Table 6.

MODEL	Torque Cover Screws to:	
	N.m	lb.ft.
CMX160	85-103	62-76
CMX250	225-275	166-203
CMX400		
CMX630	490-590	360-440

Table 6. End Cover Plug Torque

20. Insert pin (29) into piston (28). Slide the piston into end cover "B" (62). Place spring (27) over piston (28) and install shims (26). Assemble "O" ring (25) on plug (24). Thread plug (24) into end cover "B" (62). Torque plug (24) to 54-59 N.m (39-43 lb.ft.).

21. Install "O" ring (21) and back-up ring (22) on sleeve (20). Insert poppet (23) into sleeve (20) and then install sleeve into end cover "B" (62). Orient and install washer (19) on

sleeve (20) as shown in Figure 13. Assemble "O" ring (18) on plug (17). Thread the plug into end cover "B". Torque plug (17) to 75-83 N.m (55-61 lb.ft.).

NOTE

The following steps (22 and 23) pertain to CMX250, CMX400 and CMX630 models only. Refer to figure 13.

22. Assemble parts (60 through 57) into end cover "A" (33). Orient the filter screens as shown in Figure 13.

23. Thread hollow screw (56) into end cover "A" (33) and secure.

24. Assemble spring retainer (55) and spring (54) on end of meter-in spool (83).

25. Install shuttle valve ball (53). Assemble "O" ring (52) on plug (51) and thread in place. Torque plug (51) to 9.5-10.5 N.m (84-92 lb.in.).

NOTE

The following step (26) pertains to CMX400 and CMX630 models only. Refer to Figure 13.

26. Insert poppet (50) into spring (49) and then insert the poppet (50) into retainer (48). Install the complete poppet assembly into correct bore on "A" side of body.

NOTE

The following step (27) pertains to CMX160 and CMX250 models only.

27. Install poppet (50) into body bore and then install spring (49) into the poppet. (NOTE: Poppet (50) will look like poppet (41). Retainer (48) does not exist in CMX160 and CMX250 models.)

28. If required, assemble servo S/A (42) in reverse order of Figure 13b instructions. Install back-up ring (42j) on retainer (42e). Then install "O" ring (42i) next to the back-up ring. See Figure 13 for correct seal position. Lubricate and install the complete servo stem S/A (42) into the meter-out bore.

CAUTION

DO NOT FORCE servo stem S/A (42) into bore. The retainer (42e) MUST be assembled straight into the body bore to prevent stem damage. The servo stem S/A will be pressed into place during end cover installation as described in step 35.

29. Install poppet (41) and spring (40) into correct bore on "A" side of body.

30. Install filter/main orifice S/A (39) into "A" side of body. Filter screen end will point into body. (NOTE: Filter/main orifice S/A (39) does not exist in CMX160 models.)

31. Install "O" rings (47 through 44 and 38 through 34) on "A" side body face. (NOTE: "O" rings (34, 44, 45 & 46) do not exist on CMX160 models.)

NOTE

The following steps (32 and 33) pertain to CMX160 models only. Refer to Figure 13a.

32. Assemble relief valve parts (e through a) into end cover "A" (33) as shown. Torque plug (a) to 20-22 N.m (177-193 lb.in.).

33. Lubricate seat (f) threads. Assemble "O" ring (g) on seat (f). Coat pin (h) with petroleum jelly. Insert pin (h) into seat (f). Thread seat (f) into end cover "A" face. Torque seat (f) to 11.7-12.7 N.m (104-112 lb.in.).

34. Install guide pins into "A" side of body and secure.

35. Install end cover "A" (33) over the guide pins. Slide the end cover towards the body slowly. Be careful when contact is made with the servo stem piston (42d). Make sure the piston is aligned with the end cover bore. Move the cover up against the body. Install the two remaining screws (32) and thread them hand tight. Remove the two guide pins and install the other two screws. Torque the end cover screws (32) evenly to the values shown in Table 5.

NOTE

The following steps (36, 37 and 38) pertain to CMX250, CMX400 and CMX630 models only. Refer to Figure 13.

36. Install "O" ring (16) on plug (15). Thread plug (15) into end cover "A" (33). Torque plug (15) to values shown in Table 6.

37. Insert pin (14) into piston (13). Install piston (13) into end cover "A". Place spring (12) over piston (13) and then install shims (11). Assemble "O" ring (10) on plug (9). Thread plug (9) into end cover "A". Torque plug (9) to 54-59 N.m (39-43 lb.ft.).

38. Install "O" ring (6) and back-up ring (7) on sleeve (5). Insert poppet (8) into sleeve (5). Install sleeve (5) into end cover "A". Orient and install washer (4) against sleeve (5) as shown in Figure 13. Install "O" ring (3) on plug (2) and thread plug into end cover "A". Torque plug (2) to 75-83 N.m (55-61 lb.ft.).

39. Install "O" rings (1) on CMX mounting surface at cylinder "A" and "B" port.

Section VII - TEST PROCEDURE

A. GENERAL

A test of the CMX valve will be performed utilizing the test circuit shown in Figure 14. Meter-in and meter-out elements of the CMX valve will be checked and the cylinder port relief valves adjusted. This test circuit DOES NOT check the CMX valves maximum flow or maximum pressure capabilities.

If test facilities do not exist, a general operational test of the CMX valve can be performed on the vehicle. The "On Vehicle" test assumes a basic POWER MATCH™ system is used.

B. TEST STAND

1. If facilities are available, build the test circuit shown in Figure 14. Use the parts shown on the test circuit for assembly.

2. Attach the CMX valve to the test stand and torque the bolts to the values shown in Table 7.

3. Connect the CMX pressure and tank ports, the C1 and C2 control ports, and the load sensing port (LS) to the test stand.

4. Start up the test stand and allow the stand to warm up. Operate directional valves to eliminate air from the system.

5. Perform the "A" and "B" port leakage tests (steps a and b on Table 8). Set test stand valves as indicated in Table 8 and measure leakage with a beaker. CMX inlet pressure should be either 80% of relief valve setting or 2500 PSI maximum. To check CMX leakage, use SAE 10W oil at an operating temperature of approximately 120°F. If leakage is excessive, refer to Table 9.

6. Determine pressure at which the meter-out poppet opens and closes. Check both the "A" and "B" port poppets. Perform steps (c through f) as shown in Table 8.

7. Check leakage of meter-in spool at "C1 and C2" ports. Use a beaker. Perform step (g) as shown in Table 8. If leakage is excessive, refer to Table 9.

8. Check meter-in spool and shuttle valve ball shifting. Perform step (h) in Table 8.

9. Check decompression at load sensing port (LS) at lowered pilot pressure. Perform steps (i through l) as shown in Table 8.

MODEL	BOLT TYPE	TORQUE TO
CMX160	M-12×100mm long / Class 8.8 (min)	94±9 N.m (71±7 lb.ft.)
	1/2-13×4.0 inch / Grade 5 (min)	109±11 N.m (80±8 lb.ft.)
CMX250	M-12×130mm long / Class 8.8 (min)	94±9 N.m (71±7 lb.ft.)
	1/2-13×5.0 inch / Grade 5 (min)	109±11 N.m (80±8 lb.ft.)
CMX400	M-16×150mm long / Class 8.8 (min)	233±23 N.m (175±17 lb.ft.)
	5/8-11×6.0 inch / Grade 5 (min)	217±22 N.m (160±16 lb.ft.)
CMX630	M-20×170mm long / Class 8.8 (min)	456±45 N.m (336±33 lb.ft.)
	3/4-16×6.5 inch / Grade 5 (min)	385±38 N.m (284±28 lb.ft.)

Table 7. CMX Valve Attaching Bolt Types and Torques

TEST BEING PERFORMED Refer to Figures 1 & 14	EXPECTED RESULTS	GLOBE VALVE #1	DIRECTIONAL VALVES		PRESSURE GAUGES PSIG (TP = TEST PRESSURE)			
			1	2	1	2	3	4
a. "A" port leakage test. Measure leakage flow at C1, C2, and CMX tank port.	Total leakage must be less than 50cc/min.	Closed	Center	P-A B-T	TP	Zero	325	Varies with leakage
b. "B" port leakage test. Measure leakage flow at C1, C2, and CMX tank port.	Total leakage must be less than 50cc/min.	Closed	Center	P-B A-T	Zero	TP	325	Varies with leakage
c. The control pressure at which the "A" port meter-out poppet opens. Adjust pressure reducing valve.	When meter-out poppet opens, "A" port pressure will lower and flow from the tank port will be observed.	Closed	P-A B-T	P-A B-T	TP ↓ Low press.	Zero	Low press. ↓ 325	Varies with leakage
d. The control pressure at which the "A" port meter-out poppet closes. Adjust pressure reducing valve.	When meter-out poppet closes, "A" port pressure will rise and flow from tank will stop.	Closed	P-A B-T	P-A B-T	Low ↓ TP	Zero	325 ↓ low press.	Varies with leakage
e. The control pressure at which the "B" port meter-out poppet opens. Adjust pressure reducing valve.	When meter-out poppet opens, "B" port pressure will lower and flow from the tank port will be observed.	Closed	P-B A-T	P-B A-T	Zero	TP ↓ low press.	Low press. ↓ 325	Varies with leakage
f. The control pressure at which the "B" port meter-out poppet closes. Adjust pressure reducing valve.	When meter-out poppet closes, "B" port pressure will rise and flow from tank port will stop.	Closed	P-B A-T	P-B A-T	Zero	Low press. ↓ TP	325 ↓ low press.	Varies with leakage
g. Check meter-in spool leakage. Measure leakage flow at the C1 & C2 ports.	Combined leakage flow to be less than 1200cc/min.	Open	Center	Center	Zero	Zero	325	Less than 200 PSIG
h. Check meter-in spool and shuttle valve shifting.	Pressure will be maximum at the "A" cylinder port.	Open	P-B A-T	Center	TP	Zero	325	TP
	Pressure will be maximum at the "B" cylinder port.	Open	P-A B-T	Center	Zero	TP	325	TP
<p style="text-align: center;">NOTE The following steps are performed to check decompression of the LS port at lowered pilot pressure settings.</p>								
i. Lower pilot pressure to 170 PSIG (95 PSIG for lighter "A" meter-in spring).	Load sensing (LS) pressure same as test pressure (TP).	Open	P-B A-T	Center	TP	Zero	170 or 95	TP
j. Lower pilot pressure to 130 PSIG (55 PSIG for lighter "A" meter-in spring).	Load sensing (LS) pressure must decay well below TP.	Open	P-B A-T	Center	TP	Zero	130 or 55	Low pressure
k. Set pilot pressure to 170 PSIG (95 PSIG for lighter "B" meter-in spring).	Load sensing (LS) pressure same as test pressure (TP).	Open	P-A B-T	Center	Zero	TP	170 or 95	TP
l. Lower pilot pressure to 130 PSIG (55 PSIG for lighter "B" meter-in spring).	Load sensing (LS) pressure must decay well below TP.	Open	P-A B-T	Center	Zero	TP	130 or 55	Low pressure
m. Adjustment of cylinder port relief valves at 10 USGPM flow. Observe flow at tank port of CMX valve when set pressure is reached.	The "A" port cylinder relief valve must be set at pressure noted in the model code or at 2500 PSIG, whichever is applicable.	Closed	Center	P-A B-T	Rel. valve set press.	Zero	325	Zero
n. Same as above.	The "B" port cylinder relief valve must be set at pressure noted in the model code or at 2500 PSIG, whichever is applicable.	Closed	Center	P-B A-T	Zero	Rel. valve set press.	325	Zero

Table 8. Test Stand CMX Valve Tests

10. Refer to the unit model code in Table 2 and determine "A" and "B" port pressure settings. If the "A" and "B" port pressure settings as noted in the model code are below 2500 PSIG, removal of relief valve shims will not be required. If the port pressure settings are above 2500 PSIG, shims must be removed from each port relief to reduce the setting to 2500 PSIG for test. Determine the shim thickness that must be removed as follows:

$$\text{Model code pressure in PSIG} - 2500 \text{ PSIG} = \text{Pressure Difference}$$

$$\frac{\text{Pressure Difference}}{20 \text{ PSIG}} \times 0.001 \text{ inch} = \text{Shim thickness to be removed from the relief valve.}$$

11. Set compensator pressure and system relief valve test pressure (TP) to 3000 PSIG. See Figure 14.

12. Perform relief valve test steps (m and n) of Table 8. Relief valve set pressure as noted in Table 8 should be 2500 PSIG if shims were removed from the valve. If the pressure is not 2500 PSIG, adjust shims to obtain this test pressure. (Estimate 20 PSIG per 0.001 inch shim.) If the port pressure as noted in the model code is below 2500 PSIG and reads out accurately on the gauges, do not disturb the relief valve settings.

NOTE

Refer to Figure 1 during the following explanation of leakage paths.

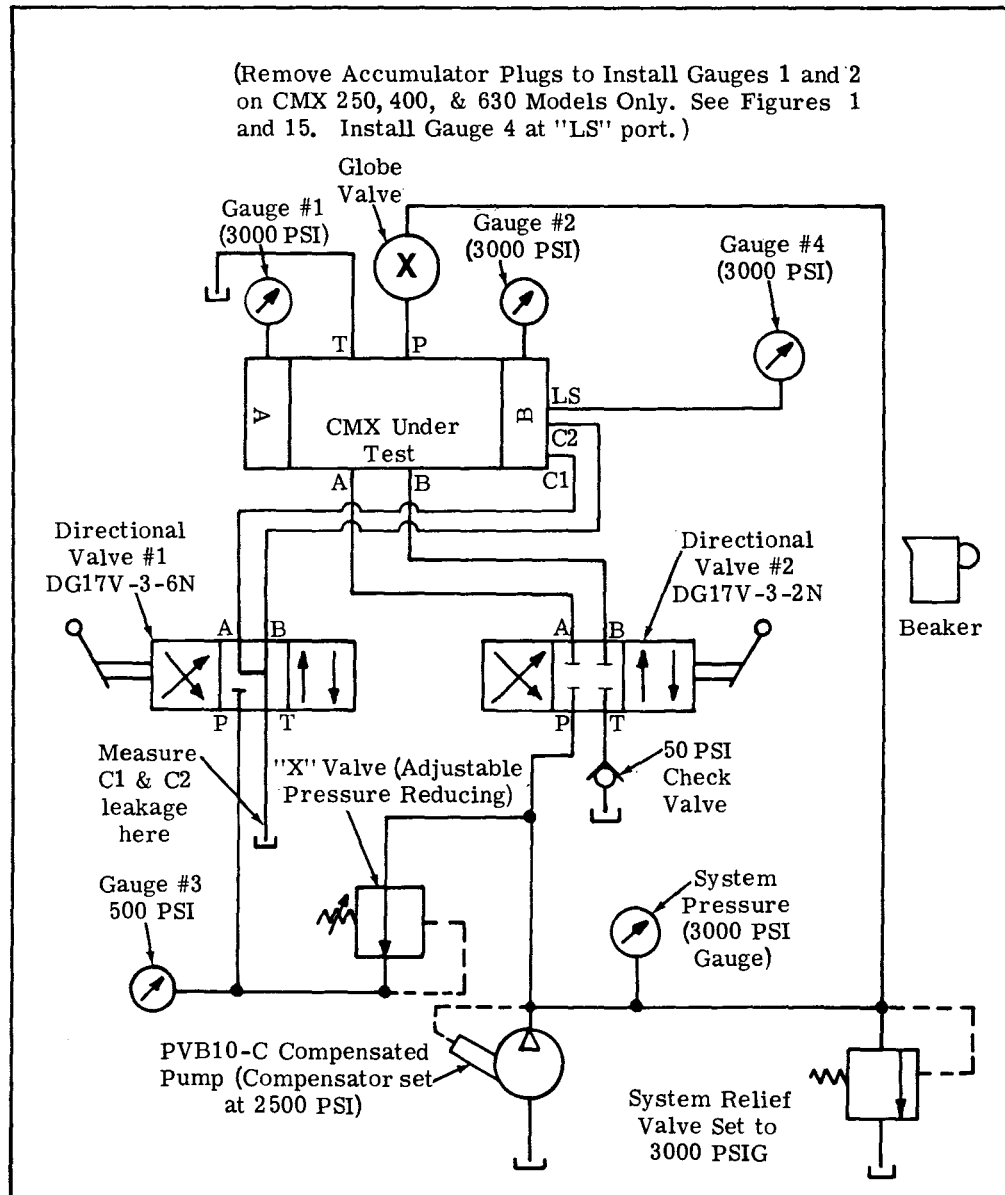


Figure 14. Low Pressure Operational Test Circuit (CMX Valve).

Possible leakage paths from "A" port to tank.	<ol style="list-style-type: none"> 1. Leakage across seat of meter-out poppet (6). 2. Leakage through stem seat of meter-out poppet. 3. Leakage across relief valve poppet (9) to tank. 4. Leakage across seat of anti-cavitation check (10).
Possible leakage paths from "A" port to control connections C1 & C2. ("P" and "LS" ports are blocked.)	<ol style="list-style-type: none"> 1. Leakage past stem of servo stem S/A through the retainer to C1 & C2. 2. Leakage past seat of the load drop check (5) through the spool bleed opening to C1 & C2. <p>NOTE: Total leakage to tank shall not exceed 50 cc/min. Leakage from C1 & C2 shall not exceed 1200 cc/min.</p>

Table 9. Possible leakage paths for the "A" cylinder port. Similar paths exist for the "B" cylinder port.

13. After the relief valve tests are completed and the relief valve verified to be operational, shim the high pressure reliefs to the correct pressures as follows: Calculate the pressure difference between the 2500 PSIG and the actual pressure setting as noted in the model code. Add the correct shim stack at 0.001 inch/20 PSIG to each actuator port relief valve. Final check of the relief pressures can be obtained on the vehicle.

C. ON VEHICLE TEST

CAUTION

Block vehicle wheels to prevent uncontrolled movement. Before opening the circuit, make certain that power is off and pressure has been released. Lower all vertical cylinders, discharge accumulators and block any load whose movement could generate pressure.

1. Remove indicated hex plugs from end covers and install pressure gauge fittings. See Figure 15 for CMX250, CMX400 and CMX630 only. Install a 6000 PSIG pressure gauge into each fitting. CMX160 valves require gauge installation at the "A" and "B" actuator ports.

2. Refer to the unit model code in Table 2 and determine "A" and "B" port relief pressure settings.

3. Place all controls in the neutral or standby condition and start up the vehicle using the standard start up procedures.

4. Exercise the controls to eliminate air from the system. Warm up the system fluid to approximately 120°F. Return the controls to neutral or standby condition.

5. If the CMX valve controls vehicle movement, block the wheels of the vehicle. If the CMX valve controls cylinder movement, fully extend the cylinders. Move the appropriate control to build up pressure. Observe the pressure gauges.

NOTE

Pressure should be as noted in the model code. If pressure readings meet model code specifications, proceed to step 6 and omit step 7. If pressure readings vary greatly from these requirements, a problem exists. The shim stack could be wrong or the relief valve may be hanging up. If this is the case, proceed to step 7 and omit step 6.

6. After all tests are completed and the unit found to function normally, turn off power and release all pressure within the system. Remove pressure gauges and fittings. Replace the hex plugs and torque to values noted in Table 6.

7. Turn off power and release all pressure within the system. Remove port relief valve plugs noted in Figure 15. Modify the shim stack to provide correct pressure setting. (NOTE: 0.001 shim thickness equals approximately 20 PSIG.) Install port relief valve plugs and torque to value shown in Table 6. Repeat steps 3 through 6. If pressure readings still do not meet model code requirements, refer to the POWER MATCH™ troubleshooting data (Table 4) for further checks of the system.

NOTE

The following step (8) pertains to CMX160 models only. Refer to Figure 13a.

8. Perform steps (1 through 6) as described above. If it is necessary to modify the shim stack, remove plug (a), spring (c) and poppet (d) from end cover "A" and/or "B". Modify the shim stack to obtain correct relief valve pressure settings per the model code. Install the shims on poppet (d). Replace spring (c) and plug (a). Torque plug (a) to 20-22 N.m (177-193 lb.in.).

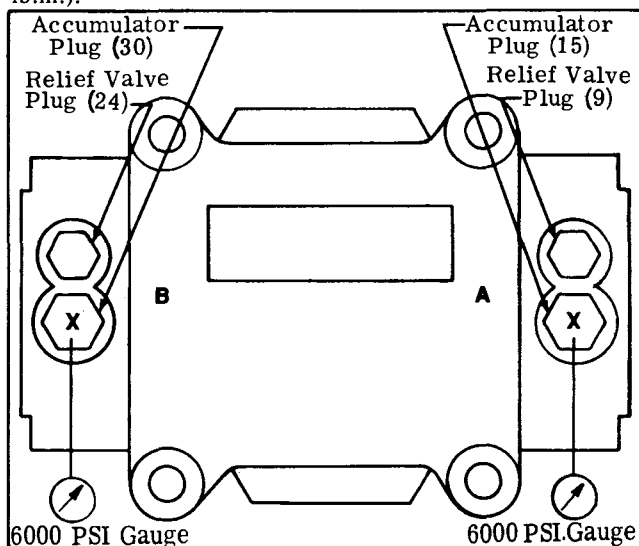


Figure 15. Pressure Gauge Connections & Relief Valve Plugs (CMX250, 400 & 630 only).



A TRIMJOVA Company

Vickers, Incorporated
5445 Corporate Drive
P.O. Box 302
Troy, Michigan 48007-0302
Phone: 313-641-4500
Fax: 313-641-4948