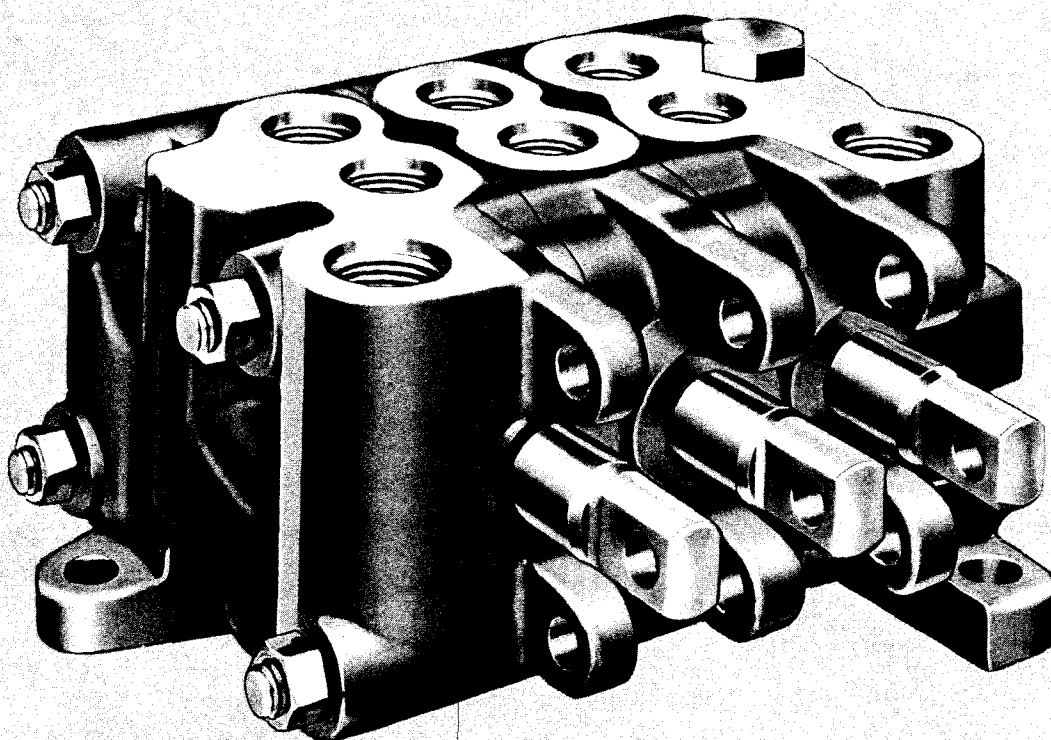


Multiple Unit Valves

CM11 Series -21 Design



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SECTION I - INTRODUCTION

A. PURPOSE OF MANUAL

Service information in this manual covers the principles of operation, installation, maintenance and repair of Vickers CM11 Series, -21 design Multiple Unit Valves.

B. GENERAL INFORMATION

Service parts information for these valves is contained in Parts Catalog M-1729-S. Oil recommendation information is shown on data sheet M-2950-S.

dimensions are on installation drawing 303. Copies are available on request from your local Vickers application engineering office or from: Vickers, Incorporated 1401 Crooks Road, Troy, Michigan 48408

Table I is a complete breakdown of the model code covering these units. Service inquiries should always include the complete model numbers which are stamped on the valve bodies.

TABLE I - MODEL CODE BREAKDOWN

CM 11 ZS 1 -R 25 V** ** *			L - 21 ***		
MULTIPLE UNIT CONTROL VALVE			SPECIAL FEATURE		
SERIES			DESIGN		
VALVE BANK MODIFICATION			OUTLET BODY TYPE		
NO - NO MODIFICATION			L - STANDARD		
ND - STANDARD SECTIONS - DUST COVERS			E - CARRYOVER PORT		
NS - STANDARD SECTIONS - ELECTRIC SWITCH ACTUATORS			E1 - E SECTION WITH ADDITIONAL OUTLET PORT		
ZO - NARROW BYPASS SECTIONS NO MODIFICATIONS			SPOOL MODIFICATION (OMIT IF NOT REQUIRED)		
ZD - NARROW BYPASS SECTIONS DUST COVERS			1 - DETENT FOR ANY SPOOL		
ZS - NARROW BYPASS SECTIONS ELECTRIC SWITCH ACTUATORS			2 - LIGHT CENTERING SPRING		
PORT CONNECTIONS			7 - HALF LOAD CENTERING SPRING		
1 - 7/8-14 UNF - 2B INLET AND DISCHARGE PORTS - 3/4-16 UNF - 2B CYLINDER PORTS			SPOOL TYPE		
2 - 1 1/16-12 UNF - 2B INLET & DISCHARGE PORTS - 7/8-14 UNF - 2B CYLINDER PORTS			A6 - COUNTERBALANCE		
INLET BODY TYPE			B - MOTOR		
F - CARRYOVER PORT - NO RELIEF VALVE			C - FLOAT		
R - STANDARD - RELIEF VALVE (PARTIAL FLOW BYPASS)			D - DOUBLE ACTING		
K - STANDARD - RELIEF VALVE (FULL FLOW BYPASS)			D3 - DUAL FUNCTION		
J - STANDARD - RELIEF VALVE (PARTIAL FLOW BYPASS)			D4 - SPECIAL METERING		
SYSTEM RELIEF VALVE SETTING - PSI			D5 - COMBINED & B SPOOL FUNCTIONS		
05 - 500 PSI 12 - 1250 PSI 20 - 2000 PSI			T - SINGLE ACTING		
07 - 750 PSI 15 - 1500 PSI 22 - 2250 PSI			W3 - SAFETY INTERLOCK		
10 - 1000 PSI 17 - 1750 PSI 25 - 2500 PSI			ADJUSTABLE SYSTEM RELIEF VALVE SETTING - PSI (OMIT IF NOT REQUIRED)		
			V05 - 500 PSI V12 - 1250 PSI V20 - 2000 PSI		
			V07 - 750 PSI V15 - 1500 PSI V22 - 2250 PSI		
			V10 - 1000 PSI V17 - 1750 PSI V25 - 2500 PSI		

SECTION II - DESCRIPTION

A. GENERAL

The CM11 - 21 Series Valves are made up of directional control valve sections mounted in banks and connected internally to common pressure and tank return passages. A valve bank usually consists of an inlet and operating (R*, K* or F*), a number of operating sections (*) and an operating and outlet section (*L or *E). Each operating section contains a sliding spool (for example A, B, C, T, D or W spool). In valve banks where only one operating section is required, an R* section is used with an L or E tank plate section.

B. ASSEMBLY AND CONSTRUCTION

Figure 1 is a cross-sectional view showing the construction and assembly of a three-section valve. Each section contains a sliding spool with centering springs and a check valve. The inlet section also contains a relief valve assembly.

Passages between the bodies connect each section to the common inlet and tank ports. Seal rings

between the sections seal the connecting passages. Sections are held together by studs and nuts.

C. OPTIONAL FEATURES

1. Micro-switch attachment - CM11*S models are equipped with a switch mounting bracket and a cam extension on the spool to actuate a micro-switch when the spool is shifted (see Section IV, paragraph F).

2. Spool detents - A spool detent assembly consists of a special end cap with a spring loaded plunger and a spool extension. The plunger engages in grooves in the spool extension to hold the spool in the desired position.

D. MOUNTING

CM11 Series -21 design valves are mounted with lugs cast into the inlet and outlet sections.

E. APPLICATION

Vickers application engineering personnel should be consulted for valve ratings and applications.

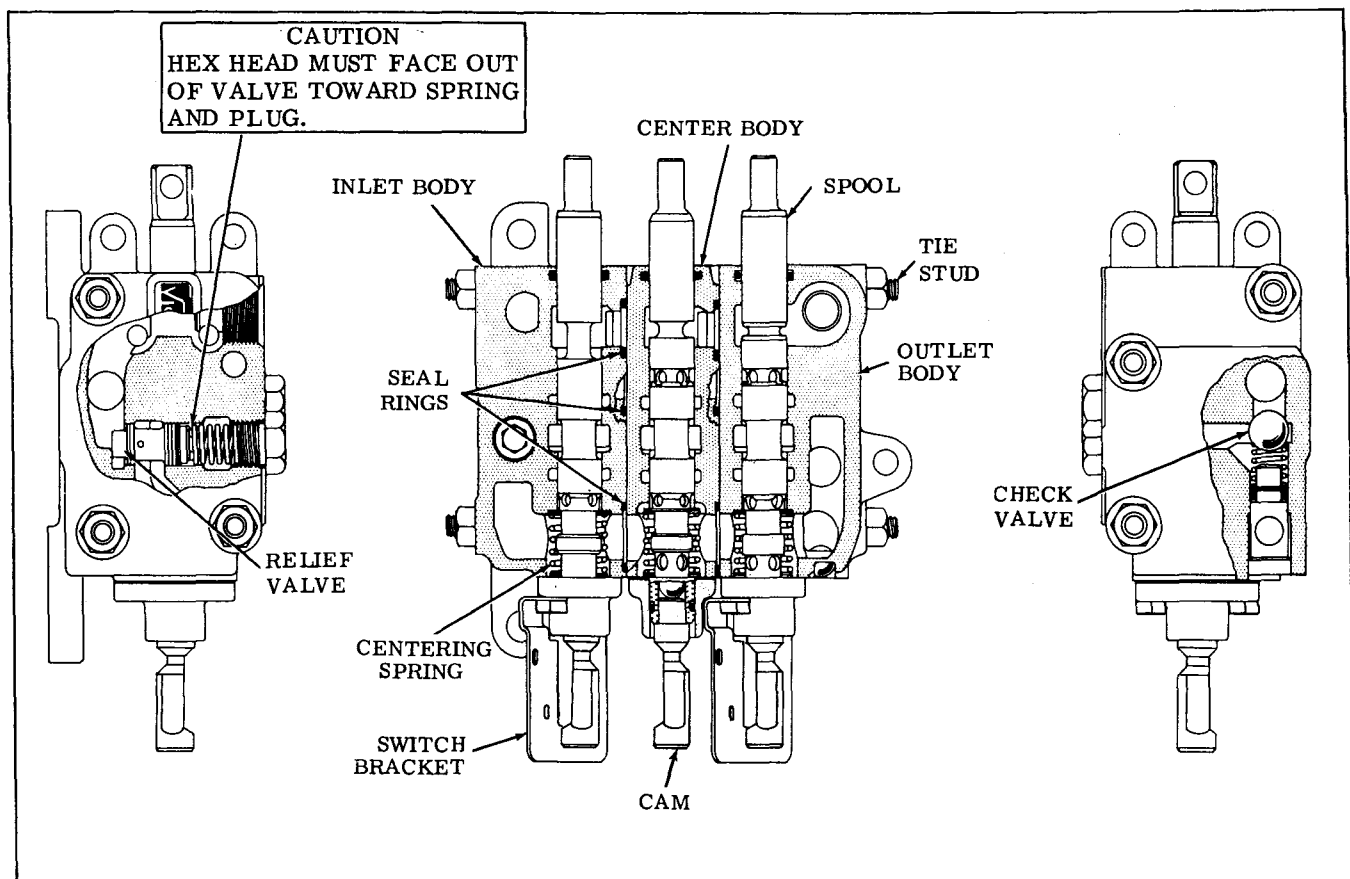


Figure 1

SECTION III - PRINCIPLES OF OPERATION

A. GENERAL

Figure 2 is a schematic illustration of a three section valve, showing the inlet and outlet ports and the by-pass, pressure and tank passages. The pressure passage is used to carry fluid to the cylinder ports when the spools are shifted. The by-pass passage permits flow directly to the outlet when the spools are not being operated. The tank passage also carries fluid to the outlet; either return flow from the cylinder ports or fluid diverted past the flow control and relief valve.

The spools are shown in the centered or neutral position. Under these conditions, fluid in the pressure passage is blocked from the cylinder ports by the spool lands. Flow through the valve is through the by-pass and tank passages to the outlet.

B. OPERATING SECTIONS

1. Inlet Sections - The CM11-21 Series valve bank may be obtained with operating, R*, F*, or K*, inlet sections. These sections are available with the spools listed in Table I.

These sections are individually described below.

(a) R* Section - The R* section is equipped with an integral relief valve for overload protection. It is built to accept a check valve to prevent return flow through the valve.

The integral relief valve, with an orifice plug, also acts as a partial flow control valve. This feature lowers the pressure drop between the inlet and outlet ports. (See paragraph 4 for relief valve and flow control operation.)

The relief valve cracking pressure is pre-set at the factory. The pre-set cracking pressures range up to 2500 psi maximum. (See Table I Model Code for pressure settings.)

(b) F* Section - The F* section has two pressure connections. One connection is made to the pump source and the second connection is made with a preceding valve assembly to accept the by-pass flow for tandem operation.

The F* section like the R* section is built to accept a check valve to prevent return flow when this feature is required. However, F* sections do not employ relief valve or partial flow by-pass.

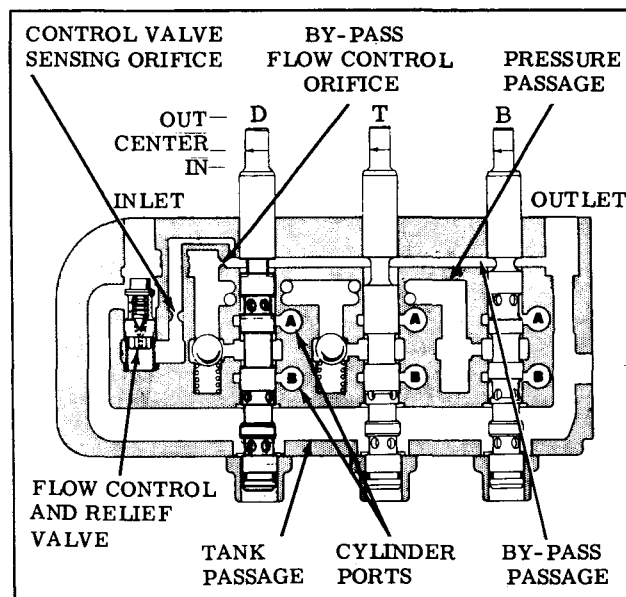


Figure 2

(c) K* Section - The K* section is essentially the same as the R* section except it has a full by-pass feature.

2. Outlet Sections

(a) *L Section - When two or more spools are required in a valve bank, the last section will be an *L section. The "*" denotes the spool type. This section contains the exhaust oil port and also is built to accept a check valve to prevent back flow when this feature is required.

(b) *E Section - This section is used for tandem operation by providing an outlet connection through which the by-pass feature for pump unloading is extended on to a subsequent valve bank. It is used in conjunction with an "F*" type inlet section in the next valve bank. Like the *L section it contains an operating spool and is built to accept a check valve to prevent back flow when this feature is required.

3. Spool Operation

Six standard spool designs are available (A, B, C, D, T and W). Any combination of spools may be used with a valve bank to perform a variety of operations. All operating spools are equipped with centering springs which return the spools to neutral.

For convenience, U.S.A.S.I. symbols are shown with the following descriptions of each spool.

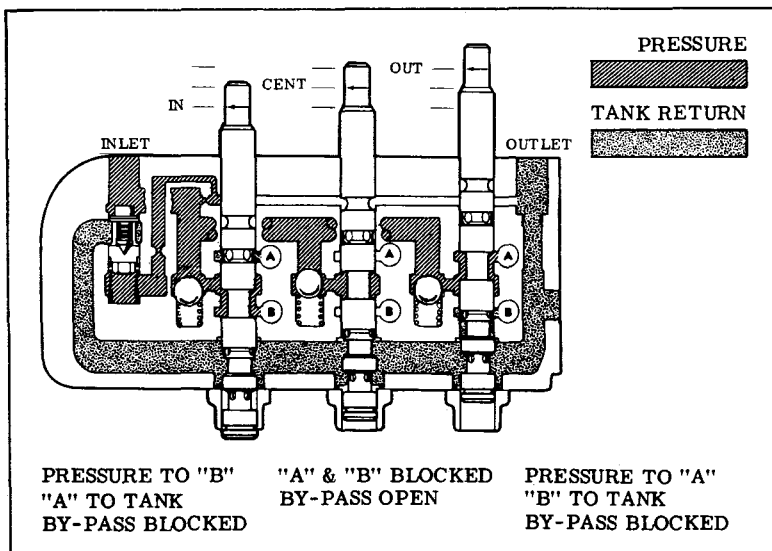


Figure 3 "D" DOUBLE ACTING SPOOL

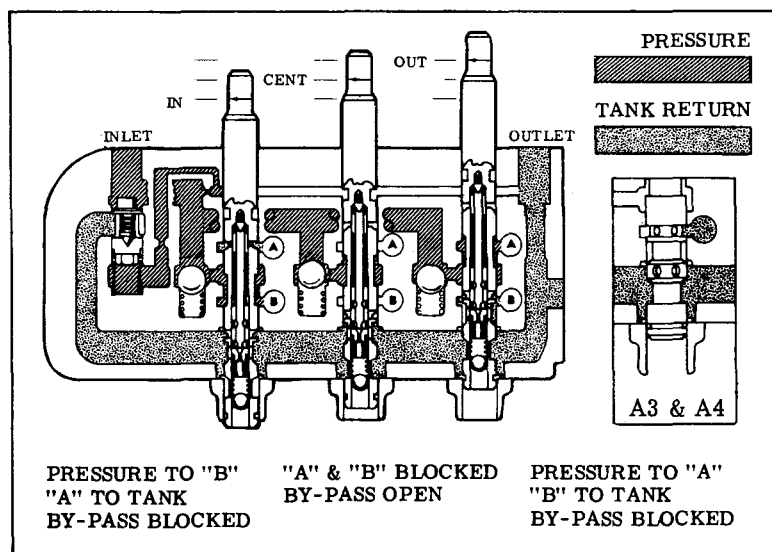


Figure 4 "A" DOUBLE ACTING SPOOL

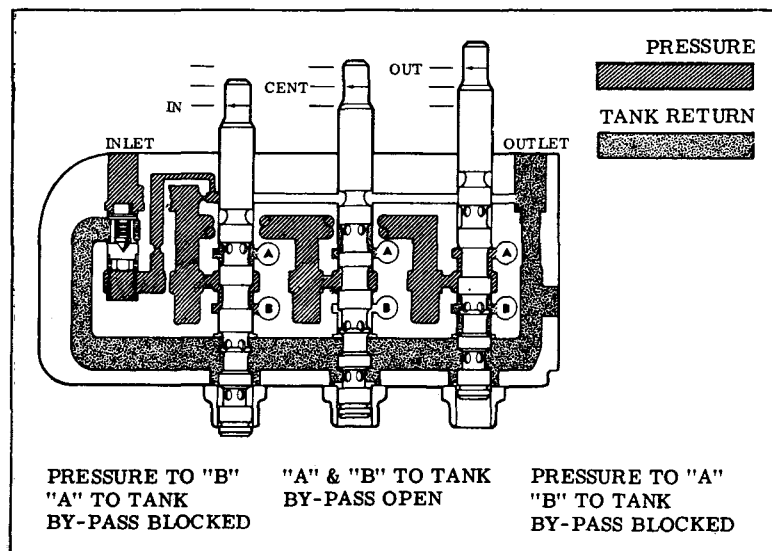
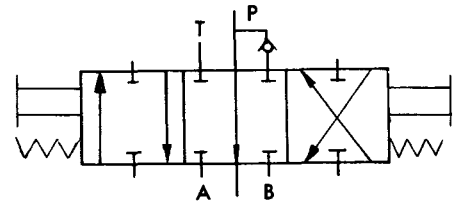


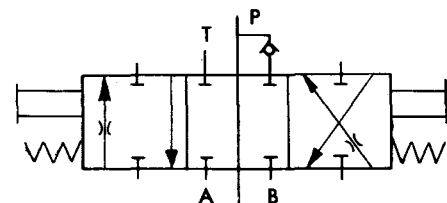
Figure 5 "B" MOTOR SPOOL

(a) "D" Double Acting Spool - "D" spools are used for applications where pump flow must be directed to either end of a cylinder, depending on the direction of movement required. The end of the cylinder not under pressure has its return flow directed to reservoir via internal coring of the valve sections. See Figure 3 for spool position versus flow.

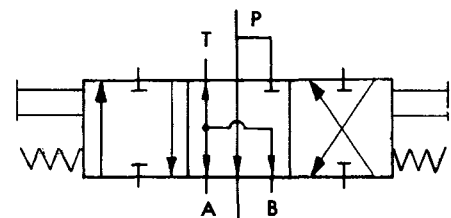


(b) "A" Double-Acting Spool - The "A" spool is a double-acting spool with variable orifices. An internal spool is used to provide this variable restriction. So long as there is a positive inlet pressure, the orifice is large, permitting unrestricted return flow. Decreased inlet pressure permits the spool to shift, decreasing the orifice size.

(c) "A3" and "A4" Spools - These are double-acting spools with fixed orifices to restrict flow to the reservoir from either cylinder port (see Figure 4). This prevents losing control of the load. Operation is otherwise the same as the "D" spool. See sub-paragraph (a) above.



(d) "B"-Motor Spool - "B" spools are used when flow is directed to the operation of a hydraulic motor instead of a cylinder. These spools are double acting in character so that the motor may be rotated in either direction. The cylinder ports are left partially open in the neutral position to allow free flow of oil between the motor and reservoir. Check valves are not used in "B" spools. See Figure 5 for spool position vs. flow characteristics.



(e) **"C" Float Spool** - "C" spools are double acting with an additional float position. The spool is retained in the float position by a detent, and it is spring centered to neutral from the "in" and "out" positions. Both cylinder ports are open to the reservoir in the float position to permit free flow of oil in either direction. See Figure 6 for spool position versus flow.

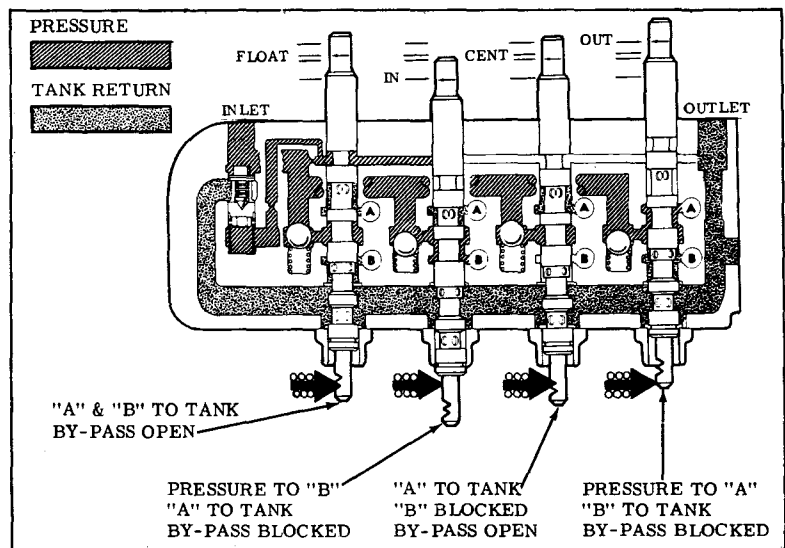
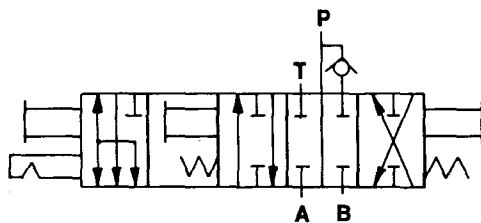


Figure 6 "C" FLOAT SPOOL

(f) **"T" Single Acting Spool** - "T" spools direct flow to one end of an operating cylinder only as in the example of the lift mechanism on a fork-type truck. Return flow is from the same end of operating cylinder and relies on gravity or mechanical means. Flow is controlled to and from port B. Port A is plugged. See Figure 7 for spool position versus flow.

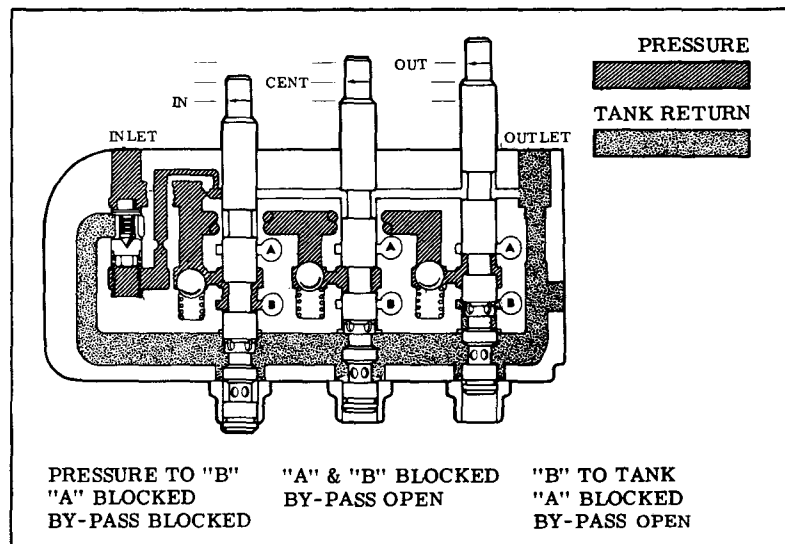
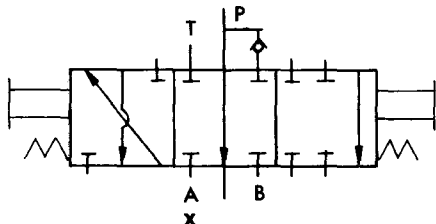


Figure 7 "T" SINGLE ACTING SPOOL

(g) **"W" Single Acting Spool** - The "W" spool is a single-acting spool which operates the reverse of the "T" spool explained above. Flow is controlled to and from port A, and port B is plugged.

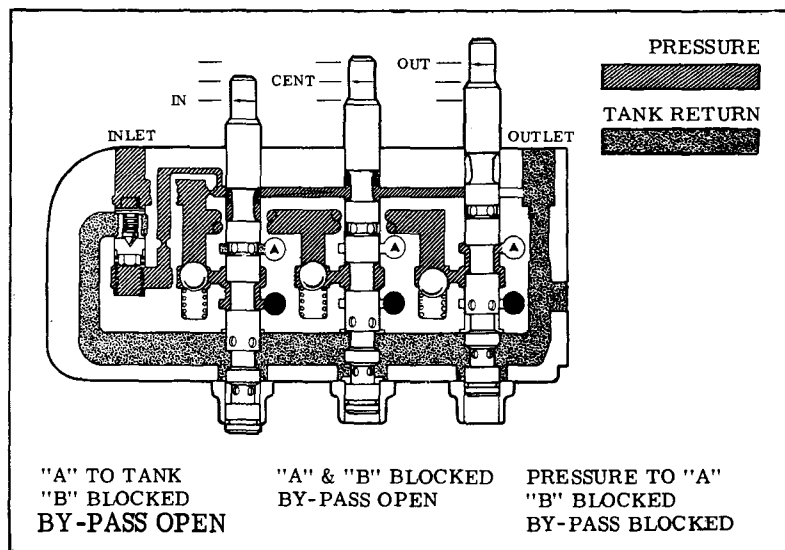
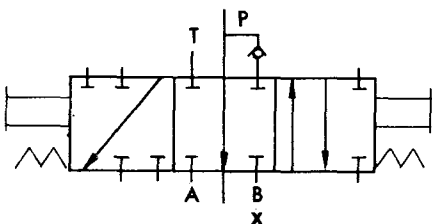


Figure 8 "W" SINGLE ACTING SPOOL

4. Flow Control and Relief Valve

Earlier design valves were equipped with simple relief valves in the inlet sections. The partial flow by-pass system in the CM11-21 valve makes use of a compound type flow control and relief valve arrangement.

By sensing the pressure drop across an orifice at the entrance to the by-pass, the valve acts as a flow control to limit flow through the by-pass to approximately seven gallons per minute. The balance of the pump delivery is diverted through the reservoir passage. This arrangement greatly reduces pressure drop through the valve in the neutral position.

When a spool is shifted to operate a portion of a machine, the flow control is inoperative and full pump volume is available to the system. The control valve then functions as an overload relief valve. System pressure is limited to a prescribed maximum by the action of this valve. Inlet body type "F" (Table I), is not equipped with a relief valve. Full pump volume is available to the system at all times.

(a) Flow Control - Figure 2 shows the valve operation in neutral with flow in excess of seven gpm. Flow across the by-pass orifice results in a pressure drop. The decreased pressure is sensed at the spring end of the valve sub-assembly through a sensing orifice. The slightly higher pressure at the other end of the valve permits it to shift down, diverting excess flow to the reservoir passage. With flow less than seven gpm, there would be negligible pressure drop across the by-pass orifice. Then the control valve would be held closed by the large spring and all flow would be through the by-pass passage.

(b) Relief Valve - Operation of the relief valve feature is shown in Figure 9. When an operating spool is shifted, fluid is ported into the system and the by-pass is blocked.

Figure 9A shows operation at less than the relief valve setting. There is no flow over the by-pass orifice, so full system pressure is sensed at the spring end of the control valve, as well as the opposite end. The valve is thus hydraulically balanced and the large spring holds the relief valve spool closed.

Maximum pressure is determined by the setting of the small spring inside the control valve assembly. When system pressure is high enough to overcome this heavy spring, the poppet is forced off its seat. (See Figure 9B.) Fluid immediately flows past the poppet to the tank passage. This flow creates a pressure drop across the sensing orifice and the control valve is no longer hydraulically balanced. When pressure drop across the sensing orifice is great enough to overcome force of the large spring, the valve spool shifts, permitting flow to the tank passage.

5. Check Valves - Timing of the valve spools is such that one cylinder port opens to pressure and the other port opens to reservoir before the by-pass passage is completely blocked. To prevent return

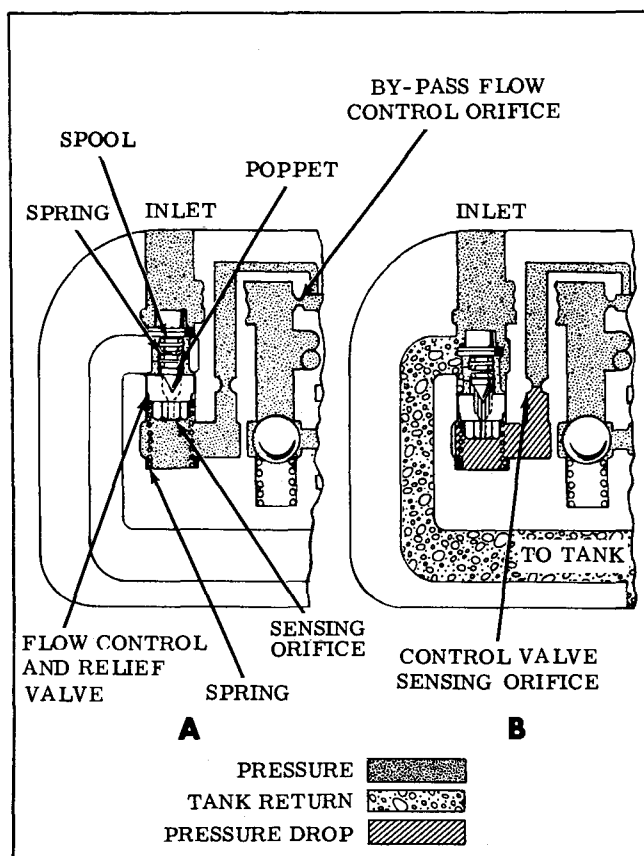


Figure 9

flow from a cylinder port from passing into the pressure passage and escaping through the partially closed by-pass, check valves are provided in each operating section except sections with "B" spool. The check valves prevent the load from dropping.

6. Detent - The spool detent consists of a special end cap with a spring loaded plunger. The plunger engages in a groove in the spool extension and holds the spool in the desired position.

7. Tandem Operation - Tandem operation permits operation of two banks of valves from the same pumping source. An internal plug in the outlet section of the first bank (Figure 10) separates the by-pass passage from the tank passage. Cylinder exhaust oil is returned to tank via the alternate discharge port, and by-pass oil is directed out the primary discharge port to the by-pass port of the bank.

In Figure 10, either bank can be operated separately or both simultaneously. This is possible because of the tandem by-pass connection from the inlet connection of the first bank to the F inlet connection of the second bank. If neither bank is operating, part of the fluid flows through both by-pass passages directly to reservoir. The balance is diverted through the tank passage of the first section as shown in Figure 2.

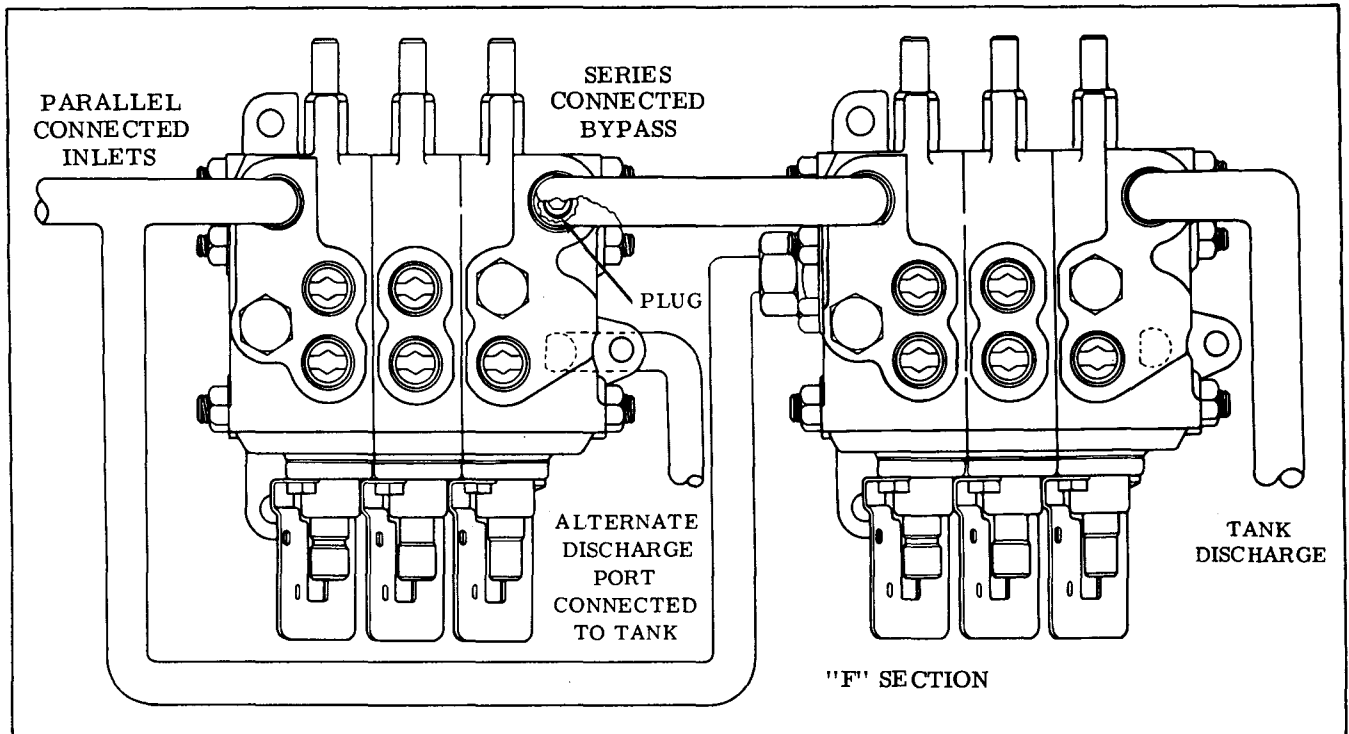


Figure 10

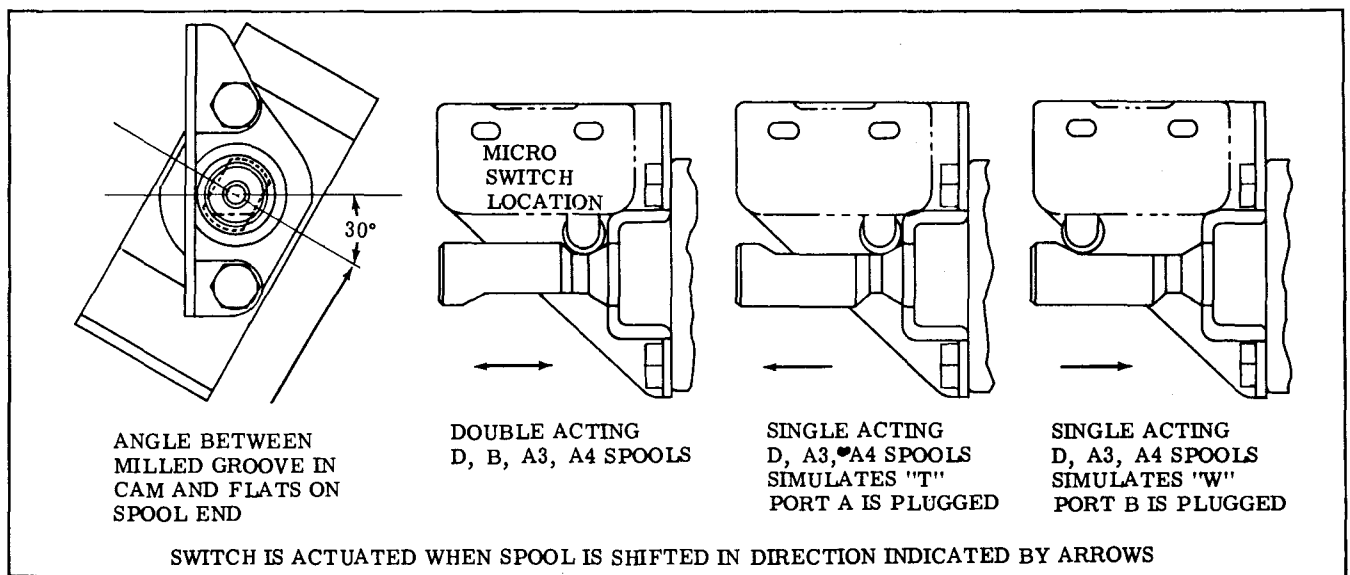


Figure 11

In some cases, it is desirable to have tandem valves connected in series where the second bank is dependent upon the operation of the first bank. The first bank has control priority because the tandem by-pass connection is not used. The cylinder by-pass oil of the first bank is directed out of primary discharge port to the inlet port of the second bank. Use a "K" inlet section in the first bank if full flow is desired to the second bank. Otherwise reduced flow will be encountered.

8. Electric Switch Section - Provision is made to actuate a switch to start the hydraulic power source on electric powered machines only when it is needed. For "T" spool operation, the "A" port must be plugged. "W" spool operation requires that port "B" be plugged.

All D, T or W electric limit switch models are supplied with "D" spools only. "T" or "W" spool operation is accomplished by mounting the switch or rotating the spool extension as shown in Figure 11.

9. Narrow By-Pass Sections - Narrow by-pass sections have narrower by-pass grooves in the spools. These provide better metering for low volume applications.

C. NON-OPERATING SECTIONS

The CM11-21 valve non-operating sections are the "E" and "L" outlet sections. These sections do not have operating spools. The functions of these sections are as follows:

1. "E" Outlet Section - The "E" type section provides an outlet section by which the by-pass feature for pump unloading is extended to a subsequent valve bank (tandem operation). It is generally used

in conjunction with the "F" type inlet section on the subsequent valve bank assembly. This "E" type section is only used with one-spool banks.

2. "L" Outlet Section - The "L" type section is basically the same section as the "E" section except it provides only one connection for exhaust oil and is used as the last section on a single-spool bank where tandem operation is not required.

NOTE

It should be noted that the pressure drop across the valve, when used in series operation, will be the sum of the pressure drops for each section.

SECTION IV - INSTALLATION AND OPERATING INSTRUCTIONS

A. INSTALLATION DRAWINGS

Installation drawing 303 should be consulted for installation dimensions.

B. MOUNTING

These valves can be mounted in any position. Enough clearance must be left to provide access to the port connections and to permit actuating the control mechanism. The valves should be securely bolted to the mounting surface.

NOTE

Valves should be mounted on a relatively flat surface to prevent possible distortion of the valve bodies.

C. PORT CONNECTIONS

Except for the alternate discharge port, all connections are compatible with standard SAE fittings and "O" ring seals. It is only necessary to tighten fittings so that there is a firm metal-to-metal contact.

D. RELIEF VALVE

Relief valve sub-assemblies in the inlet section are preset and tested by Vickers for given pressure settings. Selection of the relief valve setting is based on the work requirements of the system. If a different relief valve setting is required, the valve sub-assembly should be replaced.

E. TANDEM INSTALLATION

1. Port connections for tandem series operation are shown in Figure 10.

2. The outlet section of the first bank must be an "E" section which is equipped with a plug (see Figure 10) to block the primary discharge port from the reservoir. The alternate discharge port must be connected to the reservoir.

NOTE

Slight leakage past the internal plug is permissible. The plug should not be tightened excessively, as there is the danger of distorting the body and causing the spool to bind.

F. MICRO-SWITCH AND CAM INSTALLATION

1. Figure 11 illustrates the correct mounting positions for the micro-switch, bracket and cam.

2. To convert a standard section to an electric switch section, the end cap screws must be removed to attach the bracket. The cam must be pressed into the spool at the correct angle with the flats on the spool end as shown in Figure 11. Secure cam in spool with a good grade of epoxy adhesive.

CAUTION

Use caution while inserting cam into spool to avoid damaging nylon cam.

G. HYDRAULIC TUBING

1. The number of bends in tubing must be kept to a minimum to prevent excessive turbulence and friction of oil flow.

2. Tubing must not be bent too sharply. The minimum radius for bends is three times the inside diameter of the tube.

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

4. All tubing must be thoroughly cleaned before installation to remove dirt, rust and scale. Recommended methods of cleaning are sand blasting, wire brushing and pickling.

NOTE

For instructions on pickling, refer to Vickers Instruction Sheet M-9600.

H. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL

The oil in a hydraulic system serves as the power transmission medium. It is also the system's lubricant and coolant. Selection of the proper oil is a requirement for satisfactory system performance and life. Oil must be selected with care and with the as-

sistance of a reputable supplier.

Refer to Vickers oil recommendations for mobile hydraulic systems, data sheet M-2950-S.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Vickers sales representative.

SECTION V - SERVICE, INSPECTION AND MAINTENANCE

A. SERVICE TOOLS

No special tools are required to service Vickers CM11-21 series, multiple unit valves.

B. INSPECTION

Periodic inspection of spool operation, oil condition and pressure connections saves time-consum-

TABLE III - TROUBLE, CAUSE AND REMEDY CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Oil leaks at either end of spool. Spring-centered spools do not return to neutral.	Defective "O" rings in valve body.	Replace "O" rings.
	Broken springs.	Replace springs.
	Bent spool.	Replace with new section of same size and type.
	Foreign particles.	Clean system and valve.
	Misalignment of operating linkage.	Check linkage for binding condition.
	Valve bank improperly torqued.	Retorque nuts to specified ratings.
Detent type spools will not stay in detent position.	Worn detent barrel.	Replace detent barrel.
	Weak or broken detent spring.	Replace detent spring.
No motion, slow or jerky action of hydraulic system.	Relief valve not properly set, or stuck in base and/or worn.	Repair, clean and readjust.
	Dirt or foreign particles lodged between relief valve control poppet and seat.	Disassemble, clean and reassemble.
	Valve body cracked inside.	Replace valve section.
	Spool not moved to full stroke.	Check travel.
No relief valve action (high pressure).	Small particle of dirt plugging orifice in relief valve sub-assembly.	Remove relief valve and check hole. If blocked, clear hole.
	Relief valve sub-assembly installed backwards.	Install properly.
Load will not hold.	Oil bypassing between spool and body.	Replace valve.
	Oil bypassing piston in cylinder.	Repair or replace cylinder.
	Spool not centered.	Refer to above spool remedies.
Load drops when spool is moved from neutral to a power position.	Dirt or foreign particles lodged between check valve ball and seat.	Disassemble, clean and reassemble.
	Scored or sticking check valve.	Replace poppet.

ing breakdowns and unnecessary parts replacement.

1. All hydraulic connections must be tight. Loose connections not only allow leakage, but also permit air to be drawn into the system, resulting in noisy and erratic operation.

2. Spools should return to neutral automatically when the control is released. The standard centering spring force is approximately 28 pounds with the spool in the neutral position, and approximately 56 pounds with the spool in the shifted position. If more force is necessary, the spool may be binding or control linkage may be faulty.

3. System filters and reservoir should be checked periodically for foreign particles. If excessive contamination is found, the system should be drained. The reservoir must be cleaned thoroughly before refilling.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to the system, it should be pumped through a 25 micron filter. If such a filter is not available, or practical to use in the field, a funnel with a fine wire screen (200 mesh or better) can be used.

It is important that oil be clean and free of all substance which will cause improper operation and excessive wear of the pump or other hydraulic units in the system. Be sure to purge all air from the system.

D. LUBRICATION

Internal lubrication is provided by system oil.

E. REPLACEMENT PARTS

Only genuine parts manufactured or sold by Vickers should be used as replacement parts for these valves. Only Vickers knows the true quality level required of each part. These are listed in the applicable parts catalogs, copies of which are available on request.

F. TROUBLESHOOTING

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

SECTION VI - OVERHAUL

A. GENERAL

During disassembly, particular attention should be given to identification of parts for reassembly. Spools are selectively fitted to valve bodies and must be returned to the same bodies from which they were removed. Valve sections must be reassembled in the same order.

Figure 12 is an exploded view showing the proper relationship for reassembly. Reference is made to these figures in the procedures which follow.

B. DISASSEMBLY

1. Controls - Be sure the unit is not subjected to pressure. Disconnect and cap all lines and disconnect linkage to the spool. If hand levers are used, remove the "E" washers which retain the fulcrum rod and remove the rod, levers and pivot pins.

2. Attaching Parts - Remove the four tie studs and nuts and separate the valve sections. Be careful not to destroy or lose spacers.

3. End Caps - On CM11-21 models remove the micro-switch from the bracket. Remove the two screws which secure the spool end cap and remove the cap (and switch bracket, if used). If the cap has a detent assembly, screw out the detent plug

and remove the spring and piston. Remove the "O" ring from the cap.

4. Operating Spool - Slide the spool out of its bore and remove the "O" rings from the groove in the spool and from the valve body around the spool bore. Do not remove the centering spring, retainers or the spool extension unless it is necessary to replace them.

5. Check Valve - Grip the stem of the check valve plug with pliers and pull it out of the valve body. Remove the "O" ring and back-up ring. Remove the spring and ball from the valve body.

6. Relief Valve Sub-Assy - Screw out the plug which retains the relief valve and remove the "O" ring from the plug. Remove the spring and the relief valve sub-assembly. In F* sections, remove the solid plug.

7. Valve Body - Remove the plug and "O" ring from the blocked cylinder port on models with a single acting spool. If the alternate discharge port is plugged, it is not necessary to remove the plug unless the body is to be replaced. On F* bodies, remove the fitting, "O" rings and back-up ring.

C. CLEANING, INSPECTION AND REPAIR

1. Discard all old seals. Wash all parts in a

clean mineral oil solvent and place them on a clean surface for inspection.

2. Carefully remove burrs by light stoning or lapping. Be certain there is no paint or burring on mating surfaces of valve bodies.

3. Inspect the valve spools and bores for burrs and scoring. If scoring is not deep enough to cause objectionable leakage, the surfaces can be stoned or polished with crocus cloth. If scoring is excessive, the valve body and spool must be replaced. Check the valve spool for freedom of movement in the bore.

4. Check the relief valve for smooth movement in its bore. The valve should move from its own weight.

D. ASSEMBLY (Figure 12)

NOTE

Coat all parts with clean hydraulic oil to facilitate assembly and provide initial lubrication. Petroleum jelly can be used to hold seal rings in place on assembly.

1. Valve Body - On models with single-acting spool, install the "O" ring on the port plug and plug the appropriate cylinder port. Tighten the plug securely, but DO NOT over tighten. On F* models, install the back-up ring and then the "O" rings on the fitting. Tighten the fitting securely, but DO NOT over tighten.

CAUTION

Hex head of relief valve must face outside of unit.

2. Relief Valve - Install the "O" ring on the relief valve plug. Place the relief valve assembly in its bore, HEX NUT END UP. Install the spring and plug and tighten the plug securely but DO NOT over tighten.

3. Check Valve - Install a new back-up ring and

"O" ring on the check valve plug with the "O" ring toward the spring and ball. Place the ball and spring in the body and install the plug. Be sure the hole in the plug lines up with the stud hole in the body. Check valves are not used in "B" spool sections.

4. Operating Spool - If the centering spring was removed, install the spring and retainers on the spool. Place the "O" ring in the groove around the spool bore and install the "O" ring on the spool. Install the spool in the bore. On electric switch models, be certain the cam extension is in the correct position.

5. End Cap - Install the "O" ring in the end cap groove and install the cap, switch bracket (if used) and attaching screws. Torque the screws securely. On models with detents, grease all the detent parts. Install the end cap and check for proper spool extension alignment. Install the piston, spring and plug. Be sure to screw the plug in all the way.

6. Assembly of Unit

CAUTION

Make sure all mating surfaces of valve bodies are free of burrs and paint.

Install seal rings and the seal ring retainer in the grooves in the body of each inlet and center section. Use petroleum jelly to hold the seals in place. Carefully place the sections together in the same order in which they were removed. Coat the stud threads with "Loctite" or similar sealant and install the studs. Tighten the nuts to 17 pounds foot torque. If levers are used, install pins in each spool and assemble the levers, fulcrum rod and "E" washers.

SECTION VII - TESTING

Vickers, Incorporated application engineering personnel should be consulted for recommendations on test stand circuit requirements and construction. If test

equipment is available, valves should be tested at the recommended flow and pressure shown on installation drawing 303.

