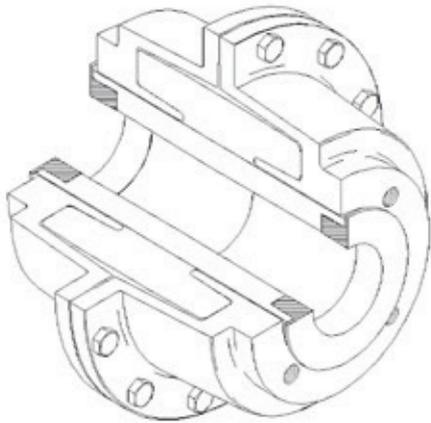




# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

Before installation these instructions must be fully read and understood



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### 1 C-VALVE BODY AND SLEEVE

#### 1.1 GENERAL INFORMATION

The Clarkson C-Valve is a throttling valve designed for slurry flow control. Though in some small sizes, the C-Valve will shut-off without damage, IT IS NOT A SHUT-OFF VALVE. Complete "bubble-tight" shutoff is not guaranteed. The valve has a cast ductile iron body which contains an elastomer muscle. The liner or sleeve is a molded elastomer part which is contained within the muscle. The sleeve is retained within the valve body with hard elastomeric retainers or, on the 6 inch and 8 inch sizes, with cast ductile iron retainer flanges. The C-Valve is available with a large selection of reduced port sleeve sizes and elastomers to fit many different applications.

#### 1.2 OPERATION

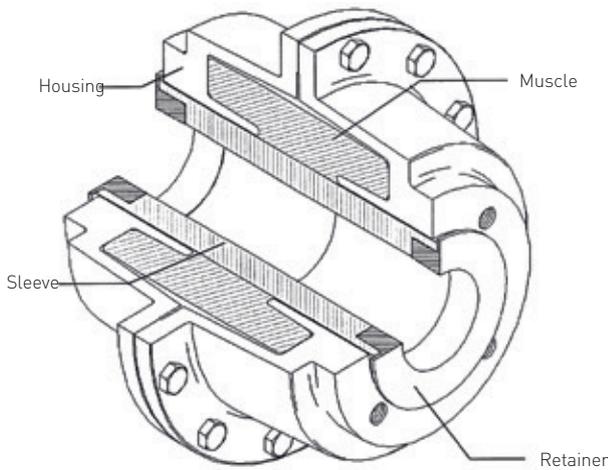
The C-Valve is actuated by applying low pressure hydraulic fluid to the outer surface of the muscle. The muscle squeezes inwardly on the sleeve which forms a variable orifice. The normal operating range is from full open to 1/2 of wide open port diameter. The port will remain round and concentric up to this point. Valves with port diameters of 2 inches or smaller can be completely shut-off. The port closes out of round at shut-off. Since the hydraulic fluid is in contact with the elastomer muscle, care in fluid selection is important to assure maximum service compatibility. Fluid selection is discussed in Section 1.5 "Hydraulic fluid selection". Actuators for the C-Valve are covered in Section 2 "Actuators". See Section 3.4 Table 1 for closing pressures.

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### 1.3 INSTALLATION

The C-Valve is usually installed with ASME B16.5 Class 150 standard pipe flanges using hex head cap screws. To insure complete sleeve support, use flat or raised faced companion flange with the contact surfaces that extend to the inside diameter of the C-Valve sleeve. The valve may be installed between concentric bell type reducers if the C-Valve is smaller than the pipeline. The use of flange gaskets is recommended on all C-Valves, but not required on NPS 4 and smaller valves. The valve should be located 5-10 pipe diameters away from any flow disturbance, other than concentric reducers. Install the C-Valve with the hydraulic connection on bottom of the body to facilitate purging the air from the valve top port. The piping used for the hydraulic fluid should be of adequate size to allow the valve to follow the control system with a minimal amount of lag time.

### 1.4 MAINTENANCE

Normal maintenance of the C-Valve involves replacing the sleeve or the muscle. These will be covered separately but both require removing the C-Valve from the pipeline. See Figure 1.

- Disconnect the hydraulic line from the C-Valve.
- Remove the flange bolts securing the valve into the pipeline.
- Spread the pipeline flanges enough to remove the C-Valve.
- Using a hoist as required, remove the valve to a suitable working area.

#### 1.4.1 Sleeve replacement

Sleeve replacement is the most common maintenance performed since this is the wear part in the slurry valve. It is performed as periodic maintenance, or due to failure. Failure is indicated by process fluid leaking from the weep holes in the end of the valve body near the pipeline flange connection.

The sleeve replacement procedure follows:

- Remove the hard elastomer sleeve retainer by prying out with a large screwdriver. For NPS 6 and 8 valves remove the ductile iron retainer flanges by first removing the slotted flat head machine screws, then prying off the flange.
- Relieve any residual hydraulic pressure from the valve body.
- If the sleeve is loose, it can be pulled from the valve body. If not, it may be necessary to loosen the sleeve by sliding a piece of lubricated banding strap around the sleeve OD to loosen it. Another method of loosening the sleeve from the housing is to bend a piece of brazing rod into a 'crank' shape and inserting it into the interface. A cranking motion will roll the rod around the sleeve and loosen it. The sleeve may now be removed.
- Prior to installing the new sleeve, inspect the valve ID for damage and wipe it clean. A little water applied into the cavity will aid in inserting the new sleeve.
- Center the sleeve in the valve body and apply just enough pressure to the valve body port to hold it in place for retainer installation. Install the elastomeric sleeve retainers with a soft mallet. For NPS 6 and 8 valves with metal retainer flanges, use the main flange bolts with adequate washers to pull the flanges into place. Be sure to tighten the flanges from both ends evenly or they may not fully seat.

The flat head machine screws can then be inserted and the flange bolts removed. Be sure to use an anti-seize on the tapped bolt holes to allow future removal.

- Actuate the valve to insure the valve operates properly and the port remains nearly round for a diameter reduction of not more than 50%. On the smaller valves with elastomeric sleeve retainers, pressurizing the body port will cause the ends of the sleeve, with the retainers, to telescope out from the flange. It is best not to stroke this sleeve more than about 30% closed since over-stroking the muscle without the pipeline companion flanges for support can cause the muscle to rupture.

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

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### 1.4.2 Muscle replacement

The muscle usually lasts through several sleeve replacements. The failure mode is either rupture from over pressuring, or excessive swelling due to chemical attack from the hydraulic fluid. Muscle failure is indicated by hydraulic fluid escaping from the weep hole on the valve body near the pipeline flange connection or failure to fully open due to swelling. The muscle replacement procedure is as follows:

- With the valve in a suitable working area, and the sleeve, retainers, and hydraulic fluid removed, place the valve body on end and remove all the bolts and nuts from the valve body.
- Match mark the valve body halves, for later assembly.
- Carefully pry apart the body halves, taking care not to damage the sealing surfaces.
- Pry out the muscle. This is sometimes difficult, and a lifting strap and come-a-long are often helpful on large valves.
- Clean and inspect the valve body castings in the bottom of the inner cavities and on the sealing flanges.
- Lubricate the ends of the new muscle, at the inside corners only, extending about halfway to the OD, and about the same distance down into the ID and all the way around. Use a grease which is compatible with the elastomer muscle, such as a silicon based grease, since a petroleum based grease will damage the elastomer.
- Place the lubricated muscle into one of the valve body halves and firmly seat it into the cavity.
- Install the new seal gasket or O-ring at the body flange.
- Place the second body half in place and align the match marks.
- Work the housing down onto the muscle as far as possible and install the bolts and nuts.
- Tighten the bolts in a crossing pattern, a little at a time, evenly until the housings are fully seated together.
- Apply 40 psi air to the valve body port to insure the muscle closes round.
- Check the ID at the elastomer/metal interface and the bolted center flange for any leaks. If leaks are found, repeat the above process to find the fault.
- The valve is now ready for sleeve installation, see Section 1.4.1 "Sleeve replacement".

### 1.5 HYDRAULIC FLUID SELECTION

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There are two different fluids recommended for use with the Clarkson C-Valve.

For use with any unitized actuator we recommend a 'Low silicate' antifreeze without stop leak. This can be used concentrated as purchased or mixed with water to approximately 50%. This fluid is fully compatible with the elastomeric C-Valve muscle.

- For actuation with a system using an electric hydraulic pump unit with a kindle pilot or electro-hydraulic control system, we recommend the use of turbine oil. Tests have shown that Chevron GST 32 turbine oil, Shell turbo oil #32, and Texaco Regal R&O 32 will minimize the swelling usually associated with the elastomer in contact with oil. Other acceptable turbine oils may exist, consult the factory for recommendations. Normal hydraulic oil is not recommended as the elastomer swelling may be rapid and significant causing valve operation problems. Swollen elastomer parts can cause valves to fail.

## 2 ACTUATORS

### 2.1 MANUAL HYDRAULIC HAND PUMP ACTUATION

---

#### 2.1.1 General information

The simplest method of actuation for the C-Valve is by the use of a hand pump. The hand pump allows manual adjustment of the hydraulic pressure and therefore the C-Valve port size and slurry flow rate. The pump units available from the factory include a lever operated piston pump, pressure release valve, reservoir, hydraulic hose with female quick disconnect coupling, and pressure gauge. Several models are available with varying flow rates and reservoir capacities as required by different C-Valve sizes. These units can be left connected to a C-Valve for convenient flow adjustment or can be disconnected and moved from one C-Valve to another. See Table 1 for actuation pressures.

#### 2.1.2 Operation

To adjust the flow through a C-Valve, connect the manual hand pump unit to the male quick disconnect fitting on the valve body and close the pressure release valve. Be sure the pump air vent screw on the fill cap is open before pumping fluid. Then pump until the desired hydraulic pressure is shown on the pressure gauge. At this time the pump can be left in place or can be uncoupled and moved to the next desired location. The check valve in the male fitting on the C-Valve will hold the pressure when disconnected. After removing the pump unit from the C-Valve, open the pressure release valve to drop the pump pressure. Reinstall the protective cover on the male coupling on the C-Valve. It is necessary to leave the pressure release valve open in order to reconnect the quick disconnect couplings.

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

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### 2.1.3 Installation

Fill the reservoir with the appropriate hydraulic fluid and connect the coupling to the C-Valve to be operated. See Section 1.5 for 'Hydraulic fluid selection'. Remove the protective cover from the male fitting on the C-Valve, and attach the female coupling on the pump unit hose to the C-Valve body. This is accomplished by opening the pressure release valve and sliding the knurled sleeve back on the female coupling. Then push the couplings together and release the sleeve. If desired, the couplings can be removed from the pump and C-Valve and the hose can be connected directly to the C-Valve port. Since the hydraulic fluid is subject to freezing (-30°F and below), it is best to locate and store the pump inside a building, or to provide heating.

### 2.1.4 Maintenance

Maintenance of the manual hand pump unit is generally limited to keeping the unit clean and full of fluid. It is especially important to keep the coupling on the hydraulic hose clean. If the pump fails to pump fluid or maintain pressure, the piston and pressure release valve can be disassembled, cleaned and inspected. Insure all check balls, cavities and O-rings are in good condition. If not, repair or replace the defective parts.

## 2.2 PNEUMATIC HYDRAULIC ACTUATORS (UNITIZED ACTUATOR)

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### 2.2.1 General information

The unitized actuator system has been designed for the Clarkson Series C-Valve to operate through its throttling range without need of an auxiliary hydraulic pressure source. The unit operates on up to 75 psig air supply and is controlled by a 3-15 psig pneumatic input signal. The actuator can be mounted directly on the valve or in a remote location. Unless otherwise specified, it will be shipped from the factory mounted on the valve and precharged with hydraulic fluid. (For these actuator systems see 'Hydraulic fluid selection' in Section 1.5).

### 2.2.2 Operation

A pneumatic positioner controls the position of the unitized actuator piston assembly by following a 3-15 psig pneumatic input signal. The large area pneumatic piston is directly coupled to a smaller area hydraulic piston, so that the air pressure is amplified into a higher hydraulic pressure in the hydraulic end. The pressurized hydraulic fluid is displaced through a hydraulic hose into the C-Valve to attain the desired valve closure.

For each C-Valve size, the hydraulic cylinder is sized to displace sufficient hydraulic fluid volume and pressure to obtain the maximum recommended closure. This requires that the range spring for the pneumatic positioner be matched to the proper valve / port size to insure correct actuator stroke.

### 2.2.3 Installation

The main concern when installing the unitized actuator is to orient the vent port so that the air in the hydraulic system can be fully purged during charging. Allow access to the charging fitting on the valve body, as well as the positioner and I/P adjustments. The air supply should be filtered and regulated to insure the pneumatic positioner is protected from dirt and moisture. The filter bowl should be orientated so that the drain will function. These same requirements will be necessary whether the actuator is valve or remote mounted. The only other requirement for remote mounting is to allow all air to be purged from the hydraulic line connecting the valve body to the actuator by eliminating any 'high spots' in the line which cannot be vented. Whenever possible, the unitized actuator should be mounted above the level of the C-Valve body and the charging fitting on the valve body should be located at the lowest point. Since the hydraulic fluid is subject to freezing, it is best to locate the actuator inside a building, or to provide heating.

The unitized actuator requires a maximum of 75 psi regulated, filtered air supply. The air supply is connected at the ¼ NPT port on the positioner. It is recommended that the air supply pressure be regulated to the lowest value necessary to actuate the valve. This air pressure can be noted on the air diaphragm pressure gauge, located on the positioner.

#### 2.2.3.1 I/P transducer and positioner installation and calibration

The current to pressure transducer (I/P) used with the Clarkson C-Valves is the Conoflow Model GT18. The normal input is 4-20 mADC, which is converted into a 3-15 psig air signal. There are two adjustments which can be made: range and zero adjustment. See conoflow installation and maintenance manual for instructions (Section 5.3).

The Moore products Model 73N12F direct acting and 73N12FR reverse acting positioners are used on the NPS 1 to 4 Clarkson C-Valves. For installation see the manufacturers' Service instructions SD73 (Section 5.1). Calibration of these positioners is limited to the range spring selection, and the zero adjustment. See Table 2 (Section 4.1) for 'Range spring application'.

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

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### NOTE

The range springs selected for NPS 3 and 4 C-Valves are chosen to operate the valve so that port diameter changes from full open to approximately 50% diameter reduction. Valves with 2 inch diameter ports and smaller will operate from full open to nearly full closure. Over closing the valve will damage the elastomeric muscle.

To adjust zero position, set input signal to 3 psi (15 psi for reverse acting). Turn adjusting screw until air diaphragm pressure barely starts to rise. For later models sizes NPS 1- 4 use the movement of the visual travel indicator as a set point. Back off screw slightly so that 3 psi (15 psi for reverse acting) yields 0 psi air diaphragm pressure.

### WARNING

*When installing a unitized actuator equipped with a 73N12FR "reverse acting" pneumatic positioner, it is very important to insure the 3-15 psig air signal is applied to the positioner BEFORE the supply air is connected. Failure to follow this recommendation can over pressure the valve and damage the valve muscle.*

The NPS 6 and 8 valves use the Moore products Model 74N positioner with instrument and diaphragm loading gauges. This model has an external tension type range spring which is adjustable within its designed stroke range. See the Moore products service instructions SD74 (Section 5.2) for calibration.

### NOTE

The stroke adjustment for the large C-Valves should be set to operate the valve's inside diameter port from full open to approximately 50% diameter reduction. Over-closing the valve will damage the elastomeric muscle.

### 2.2.3.2 Remote actuator mounting procedure

It is sometimes necessary to mount the unitized actuator remotely from the C-Valve. This may be due to maintenance access, process considerations such as vibration, temperature, etc. Tubing between the actuator and the valve should be  $\frac{3}{8}$  I.D. or larger and provide air vents at any high spots. Trapped air and restricted flow will diminish the valve's performance.

When remote actuator mounting is desired the following suggestions will eliminate most potential problems:

- If possible, mount the actuator higher than the C-Valve.
- Mount the actuator with the vent port at the highest point in the system.

- If possible, make the hose or tubing-run with a continuous grade to eliminate air pockets.
- If a continuous grade is impracticable, install vents at all air-trap points.
- Install the C-Valve with the hose or tubing connected to the top port of the valve.
- When charging the circuit, connect the charging pump to the bottom port of the C-Valve.
- Open the vents in order of their location with the one nearest to the C-Valve first.
- Pump fluid into the C-Valve until all air is purged from each vent and then close the vent(s).
- Move to the next vent point and repeat charging step until all including the actuator vent are charged.

### 2.2.3.3 Rotation of actuators

It may be necessary to rotate the C-Valve from horizontal to vertical pipeline mounting or the reverse. Consider the following suggestions:

- The actuator fluid vent plug, located near the hydraulic hose, should be the high point in the system to facilitate charging with hydraulic fluid and complete venting of all trapped air.
- The optional filter regulator should be positioned to allow any trapped airline moisture to be drained.
- If the actuator vent hole is subject to a dirty environment, it may need to be protected. This can be accomplished by installing a breather/vent in the port and plugging the tapped holes. It is important not to plug the vent since venting is necessary.
- The mounting between the actuator and the valve body is designed to allow installation with the fluid vent plug remaining at the highest point in the system regardless of pipeline orientation. The actuator will operate in any orientation, but it is recommended that the vent be on top to aid in recharging the hydraulic fluid.
- The filter regulator will need to be re-tubed to accommodate its new position. Use only the comparable size and type tubing and fittings as were supplied with the original equipment.
- It may be desirable to rotate the I/P converter, if provided. This will allow the electrical hook up, test, and adjustment points to be made more accessible.

### 2.2.4 Maintenance

#### 2.2.4.1 Actuator assembly and disassembly instructions

### NOTE

All components must be thoroughly cleaned prior to performing these procedures.

The unitized actuator system is made up of two major components:

1. The air over hydraulic actuator
2. The positioner

The positioner used on 1 inch through 4 inch C-Valve actuators is the Moore products Model 73N12F direct acting or Model 73N12FR reverse acting, built-in positioner; and on the 6 inch and 8 inch C-Valve actuators the Model 74 side mount positioner is used.

For service instructions, see Moore products service instructions SD73 or SD74 (Section 5.1 and 5.2). These positioners operate on a 3-15 psig air signal.

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

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### 2.2.4.1.1 Unitized actuator for NPS 1 to 2 C-Valves

This procedure describes the disassembly and assembly of the NPS 1, 1.5, and 2 C-Valve actuator equipped with internal reservoir. The procedure is grouped into sub-assemblies to accommodate different assembly requirements. The fluid should be drained from the actuator prior to beginning this procedure.

#### Required tools and equipment

- 3/8 through 3/4 combination wrenches
- Slotted screwdriver
- 7/16 deep well socket wrench or nut driver
- PTFE tape or suitable hydraulic thread sealant liquid thread lock
- Dow corning 111 or equal silicone grease

#### Actuator disassembly C1-2

- See Figure 2.
- Match mark the entire actuator assembly with a felt marker before disassembly.
- Remove the pneumatic positioner (item 25) by removing the 6 slotted 1/4-20 UNC cap screws. The positioner is probably stuck to the gasket and a sharp tap with a soft mallet should loosen it. The positioner range spring (item 27) is in compression and care must be taken to avoid losing the brass range spring washer and range spring during positioner removal.
- Remove the travel indicator tube (item 39) using only the wrench flats provided.
- Remove the bonnet (item 26), and the coupling clamp (item 6). The bonnet is spring loaded by the return spring (item 3), so hold the bonnet securely while loosening the clamp. Remove the bonnet and clamp.
- Remove the air side diaphragm, plunger assembly, and return spring.
- The hydraulic quad ring seal (item 5) can now be removed for inspection or replacement.
- Remove the coupling clamp to access the reservoir area and the two seal O-rings (items 15 and 16).
- Remove the sight plug (item 12) to access the self-charging check valve (item 11).
- The check valve can now be removed.

#### Actuator assembly C1-2

- In the following order, insert the 1/2-20 x 3/4 hex cap screw (item 28) through the range spring locator (item 29), diaphragm retainer plate (item 30), diaphragm (item 31), piston (item 32), and backup plate (item 33).  
**Note:** the exposed fabric, marked "piston side", of the diaphragm should be in contact with the piston.
- Apply thread sealant to the 1/2" screw and thread it into the tapped hole in the plunger (item 4), torque to 25 ft-lbs.
- Install the filter/breather plug (item 10) into 1/4 NPT port on the outside of the actuator body (item 1).

- Apply thread tape or thread sealer to the check valve (item 11), and sight plug (item 12).
- Install check valve, with flow arrow pointing toward the centerline of the actuator body, into the 1/8 NPT port in the reservoir cavity.
- Install the sight plug in the 3/8 NPT port directly above the check valve.
- Install the quad ring seal (item 5) into the machined groove inside the actuator body. Apply a film of silicone lubricant over the exposed surface of the quad ring.
- Apply thread tape or sealer to 1/4 NPT end of the hydraulic hose assembly and install it into the recessed 1/4 NPT port on the outside of the actuator body.
- Apply thread tape or thread sealer to the reservoir breather (item 18), hand tighten breather into the 1/4 NPT port located on the outside of the cap (item 17). The breather will be fully tightened after charging the actuator.
- Install air vent valve (item 19) into the 1/8 NPT port.
- Install the pressure gauge (item 20) into the remaining 1/4 NPT port. The top of the pressure gauge scale should be positioned toward the air vent.
- Place actuator on a padded flat surface so that the reservoir cavity is facing upward.
- Place the O-rings (items 15 and 16) in their respective grooves.
- Position the cap assembly on body so that the "V" flanges are concentric and the reservoir breather is opposite (180 degrees) from the sight plug on the body.
- Install the coupling clamp so that the clamp screw is in line with the sight plug (item 12) on the body; tighten screw.
- Place the body assembly on a padded flat surface with the large machined cavity facing upward and slide the return spring (item 3) over boss in the center of the body.
- Roll the diaphragm into a convoluted shape.
- Place the piston/plunger assembly on return spring so that spring is captured in the groove on the underside of the backup plate.
- Place the bonnet (item 26) over the piston, approximately center the bonnet and rotate it so that one of the six 1/4-20 tapped holes is in line with the sight plug on the body assembly. Insure the travel indicator rod is centered on the SAE port in the bonnet.
- Compress the spring with the stack of parts so that the plunger passes through the quad ring seal; assist the convolution of the diaphragm into the machined 5-1/2-diameter bore.
- Push the assembly further until the flange of the diaphragm is sandwiched between the flanges on the body and the bonnet.
- Accurately center the body and bonnet flanges and recheck that the tapped hole is still aligned with the sight plug on the body;

and the travel indicator rod is centered, adjust as required, install the coupling clamp to the "V" flange. The coupling clamp screw should be lined up with and be perpendicular to the sight plug on the body. Hand tighten the clamp screw. Recheck bonnet for alignment with body, adjust as required and fully tighten clamp screw.

# CLARKSON C-VALVE SLURRY CONTROL VALVES

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### Actuator mounting procedure NPS 1 to 2 C-Valve

- Apply thread tape to ¼ NPT end of the hose assembly (item 2). Screw ¼ NPT end of hose assembly into angled port in the side of the actuator assembly by using a ⅝ open-end wrench.
- Apply double sided tape or adhesive to the ends of the curved section of the mounting brackets (item 9). Place mounting pads (item 8) on corners where the tape was applied.
- Pass the 2-¼ long hex cap screws through mounting brackets, C-Valve body holes and flat washers. There should be a flat washer on either side of each bracket leg. Hand tighten nuts.
- Apply thread tape to 45 degree elbow (item 14) and install the fitting in the C-Valve body port.
- Place actuator assembly on mounting brackets. The breather vent on the bottom of the actuator should be between the brackets, and pointed directly at the centerline of the actuator. Place band clamps (item 7) around the actuator and brackets, tighten clamps so that actuator can still be shifted on the brackets. Make final adjustments required to make the actuator and valve body parallel to each other. Tighten mounting screws and band clamps.
- Connect hose assembly to the 45 degree elbow on the valve body. The hose should lie in a flat plane; adjust as required.
- Attach bottom bracket with the 2 inch long hex screws, nuts, and lock washers to the valve body.
- Apply thread tape to hex nipple. Place dust cap loop over nipple end and thread the nipple into the ¼ NPT port on the bottom of the valve body. Thread the quick disconnect coupling onto nipple.
- Attach the positioner (item 25) to the end of the actuator so that the middle ¼ NPT port is level. Install gauges and fittings (item 21, 22, 23 and 24) as shown on the illustration, Figure 2.
- Install the travel indicator over the indicator rod and into the SAE port. Tighten using only the wrench flats provided.
- See hydraulic charging procedure, Section 2.2.4.2, for charging instructions. See installation, Section 2.2.3 for installations.

### 2.2.4.1.2 Unitized actuator for NPS 3 and 4 C-Valves

Inspect all rubber components before starting to assemble components. Replace scratched or torn components. All hydraulic fluid should be drained prior to beginning this procedure.

### Required tools and equipment

- Screwdriver
- ⅜, ⅝, ¾ combination open end-box end wrenches
- ⅜ allen wrench
- Air pressure regulator
- Hydraulic fluid
- Scissors and hand hydraulic charging pump

### Actuator disassembly C3-4

- See Figure 3.
- Match mark the entire actuator assembly with felt marker before disassembly.
- Disconnect the hydraulic hose (item 48) and catch any leakage in a suitable container.
- Remove the actuator assembly from the C-Valve body.
- Support the actuator assembly using the angle bracket (item 43) so that the positioner is on top.
- Remove the positioner, range spring, and spring brass washer (items 1 and 15). Take care not to damage the gasket, or lose the range spring or brass washer.
- Remove the travel indicator tube (item 12) using only the wrench flats provided.
- Remove the cap screws (item 13) holding the upper housing (item 14) to the assembly.
- Loosen the diaphragm (item 21) flange from the housing flanges, and remove the upper housing.
- Note and mark the position of the travel indicator rod (item 18).
- While securely holding the piston rod (item 24) with a ⅝ box wrench, loosen and remove the hex jam nut and spring locator (item 16 and 17). Be careful not to twist this assembly.
- Remove the retainer plate, diaphragm, piston, and back-up plate (items 20, 21, 22 and 23).
- Loosen and remove the six hex socket cap screws (item 40) from the bottom side of the lower housing (item 36), and remove the entire hydraulic cylinder/piston assembly from the lower housing.
- Remove the remaining hex jam nut (item 16). The remaining hydraulic side components can now be separated.

### Actuator assembly C3-4

- Place the hydraulic diaphragm (item 29) with the rubber side out (fabric side should be identified as "piston side" and placed against the piston) and slip it over hydraulic piston (item 26). Align the holes in the piston and diaphragm.
- Place the back-up plate (item 25) over threaded piston rod (item 24), on the end opposite the hexagonal wrench flats.

- Push the hydraulic piston with diaphragm onto the threaded piston rod and over the back-up plate.
- Slip the O-ring (item 31) over piston rod and against diaphragm.
- Slip retainer plate (item 30) onto piston rod.
- Install the seal washer (item 32) over the guide rod with the tapered side against the O-ring and the shoulder inserted into the hole in the retainer plate.
- Carefully apply a small amount of thread anti-seize to one end and inside one of the jam nuts (item 16). Screw the jam nut finger tight onto piston rod.

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- Place exposed end of piston rod in a vise with soft protective insulator between the jaws and the piston rod.
- Tighten jam nut to 75 in-lb. torque.
- Roll the diaphragm back on itself, with the flange side out.
- Tuck the diaphragm into the hydraulic cylinder (item 28), mating flange-to-flange. Line up flange holes.
- Place lower housing (item 36) on a flat surface, flange side up.
- Insert guide rod (item 33) into lower housing, apply a liquid thread lock, and tighten as necessary.
- For a NPS 3 C-Valve application only, slip the 1.75 inch long travel limit (item 34) over guide rod.
- Insert hydraulic O-ring (item 35) into the groove in the lower housing.
- Place the complete hydraulic assembly over the guide rod, pushing hydraulic cylinder downward.
- Line up the flange holes and make sure the hydraulic cylinder is seated into the pilot bore of the lower housing.
- Slip reinforcing ring (item 27) over the hydraulic cylinder while lining up flange holes.
- Insert socket-head cap screws (item 40) from the bottom of the lower housing and into the threaded reinforcing ring, finger tight. Tighten in increments, working from side-to-side, rotating in a circle until all screws are torqued to 120 in-lb.
- Inspect the area between the hydraulic piston and the hydraulic cylinder to see that the diaphragm convolution is intact and uniform all the way around the annulus. If not, disassemble and repeat the above procedures. Special care should be taken not to raise piston rod any more than necessary from this point in the assembly procedure onward, as this would likely upset the convolution. Disassemble and repeat the above procedures if the piston rod can be seen to rotate while moving away from the lower housing, indicating that the convolution has been lost or twisted.
- Place the air side back-up plate (item 23) over exposed piston rod.
- Place air diaphragm and air piston (items 21 and 22), with the fabric side of the diaphragm against the piston, over piston rod, carefully tucking the diaphragm inside the lower housing. Use a thin but smooth rounded piece of metal or plastic (tongue depressor) until the diaphragm flange mates with the lower housing flange.
- Slip retainer plate (item 20) and spring locator (item 17) over piston rod.
- Carefully apply a small amount of thread anti-seize to one end and inside one of the jam nuts. Screw the jam nut onto piston rod finger tight.

- Align the travel indicator rod in the same position as originally found on disassembly.
- Restrain the piston rod  $\frac{3}{8}$  hex end from rotating using a box-end wrench with one hand while using the other to tighten jam nut to 75 in-lb.

### NOTE

Take special care not to rotate piston rod and thus put a twist into the hydraulic diaphragm. **This is extremely important.**

If twisting is suspected, disassemble and repeat the above procedures.

- Place upper housing (item 14) onto lower housing, lining up flange holes and the travel indicator.
- Insert cap screws (item 13) into flange holes and tighten finger tight.
- Tighten in increments working from side-to-side, rotating in a circle until all screws are torqued to 75 in-lb.
- Install the travel indicator support tube using only the wrench flats provided.
- Pressurize hydraulic end to 150 psi for 5 minutes to verify that there are no leaks. If the pressure doesn't hold, disassemble, inspect and replace any faulty components and re-assemble.
- Mount the actuator to C-Valve, connect hydraulic hose (item 48). Install to the assembly positioner (item 10) with spring washer and range spring. Charge and calibrate per instructions. (See Section 2.2.4.2 and 2.2.3.1).

### 2.2.4.1.3 Unitized actuator for NPS 6 and 8 C-Valves

Inspect all rubber components before starting to assemble components. Replace scratched or torn components.

#### Required tools and equipment

- Screwdriver
- $\frac{3}{8}$  through  $\frac{3}{4}$  combination open end-box end wrenches
- $\frac{3}{16}$  and  $\frac{5}{16}$  allen wrench
- $1\frac{1}{8}$  deep socket with ratchet handle
- Air pressure regulator
- Liquid thread lock
- Hydraulic fluid
- Scissors and hand operated hydraulic charging pump

#### Actuator disassembly C6-8

- See Figure 4.
- Disconnect the hydraulic hose (item 61) from the C-Valve and catch any leakage in a suitable container.
- Remove the actuator assembly from the C-Valve body.
- Support the actuator assembly using the angle brackets (item 63) with the positioner on the top.

- Match mark the entire actuator assembly with a felt marker before disassembly.
- Remove the air tubing between the positioner (item 43) and the upper housing (item 1).
- Remove the range spring guard (item 51).
- Remove the cap screw (item 55) from the positioner rod (item 17), and remove the positioner complete with range spring (items 43 and 52).
- Remove all the cap screws securing the upper housing to the assembly.
- Carefully loosen the air diaphragm (item 12) flange from the housing flanges and remove the upper housing.

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## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

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- While supporting the internal piston assembly, remove the slotted round head cap screws (item 39) from the opposite end of the assembly.
- Remove the entire piston assembly from the piston case by pulling out from the open end.
- Place the hydraulic end of the casting (item 36) on a flat surface or table with the diaphragm end facing up.
- While securely holding the air side retainer plate (item 11), loosen and remove the hex jam nut (item 8), washer, (item 9) travel limit (item 10) and the O-ring (item 31) if installed.
- Remove the retainer plate, diaphragm, air piston (item 13), back-up plate (item 16), and spreader tube (item 22).
- Loosen and remove the ten hex socket cap screws (item 25) from the clamp ring (item 27) and remove the ring.
- Remove the large O-ring (item 35).
- Loosen the diaphragm gasket and remove the piston assembly from the hydraulic end of the casting.
- Remove the remaining hex jam nuts and the remaining hydraulic side components can now be separated.
- Insert guide rod (item 33) into hydraulic end, apply a liquid thread lock and tighten as necessary.
- For a NPS 6 C-Valve application only, slip the travel limit tube (item 34) over guide rod.
- Insert the O-ring (item 35) into the groove provided inside the hydraulic end.
- Place the just completed hydraulic piston assembly over the guide rod, lowering the assembly down onto the machined cast surface along with the O-ring. Insure the hydraulic cylinder and diaphragm flanges seat into the casting. It may be necessary to trim the diaphragm flange to insure seating. Adjust the assembly as necessary to insure concentricity between the hydraulic cylinder and hydraulic piston.
- Place the clamp ring (item 27) over the hydraulic cylinder and lower into the cylinder.
- Install the cap screws and lock washers (items 25 and 26) to secure the clamp ring and tighten in a cross pattern until all are torqued to 120 in-lb.
- Place the spreader tube (item 22) over the guide tube and into the groove provided in the backup plate.
- Inspect the area between the hydraulic piston and the hydraulic cylinder to see that the diaphragm convolution is intact and uniform all the way around the annulus. If not, disassemble and repeat the above procedures. Take special care not to raise piston rod any more than necessary from this point in the assembly procedure onward, as this would likely upset the convolution. Disassemble and repeat the above procedures if the piston can be seen to rotate while moving away from the lower housing, indicating that the convolution has been lost or wrinkled.
- Carefully apply a small amount of thread anti-seize to one end and inside of one of the jam nut. Screw the jam nut finger tight onto piston rod.
- Restrain piston assembly with one hand while using the other to tighten jam nut to 75 in-lb. of torque.

### NOTE

Take special care not to rotate piston rod and thus put a twist into the hydraulic diaphragm. **This is extremely important.**

### Actuator assembly C6-8

- Install the threaded clamp collar (item 21) onto the guide tube (item 20). Turn the clamp away from the hollow end of the guide tube until it seats against the square shoulder and tighten the cap screws to 120 in-lb torque.
- Install the hydraulic end backup plate (item 23) onto the guide tube with the grooved end toward the clamp collar.
- Place the piston (item 24) over the backup plate and onto the guide tube.
- Place the hydraulic diaphragm (item 29) with the rubber side out, (fabric side should be identified as "piston side" and placed against the piston) slip it over hydraulic piston and onto the guide tube.
- Place the O-ring (item 31), the retainer plate (item 30) and the seal washer (item 32) onto the guide tube and against the diaphragm. Carefully apply a small amount of thread anti-seize to one end and inside of one of the jam nuts. Screw the jam nut (item 8) onto guide tube and tighten the nut to 150 in-lb. Torque.
- Roll the diaphragm back on itself, with the flange side out.
- Tuck the diaphragm into hydraulic cylinder (item 28), mating flange-to-flange. Take care to insure the diaphragm forms a proper convolution roll with no wrinkles.
- Place the hydraulic end casting (item 36) on a flat surface or table with the open end facing up.
- Insert the positioner actuating rod (item 17) with nut and lock washer into the backup plate (item 16) on the side with the roll pins. The end of the rod should just be flush with the top surface of the plate. Tighten the nut securely.
- Place the back-up plate over the guide tube with the three roll pins inside the spreader tube for alignment. The positioner actuating rod will fit through a groove provided in the hydraulic end flange.
- Place air piston (item 13), with the guide shoes installed and air diaphragm (item 12) over the piston rod. Be sure the fabric side of the diaphragm contacts the piston.
- Slip retainer plate (item 11), O-ring (item 31), travel limit (item 10) and flat washer (item 9) over piston rod.

# CLARKSON C-VALVE SLURRY CONTROL VALVES

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If twisting is suspected, disassemble and repeat the above procedure.

- Turn the entire assembly upside down and place on 2 x 6 inch wooden blocks.
- Roll the large air diaphragm down as far as possible toward the table.
- Turn the large piston case (item 37) with the flange down and place over the piston assembly. Align the groove with the positioner rod.
- Secure with the slotted cap screws and flat washers (items 39 and 38). Be sure to install the range spring guard bracket (item 40) with the screw closest to the positioner mounting point.
- Turn the assembly back over and stand it on the hydraulic-end casting.
- Carefully tuck the air diaphragm into the gap between the piston case and the piston using a thin flat dull blade such as a tongue depressor or deburred shipping banding strap.
- Place upper housing (item 1) onto the assembly, lining up flange holes. Be sure the diaphragm flange is not wrinkled or folded over.
- Install the lifting bracket (item 4), in line with the positioner mounting pad, using the hex socket cap screws (item 5), lock washers and hex nuts (items 6 and 7).
- Insert cap screws (item 2) into flange holes and tighten finger tight.
- Tighten in a cross pattern, rotating in a circle until all screws are torqued to 75 in-lb.
- Pressurize hydraulic end to 150 psi for 5 minutes to verify that there are no leaks. If the pressure doesn't hold, disassemble, inspect and replace faulty components.
- Install the positioner (item 43), range spring (item 52), positioner mounting bracket (item 41), and range spring guard (item 51) to the boss provided.
- Connect the range spring arm (item 54) to the positioner rod, align and tighten.
- Mount the actuator to C-Valve. Connect hydraulic hose (item 61), and the air tubing to the positioner. Charge and calibrate per the instructions in Sections 2.2, 4.2 and 2.2.3.

### 2.2.4.2 Hydraulic charging procedure

In order to facilitate charging the C-Valve with unitized actuator, a low pressure hydraulic source is required. A hand pump with hose, fitting, and pressure gauge is available from the factory, but any pressure source properly cleaned and configured will work. The hydraulic source should include a pressure gauge (0-100 psi) and a short length of hose with a female quick disconnect fitting (Aeroquip #5601-4-4S or Emerson P/N 3004) for connecting to C-Valve hydraulic fill port.

All unitized actuators have vent ports in the hydraulic chamber. The valve body is supplied with a male quick disconnect fitting to allow charging (Aeroquip #5602-4-4S or Emerson P/N 3005). The other valve body port is connected to the unitized actuator by a flexible hydraulic hose.

### For NPS 1 to NPS 2 C-Valves

#### Required tools and equipment

- $\frac{3}{16}$  or small adjustable wrench
  - Slotted screw driver
  - Hydraulic pressure supply source
  - Small flexible spout funnel
  - Air chuck (optional)
  - Small cup or flask
  - One-half gallon hydraulic fluid (see 'Hydraulic fluid selection' in Section 1.5)
  - Actuator assembly drawing Figure 2
- 
- Position the actuator assembly so that the reservoir breather (Item 18) is at the highest point in the hydraulic system and the assembly is tilted about 15 degrees from horizontal.
  - Remove the breather fitting.
  - Fill the reservoir with fluid using the funnel.
  - Replace the breather.
  - To minimize fluid leakage, if the assembly was removed from the pipeline for servicing, shut and lock the breather valve until the valve is reinstalled in the pipeline.
  - The breather should be open when the valve is in service.
  - Connect hydraulic pressure supply source to the male quick disconnect coupling on the valve body.
  - Depress air vent (Item 19) valve with an air chuck or by hand.
  - Slowly pump fluid into the hydraulic system until clear fluid flows from the air vent.
  - Disconnect the coupling.
  - Connect 75 psig air supply to supply port on valve positioner.
  - Gradually apply a 15 psig air input to the instrument port on the positioner (Item 25).
  - Stroke the valve several times by varying the instrument air pressure from 0 to 15 psig.
  - Remove all air pressure from the unit.
  - Reconnect the hydraulic pressure supply source to the valve charging fitting.
  - Pump the hydraulic pressure to about 20 psig and disconnect the coupling.
  - Release fluid from the air vent until the hydraulic pressure drops to 5-7 psig.
  - If air bubbles are seen, repeat steps 3, 4 and 5 until all air is purged.

# CLARKSON C-VALVE SLURRY CONTROL VALVES

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### For NPS 3 to NPS 8 C-Valves

#### Required tools and equipment:

- Hydraulic pressure supply source
- ¼ hex key (allen wrench)
- Dry absorbent rag to catch vented fluid
- Hydraulic fluid [see 'Recommended hydraulic fluids' in Section 1.5]
- Actuator assembly drawing Figures 3 and 4

- Position the actuator so that the vent plug is on top.
- Open the vent plug and pump fluid into the system until fluid appears at the vent.
- Close the vent and continue to pump fluid into the system until the needle on the pressure gauge moves to 5-10 psig of hydraulic pressure precharge.
- Open the vent plug slightly to discharge any air in the system.
- Use the handpump to replace any lost volume.
- Close all vents and cycle the actuator three or four times, then repeat the final bleed procedure, and precharge to 5-10 psig.

### 2.3 KINDLE PILOT PNEUMATIC HYDRAULIC ACTUATORS

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#### 2.3.1 General information

The pneumatic hydraulic actuator (pilot) is a control device designed to supply regulated hydraulic pressure to the Clarkson C-Valve by following a 3-15 psig air control signal. This signal can be generated directly from a pneumatic controller, or manual loading station, or can be converted from a 4-20 mA DC electrical signal using a current to pressure transducer (I/P).

#### 2.3.2 Operation

The kindle pilot actuator multiplies the input air signal pressure change by a 20:1 ratio in the hydraulic output pressure. For example if the pneumatic control signal increases by 10 psig, (example from 4 to 14 psig), the output hydraulic pressure will increase approximately 20 times this amount or 200 psig. The pilot includes a "bias" air pressure regulator which can be used to set the instrument signal "zero point" anywhere between 0 and 15 psig. The normal purpose of this adjustment is to limit the hydraulic output pressure to the requirements of the particular C-Valve in use. This is accomplished by reducing the effective input signal pressure range and therefore the maximum output pressure. The hydraulic pressure source is normally provided by a separate electric hydraulic power unit such as the Clarkson 2GL unit.

#### 2.3.3 Installation

The pilot is installed between the hydraulic pressure source and the C-Valve. It can be installed in any orientation. Its location should be fairly close to the C-Valve to minimize the pressure losses in the piping. Be sure to consider flow friction losses in designing the piping system layout and pipe size. If possible, the pilot should be located above the hydraulic pressure source, but below the C-Valve port with the pressure line connected to the lower C-Valve port, to aid in purging air from the hydraulic lines. Install isolation valves on both the inlet and outlet lines of the pilot. The system can be purged by removing the plug from the top port on the C-Valve, and pumping fluid through the circuit until all visible air bubbles stop. Since the hydraulic fluid is subject to freezing, it is best to locate the pilot inside a building, or to provide heating.

All connections are made to the ¼ NPT pipe nipples on the outside of the kindle pilot enclosure. See the outline dimension drawing for port locations. Air supplied to the pilot should be filtered to minimize the possibility of contamination. The pilot "bias" air regulator should be set to limit the maximum output pressure to the C-Valve to avoid damaging the valve's muscle. See Table 1, Section 3.4 for actuation pressures. If the bias air is set above 3 psig the controller range or span can be adjusted to allow operation over the full control range.

#### 2.3.4 Maintenance

This unit does not require regular maintenance. If the pilot acts "sticky" or stops maintaining proper output pressure, the hydraulic pilot valve may be clogged. It can sometimes be cleaned by removing the ⅜" hex plug from the bottom of the device. This should be done with the pressure from the hydraulic pressure source shut off. Then with the supply pressure valve from the hydraulic pressure source cracked opened, adjust the control signal up and down several times to flush out any foreign material. This is often sufficient to clean out any foreign materials and get the unit operating again. If this does not solve the problem, then the pilot may need to be repaired. Such repair should always include replacing all the rubber parts. See Figures 5 and 6 for aid in reassembling the pilot.

### 2.4 CLARKSON C-VALVE WITH PLC (PROGRAMMABLE LOGIC CONTROLLER) SYSTEM

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#### 2.4.1 General information

This system is designed to control the hydraulic pressure supplied to the C-Valve for slurry flow control. The system normally includes the following:

- Pressure transducer which indicates the hydraulic pressure within the C-Valve body.
- Three way dual coil closed center solenoid valve to adjust the hydraulic pressure to the C-Valve.
- Flow control needle valve to modulate the oil flow to the C-Valve.
- PLC to control the system (an existing DCS system can be programmed for this function if desired).

# CLARKSON C-VALVE SLURRY CONTROL VALVES

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### 2.4.2 Operation

In operation, the customer supplied analog control signal of 4-20 mADC is input into the PLC. This signal value is compared to the analog feedback signal from the pressure transducer attached to the C-Valve hydraulic port. The PLC logic then energizes the appropriate coil on the dual coil solenoid valve, through built in relays, to adjust the pressure to the required value for flow control. An adjustable needle valve dampens the hydraulic fluid flow to allow smooth C-Valve pressure changes. A change in the control signal will cause the PLC to readjust the C-Valve to the new pressure. Also, drift in the feedback pressure will also cause the system to reset to the control point. On electrical power failure to the PLC or loss of either input signal, the C-Valve will lock in last position. If only the input or feedback signals are lost signal alarm relays will be energized. These relays are #5 for valve 1 and #6 for valve 2 on the PLC. The 'electrical power loss-lock in last position' included in the system is subject to drifting to open position with time. A true 'hydraulic pressure loss-lock is last position' could be installed as an option.

The PLC supplied by the factory is a Modicon Micro. This unit can be pre-programmed to operate two separate C-Valves following two separate input control signals. Each C-Valve will require a separate three-way solenoid valve, transducer, and needle valve. A single model 2GL hydraulic power unit supplying 375 to 400 psig can be used to operate several separate C-Valve systems. The PLC can be programmed for either direct or reverse acting operation.

Each different Clarkson C-Valve requires a unique maximum hydraulic pressure to obtain the allowable maximum throttling position without valve damage. This pressure value is set within the program in the PLC. The ability to adjust this set point is available for the PLC with an optional program called 'modsoft', or through an optional keypad interface available with the PLC.

### 2.4.3 Installation

The general arrangement of the components in this system is shown on the schematic drawing C6904 (ref. Section 4.9). This drawing also shows how these components are interconnected. For details on installation of the 2GL HPU see the appropriate referenced drawings. Separate instructions are also available for the C-Valve. It is suggested that the pressure transducer and gauge be mounted and connected in close proximity to the C-Valve. The three-way control valve with the flow control valve can be mounted near the hydraulic pressure source.

### 2.4.4 Wiring

The wiring required for the PLC with two C-Valves for this system involves the following basic steps. Reference wiring drawing C6926 (ref. Section 4.10) for details.

1. Wire 24VDC power to the power terminals on the PLC.
2. Connect the valve #1 feedback pressure transducer to analog input terminals 14 and 15.
3. Connect the valve #2 feedback pressure transducer to analog input terminals 20 and 21.
4. Connect the valve #1 control signal of 4-20 mADC to analog input terminals 11 and 12.
5. Connect the valve #2 control signal of 4-20 mADC to analog input terminals 17 and 18.
6. Connect the valve #1 solenoid coil A to relay outputs 1A and 1B.
7. Connect the valve #1 solenoid coil B to relay outputs 2A and 2B.
8. Connect the valve #2 solenoid coil A to relay outputs 3A and 3B.
9. Connect the valve #2 solenoid coil B to relay outputs 4A and 4B.
10. The two valve 'SIGNAL FAULT' relays can be wired to sound an alarm if desired. They are connected to output relay terminals C, 5C and 6C.
11. Be sure to install the jumper wires shown on the wiring drawing.

### 2.4.5 Calibration

The calibration of this system, assuming a fixed ratio pressure transducer, is accomplished by the PLC or DCS programmer. If a variable ratio pressure transducer is used, adjusting its setting can change the system control set point. If the optional 'Key pad' is purchased with the PLC, some calibration adjustments can be input directly. The overall goal of any calibration is to allow the pressure to the C-Valve to range from zero to the maximum allowable pressure with an input signal varying from 4-20 mADC.

## 3 TROUBLESHOOTING AND MAINTENANCE

### 3.1 PREVENTATIVE MAINTENANCE

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The following recommendations will help in maintaining the C-Valve.

- Keep the outside of the valve clean so that gauges can be read and filter/ breathers are clear.
- Inspect regularly for leakage of air, hydraulic fluid, or slurry. Locate the source and correct any leak immediately.
- Keep all gauges in working condition.

Troubleshooting and calibration require accurate measurement of air supply, instrument, air diaphragm, and hydraulic pressure.

- Because the C-Valve sleeve is a replaceable wear part, it is recommended that a maintenance log be used to record sleeve life. This information can be used to schedule sleeve replacement and stock spare parts.
- Do not use the C-Valve as an isolation valve or leave in the fully closed position for long periods.

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

### 3.2 TROUBLESHOOTING UNITIZED ACTUATORS

The following flowchart can be used to troubleshoot a problem with a C-Valve equipped with a unitized actuator.

Problem	Solution	Result
1. Proper elect. signal from controller?	Correct control.	Problem solved Problem not solved: go to 2
2. I/P air supply regulator set at 25 psi?	Provide regulated 25 psi air to I/P.	Problem solved Problem not solved: go to 3
3. I/P produces full range air signal 3-15 or 15-3 psi?	Adjust, fix, or replace I/P. See Note 1.	Problem solved Problem not solved: go to 4
4. Regulated air supply present at positioner supply port?	Check and adjust air supply regulator. See Note 2.	Problem solved Problem not solved: go to 5
5. Positioner air output and hydraulic press. Is proportional to instrument air signal?	Check: range spring seating, positioner zero point, piston position. Repair as required. See Note 3.	Problem solved Problem not solved: go to 6
6. Valve controls flow in middle range of input signal when operating under normal conditions?	Check valve sizing for proper C <sub>v</sub> range. check sleeve and/or muscle for wear. Replace as required. See Note 4.	

#### NOTES

1. See I/P supplier's operating and maintenance manual for details (ref. Section 5.3 of this manual).
2. Use initial setting of 75 psi; setting can be reduced to 5 psi over maximum air diaphragm pressure to prevent over pressurizing muscle.
3. See Moore products service instructions for details. If piston is not in its fully retracted position, determine and fix the cause of leakage and recharge per operating and maintenance instructions (ref. Sections 5.2 and 5.3 of this manual).
4. See Clarkson C-Valve sizing guide for valve application information.

### 3.3 TROUBLESHOOTING PLC SYSTEM

The following is a partial list of possible system problems and likely solutions. This is based on using the Modicon 612 PLC. Items with \* are for complete unit P/N 41102 with key pad and power supply.

System does not show power light:

- Check proper power is supplied to connections (24 VDC).
- Check for readout on keypad.\*
- Check for run and ready lights on PLC.
- Check power supply light illuminated.\*
- Check fuses.\*

MT-200 Keypad interface has no readout:

- Check power lead is connected to PLC 'com 1' port.

PLC output lights #5 and #6 illuminated:

- Check for control and feedback signals for valve 1 with light #5, and valve 2 for light #6.
- Check these signals are not less than 4 mA DC (408-412 digital).

C-Valve closing to far:

- Check and reset the maximum pressure to the valve on the MT-200 unit.\*

C-Valve is not following control signal:

- Check connection to three way solenoid valve, both electric and hydraulic.
- Check that the 2GL hydraulic power unit is operating and properly connected.
- Check to insure flow control hydraulic needle valve is not fully closed off.
- Check the delay time is sufficient and the flow control hydraulic needle valve is open enough to allow the valve to open in a reasonable time.\*

C-Valve not operating smoothly:

- Set the flow control hydraulic needle valve to reduce the hydraulic fluid flow velocity.

\* These checks can be made by viewing the MT-200 keypad interface unit. Select 'messages, micro' then arrow through to check all status readouts (see MT-200 instructions). If the PLC is purchased without the power supply and keypad this is not relevant.

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## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

### 3.4 NOMINAL C-VALVE MAXIMUM HYDRAULIC PRESSURE AND DISPLACEMENT VOLUME

**TABLE 1**

Valve size NPS	Port code	Sleeve	Pressure (psig)	Displacement volume (cu. in.)
1	P13	1 x .13	180	2.5
	P19	1 x .19	180	2.5
	P25	1 x .25	250	2.5
	P38	1 x .38	250	2.5
	P50	1 x .50	280	2.5
	P63	1 x .63	285	4.0
	P75	1 x .75	290	4.0
	-	1 x 1.00	340	4.0
1 ½	P1	1.5 x 1.00	350	5.0
	-	1.5 x 1.50	285	5.0
2	P1	2 x 1.00	280	9.0
	P15	2 x 1.50	190	10
	-	2 x 2.00	180	12
3	P15	3 x 1.50	235	20
	P2	3 x 2.00	190	20
	P25	3 x 2.50	150	25
	-	3 x 3.00	126	43
4	P2	4 x 2.00	185	46
	P3	4 x 3.00	135	46
	-	4 x 4.00	125	57
6	P3	6 x 3.00	190	70
	P4	6 x 4.00	210	102
	P5	6 x 5.00	145	113
	-	6 x 6.00	133	124
8	P4	8 x 4.00	140	259
	P6	8 x 6.00	200	299
	-	8 x 8.00	140	364

**NOTE**

The maximum hydraulic pressure values in the above Table 1 are based on closing the C-Valve to 50% of the full open port diameter for sleeves with port diameters greater than 2 inches. All values assume the valve ends are flanged. The pressure values for sleeves with port diameters smaller than 2 inches are based on visual closure. All these values are approximate and intended as a guideline only. Values will vary with different sleeve and muscle material selections.

## 4 PART IDENTIFICATION

### 4.1 RANGE SPRING APPLICATION FOR UNITIZED ACTUATORS

**TABLE 2**

Valve size NPS	Port code	Sleeve	Stroke (in.)	Part no.	Color
1	P13	1 x .13	.63	2952	Y-W-Y
	P19	1 x .19	.63	2952	Y-W-Y
	P25	1 x .25	.63	2952	Y-W-Y
	P38	1 x .38	.63	2952	Y-W-Y
	P50	1 x .50	.63	2952	Y-W-Y
	P63	1 x .63	.63	2952	Y-W-Y
	P75	1 x .75	1.00	2953	G-W-G
	-	1 x 1.00	1.00	2953	G-W-G
1 ½	P1	1.5 x 1.00	1.25	2962	O-W-O
	-	1.5 x 1.50	1.25	2962	O-W-O
2	P1	2 x 1.00	2.25	2958	W-B-W
	P15	2 x 1.50	2.50	2959	G-Y-G
	-	2 x 2.00	3.00	7951	O-Y-O
3	P15	3 x 1.50	1.38	2956	R-BR-R
	P2	3 x 2.00	1.38	2956	R-BR-R
	P25	3 x 2.50	1.75	2957	G-BR-R
	P3	3 x 3.00	2.25	2958	W-B-W
4	P2	4 x 2.00	3.25	2961	O-G-O
	P3	4 x 3.00	3.25	2961	O-G-O
	-	4 x 4.00	4.00	2960	BR--BR
6	All sleeves	6 x 3.00-6.00	Adjustable	2593	BR
8	All sleeves	8 x 4.00-8.00	Adjustable	2594	R

**LEGEND**

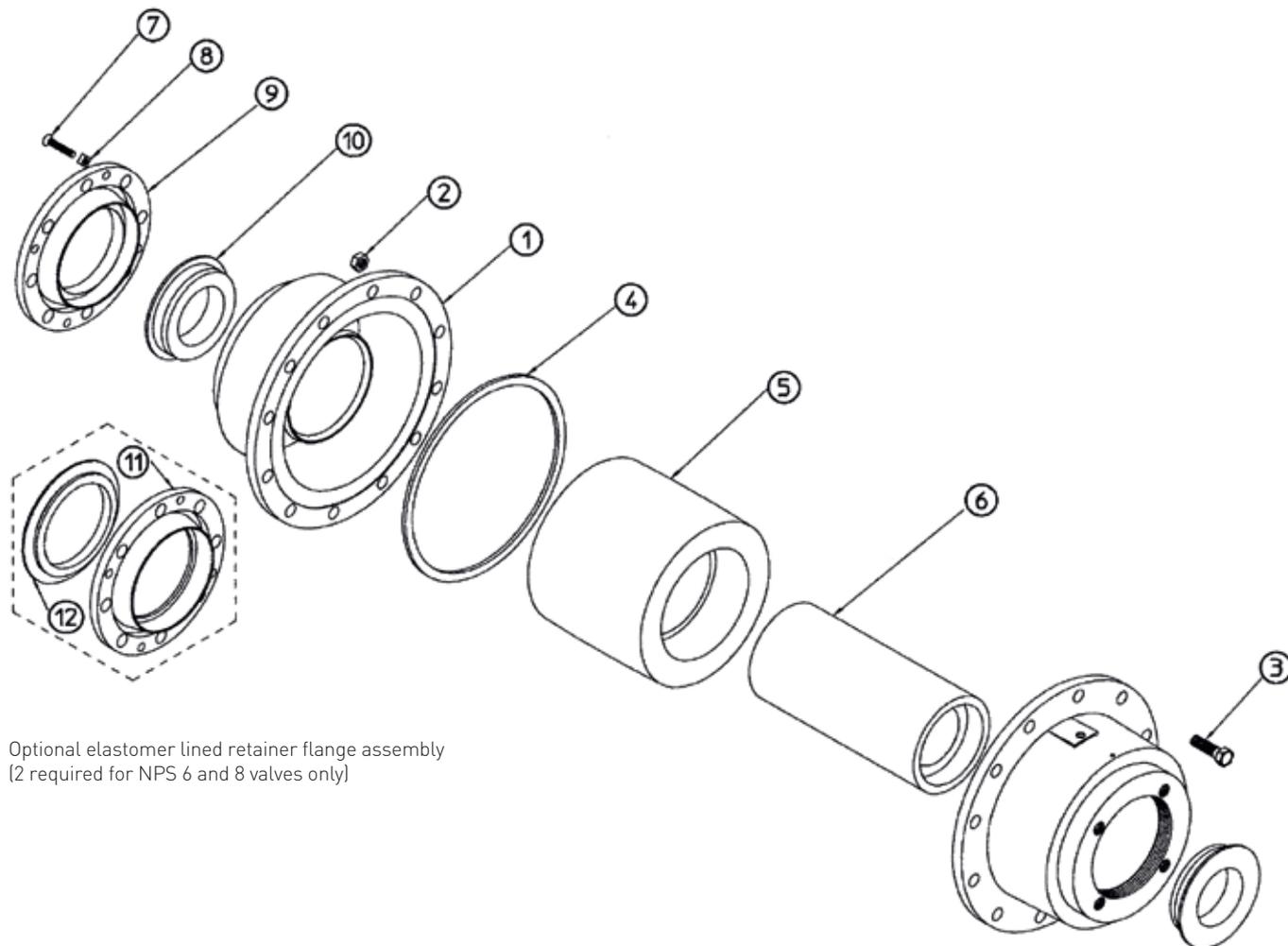
- B** Black
- BR** Brown
- G** Green
- O** Orange
- R** Red
- Y** Yellow
- W** White
- Blank

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

### 4.2 C-VALVE C1-8 LEGEND

FIGURE 1  
C1-8 VALVE BODY



Optional elastomer lined retainer flange assembly  
(2 required for NPS 6 and 8 valves only)

TABLE 3 - C-VALVE C1-8 LEGEND

Item	Description	Part no. 1	Part no. 1½	Part no. 2	Part no. 3	Part no. 4	Part no. 6	Part no. 8	Qty. req.
1	Housing	01321.1	01308.1	01313.1	01316.1	01318.1	01457.2	02358	2
	Housing with groove NPS 8 only							02359	*
2	Housing hex nut	01304	01311	01311	01311	01311	01444	01445	-
3	Housing hex bolt	01920	01127	01127	01320	01596	01464	06540	-
4	Gasket [O-ring on NPS 8 only]	01338	01309	01314	01310	01319	01465	02361	1
5	Muscle	01305	01312	01315	01317	01322	01458	02360	1
6	Sleeve [full port P/N indicated]	01096	01107	01118	01129	01140	01151	01162	1
7	Retainer flange screw (NPS 6 and 8 only)						02432	01707	8
8	Retainer square nut (NPS 8 only)							01728	8
9	Retainer flange (NPS 6 and 8 only)						01294.3	01367.2	2
10	Sleeve retainer (NPS 1-4 only)	02305	02306	02307	02308	02309			2
11	Retainer flange with insert (optional)						02765	02767	2
12	Elastomeric insert						02766	02768	1

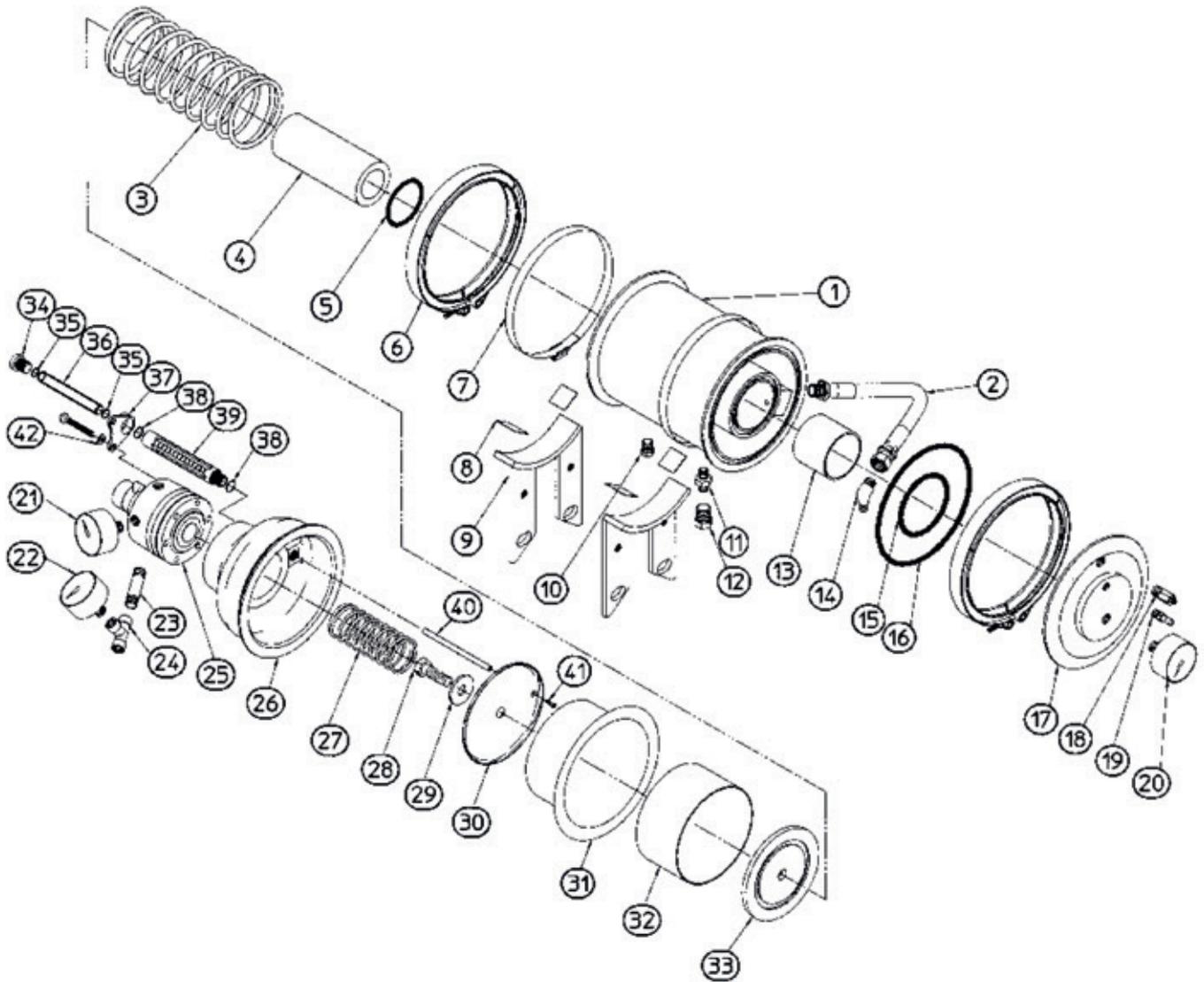
\* One of each part nos. 02358 and 02359 required

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

### 4.3 C-VALVE C1-2 ACTUATOR LEGEND

FIGURE 2  
C1-2 ACTUATOR



# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

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**TABLE 4 - C-VALVE C1-2 ACTUATOR LEGEND**

Item	Description	Part no.	Qty. req.
1	Actuator body C1-2	07866	1
2	Hose assembly	08351	1
3	Return spring C1-2	07906	1
4	Actuator plunger	07882	2
5	Quad ring C1-2	07904	1
6	Coupling camp	07860	2
7	Actuator band clamp C1-2	07907	2
8	Rubber mtg. pad C1-2	07910	4
9	Actuator bracket C1-2	07897	2
10	Fitting ¼ NPT filter/breather	07905	1
11	Check valve	07908	1
12	Sight plug ¾ NPT	07949	1
13	Journal bearing	07858	1
14	Fitting adpt. ¼ NPT x ½ SAEM	07909	1
15	O-ring C1-2 hydraulic	07903	1
16	O-ring C1-2 reservoir	07902	1
17	Actuator cap	07878	1
18	Reservoir breather	07950	1
19	Tank valve ⅛ NPT	07901	1
20	Gauge 0-600 psi	06428	1
21	Gauge 0-100 psi	02913	1
22	Gauge 0-30 psi	01093.3	1
23	Nipple ¼ NPT x 2 SST	02100	1
24	Fitting tee ¼ NPT	03575	1
25	Positioner	02793*	1
26	Actuator bonnet	07867	1
27	Range spring	*	1
28	Screw ½-20 x ¾ HHCS	07952	1
29	Range spring locator	03821	1
30	Retainer plate 5½ RDA	03921	1
31	Diaphragm 5½	03905	1
32	Piston	03916	1
33	Plate backup C1-2	07879	1
34	Plug #6 O-ring	08515	1
35	O-ring	08574	2
36	Travel indicator tube	08570	1
37	Travel indicator bracket	08571	1
38	O-ring	08575	2
39	Tube support	08572	1
40	Indicator rod	08573	1
41	Screw 6-32 x ½ FH SLTD	08543	1
42	Washer ¼ flat	01693.2	2

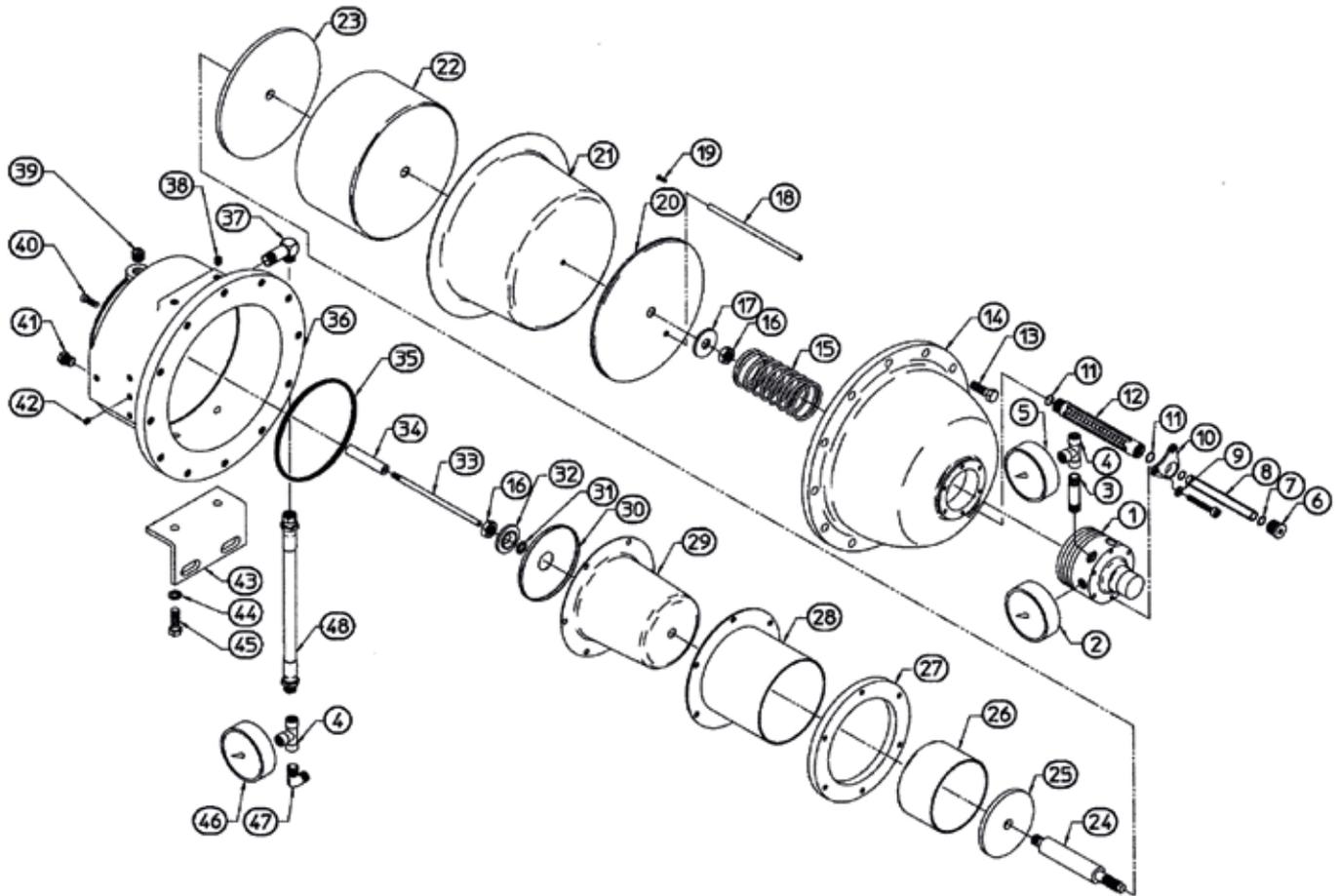
\* Check model code and/or range spring chart in Table 2 for complete part number

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

### 4.4 C-VALVE C3-4 ACTUATOR LEGEND

FIGURE 3  
C3-4 ACTUATOR



# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

**TABLE 5 - C-VALVE C3-4 ACTUATOR LEGEND**

Item	Description	Part no.	Qty. req.
1	Positioner Moore 73N12F/FR	02793*	1
2	Gauge 0-100 psi	02913	1
3	Nipple ¼ NPT x 2	02100	1
4	Fitting Tee ¼ PF STL	03575	2
5	Gauge 0-30 psi	01093.3	1
6	Plug #6 O-ring	08515	1
7	O-ring	08574	2
8	Travel indicator tube	8599	
9	Washer ¼ Flat	01693.2	1
10	Travel indicator bracket	08571	1
11	O-ring	08575	1
12	Tube support	8598	
13	Screw ¾-16 x 1¼ HHCS	01116	12
14	Upper housing	06106	1
15	Range spring	*	1
16	Nut ½-20 hex jam	01392.2	2
17	Spring range locator	03821	1
18	Indicator rod	8600	
19	Screw 6-32 x ½ FH SLTD	08543	1
20	Retainer plate 8" RDA	03820	1
21	Diaphragm 8"	03819	1
22	Piston 8" DRDA	03818.2	1
23	Backup Plate 8" RDA	03817	1
24	Piston rod	08434	1
25	Plate backup 4½" RDA	03812	1
26	Piston 4½" DRDA	08437	1
27	Reinforcing ring 4½" RDA	03814	1
28	Cylinder 4½" DRDA	03813	1
29	Diaphragm 4½"	03810	1
30	Retainer plate 4½" RDA	08436	1
31	O-ring	08435	1
32	Seal washer	08440	1
33	Guide rod	03806	1
34	Travel limit C3 only	08438	1
35	O-ring	08439	1
36	Lower housing	08466	1
37	Fitting ELB ¼-20 x 2 SKT HCS	03338	1
38	Screw ¾ x ½ SKT set	08137	2
39	Pipe plug ¼ NPT	01307	1
40	Screw ¼-20 x 2 SKT HCS	06234	6
41	Fitting ¼ NPT filter breather	07905	1
42	Screw ¼-20 X ¼ SKT set	1373	1
43	Bracket	06164	1
44	Washer ¾ lock	01691	2
45	Screw ¾ x ¾ HHCS	03026	2
46	Gauge 0-300 psi	01906.1	1
47	Fitting ELB ¼ PM	03543	1
48	Hose assembly	03080.4	1

\* Check model code and/or range spring chart in Table 2 for complete part number

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

### 4.5 C-VALVE C6-8 ACTUATOR LEGEND

FIGURE 4  
C6-8 ACTUATOR

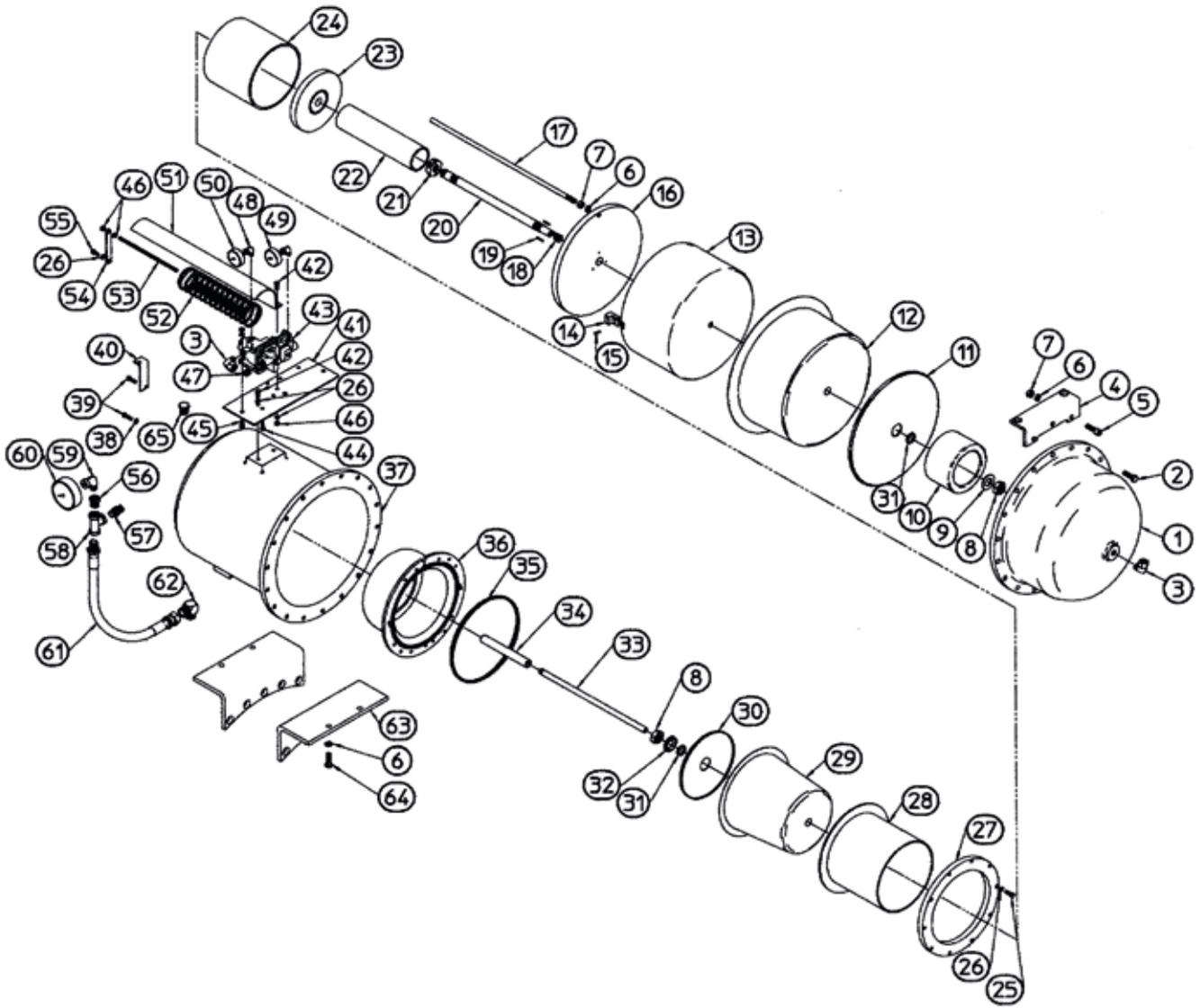


TABLE 6 - C-VALVE C6-8 ACTUATOR LEGEND

Item	Description	Part no.	Qty. req.
1	Upper RDA housing	01955.4	1
2	Screw 3/8-16 x 1 1/4 HHCS	01116	15
3	Fitting ELB 3/8T x 1/4 PM	02828	2
4	Lifting bracket C6-8	06512	1
5	Screw 3/8-16 x 1 3/4 SKT HCS	03224	3
6	Lock washer 3/8	01691	8
7	Nut 3/8-16 hex	01304	4
8	Jam nut 3/8-16 hex	01642.2	2
9	Washer 3/4 flat	03062.2	1
10	Travel limit open position	08528	1

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

**TABLE 6 - C-VALVE C6-8 ACTUATOR LEGEND (CONTINUED)**

Item	Description	Part no.	Qty. req.
11	Retainer plate 12 inch	08527.2	1
12	Diaphragm 12 inch	06563	1
13	Piston 12 inch	03933.2	1
14	Piston guide shoe	06089	3
15	Screw 8-32 x 1/2 SLTD FHMS	03992	6
16	Backup plate 12 inch	08507	1
17	Positioner actuating rod	03894	1
18	Plug #6 SAE	08515	2
19	Roll pin	01563	3
20	Guide tube	08506	1
21	Collar clamp	08516	1
22	Spreader tube	08512	1
23	Backup plate 7 inch	08510	1
24	Piston 7 inch	08509	1
25	Screw 1/4-20 x 1 1/4 HHCS	03908	10
26	Washer 1/4 lock	02886	18
27	Clamp ring 7 inch	03889	1
28	Cylinder 7 inch	03892	1
29	Diaphragm 7 inch	03910	1
30	Diaphragm retainer plate	08511	1
31	O-ring	03900	2
32	Seal washer	08513	1
33	Guide rod	03891	1
34	Travel limit closed (C6 only)	06468	1
35	O-ring	08514	1
36	Hydraulic end	03884	1
37	Piston case housing	03886	1
38	Washer flat 1/4	01693	3
39	Screw 1/4-20 x 1/2 HHCS	06459	2
40	Bracket range spring guard	06170.2	1
41	Positioner bracket	03895	1
42	Screw 1/4-20 x 1/2 RHCS	01524	4
43	Positioner Moore 74N	02588	1
44	Screw 1/4-20 x 3/4 SLTD FHCS	02970	1
45	Screw 1/4-20 x 3/4 HHCS	01508	1
46	Nut 1/4-20 hex	01584	7
47	Pipe plug 1/4 NPT hex SKT	01307	1
48	Fitting ELB 1/8P street	06522.2	2
49	Gauge 0-160 psi	03452	1
50	Gauge 0-30 psi	03451	1
51	Range spring guard C6, C8	06458, 0618	1
52	Range spring C6, C8	02593, 0259	1
53	Stud 1/4-20 x 7/2	02805	1
54	Range spring arm	02688	1
55	Screw 1/4-20 x 5/8 HHCS	01510	1
56	Fitting bushing 3/8P x 1/4P	03139.3	1
57	Fitting adpt street #6 SAE x 3/8 NPT	08557	1
58	Fitting tee 3/8P	06462	1
59	Fitting ELB 1/8P street	03574	1
60	Gauge 0-600 psi	06428	1
61	Hose assembly	04792	1
62	Fitting ELB 3/8 PM x 3/4 SAEM	03176	1
63	Bracket actuator mount C6-8	07256	2
64	Screw 3/8-16 x 1 HHCS	01105	4

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

### 4.6 PNEUMATIC HYDRAULIC PILOT

FIGURE 5  
PNEUMATIC HYDRAULIC PILOT  
(KINDLE PILOT)

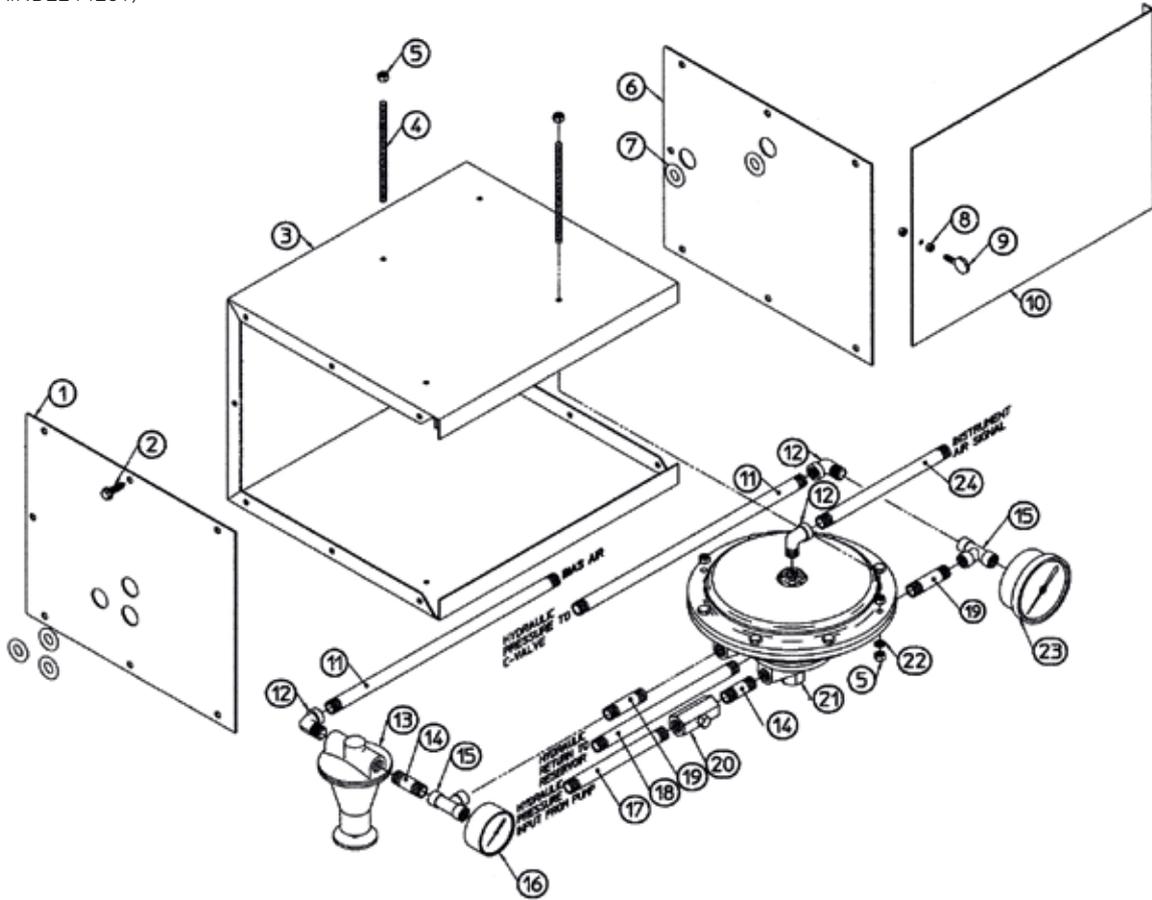


TABLE 7

Item	Description	Part no.	Qty. req.
1	Left side cover	03401	1
2	Screw 1/4-20 x 5/8 self tapping	02930	14
3	Enclosure	03402	1
4	Stud 1/4-20 x 4 7/8	02099	2
5	Nut 1/4-20 hex	01584	6
6	Right side cover	03400	1
7	Rubber grommet	02108	5
8	Nut 10-24 hex	01620	2
9	Thumb screw 10-24	03404	1
10	Enclosure door	02914	1
11	Nipple 1/4 NPT x 13	02115.1	2
12	Fitting ELB 1/4 NPT street	03574	3
13	Regulator 0-15 psig	1092.2	1
14	Nipple 1/4 NPT X 1 1/2	02101	2
15	Fitting tee 1/4 NPT	03575	2
16	Gauge 0-15 psig	01093.2	1
17	Nipple 1/4 NPT x 5 1/2	02102	1
18	Nipple 1/4 NPT x 8	02104	1
19	Nipple 1/4 NPT x 2	02100	2
20	Check valve	01091	1
21	Pilot assembly	01090	1
22	Washer lock 1/4	02886	2
23	Gauge 0-300 psig	01906.2	1
24	Nipple 1/4 NPT x 7 1/4	02103	1

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

### 4.7 PNEUMATIC HYDRAULIC POWER UNIT

FIGURE 6  
PILOT ASSY

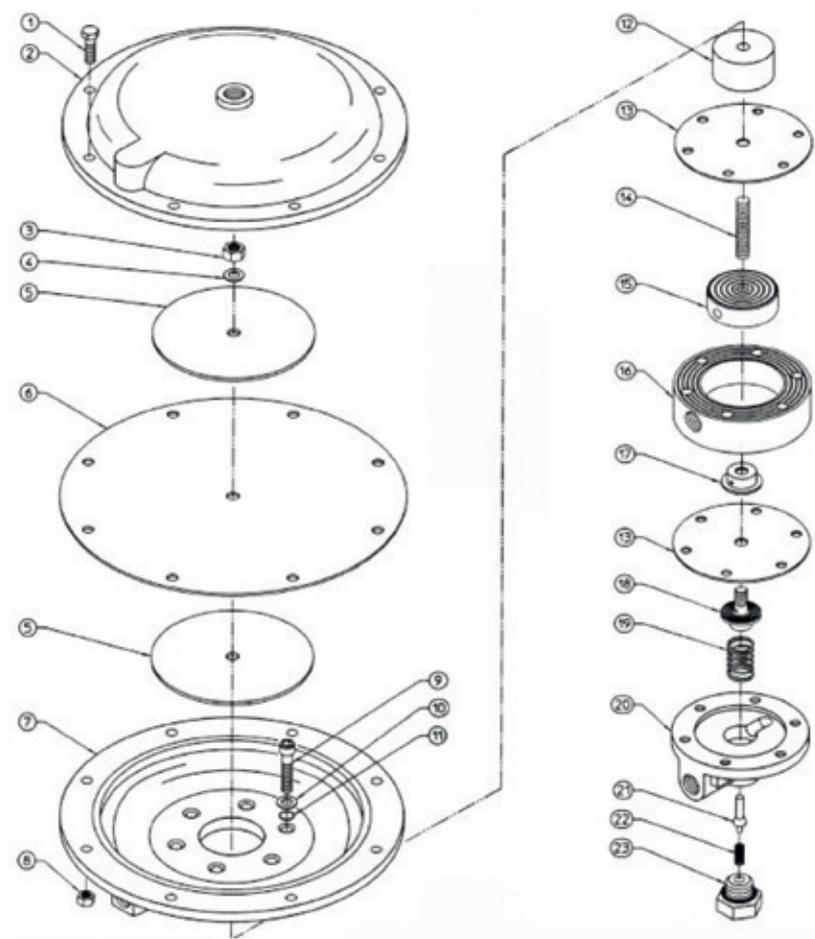


TABLE 8

Item	Description	Part no.	Qty. req.
1	Screw ¼-20 x 1 HHCS	01509	6
2	Upper diaphragm housing	01090.1	1
3	Nut 5/16-18 hex	01358	1
4	Washer ¼ flat	01693	1
5	Low pressure diaphragm plate	01090.4	2
6	Low pressure diaphragm	01090.3	1
7	Lower diaphragm housing	01090.2	1
8	Nut ¼ hex	01584	6
9	Screw ¼-20 x 2 SKT HCS	03681.2	6
10	Washer ¼ flat sae	01693.4	6
11	O-ring	8620	6
12	Diaphragm force block	01090.6	1
13	High pressure diaphragm	01090.7	2
14	Screw low pressure diaphragm	01090.5	1
15	Vent ring spacer block	01090.10	1
16	Center disc	08589	1
17	Upper valve seat	08555	1
18	Lower valve seat	08556	1
19	Neutral spring	01090.13	1
20	Regulating valve housing	01090.16	1
21	Valve plunger	01090.14	1
22	Plunger spring	01090.15	1
23	Plunger return spring plug	01090.17	1

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

### 4.8 2GL HYDRAULIC PUMP UNIT

FIGURE 7  
2GL HYDAULIC PUMP UNIT

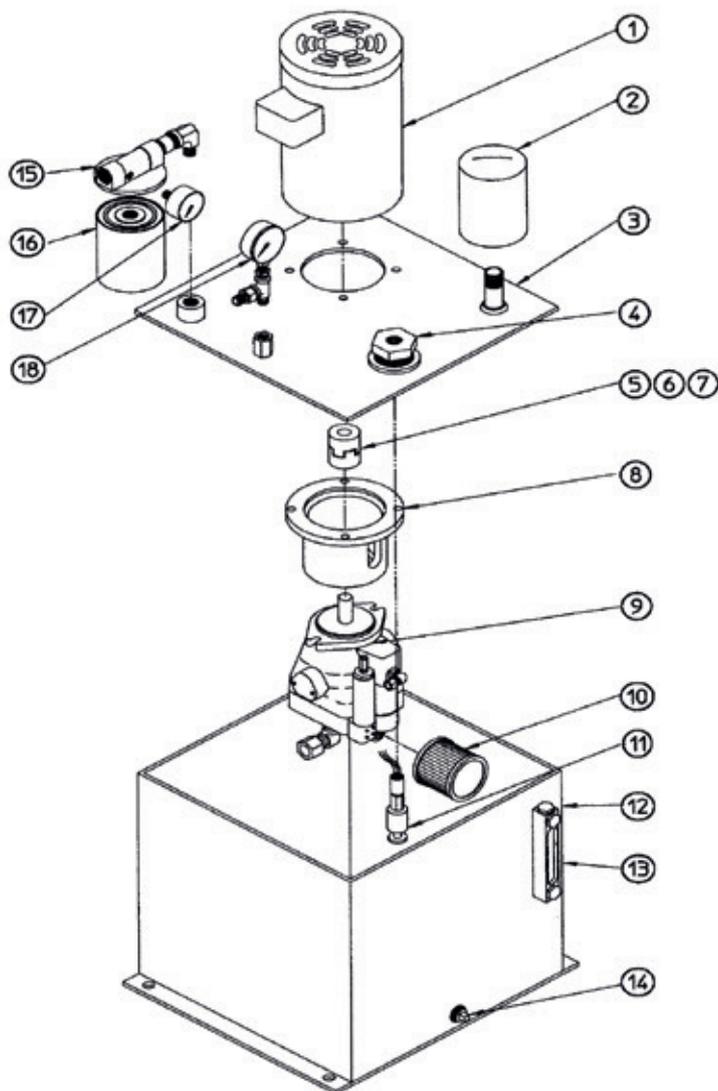


TABLE 9

Item	Description	Qty. req.
1	Motor	1
2	Filter element (03C)	1
3	Top plate HPU	1
4	Hex bushing 1¼ x ½	1
5	Motor coupling	1
6	Coupling insert	1
7	Pump coupling	1
8	Pump adapter	1
9	Pump piston	1
10	Suction strainer	1
11	Temperature/level switch	1
12	Reservoir 12 gal.	1
13	Liquid level/temp. gauge	1
14	Drain plug	1
15	Return filter housing	1
16	Return filter element (10C)	1
17	Filter gauge	1
18	Pressure gauge 0-600 psig	1

**NOTES**

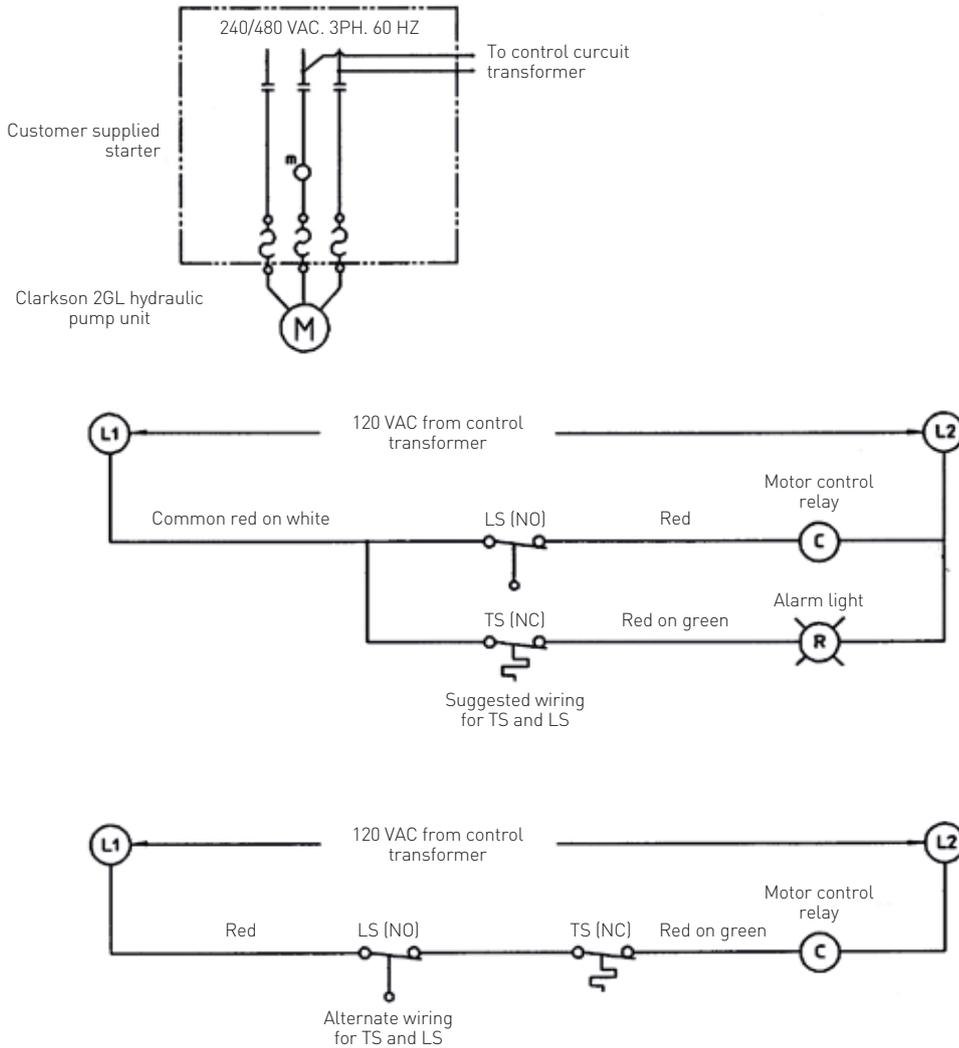
See Parker H.P.U. Section 5.5.

See wiring diagrams Figures 8A and 8B.

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

FIGURE 8A  
3 PHASE 2GL PUMP SYSTEM CONNECTIONS



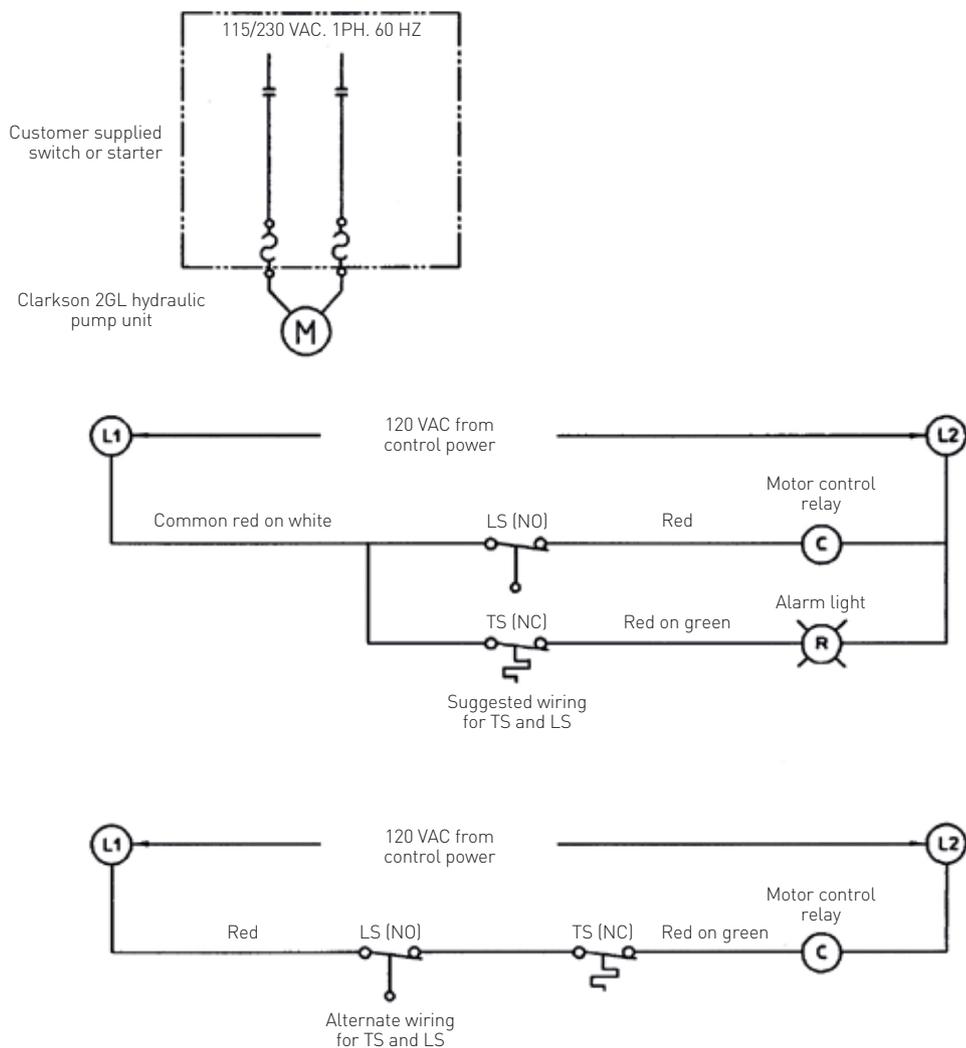
### NOTES

1. The combination temperature switch (TS) and level switch (LS) is supplied on the Clarkson 2GL hyd. power unit.
2. Ts is normally closed contact and opens at 160 degrees F. This contact is usually used for an alarm signal.
3. LS is normally open contact and is closed when the reservoir level is adequate for the unit to operate. This contact should be wired to stop the pump motor if there is not sufficient oil.
4. Phantom lines indicate enclosures.

# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

FIGURE 8B  
1 PHASE 2GL PUMP SYSTEM CONNECTIONS



### NOTES

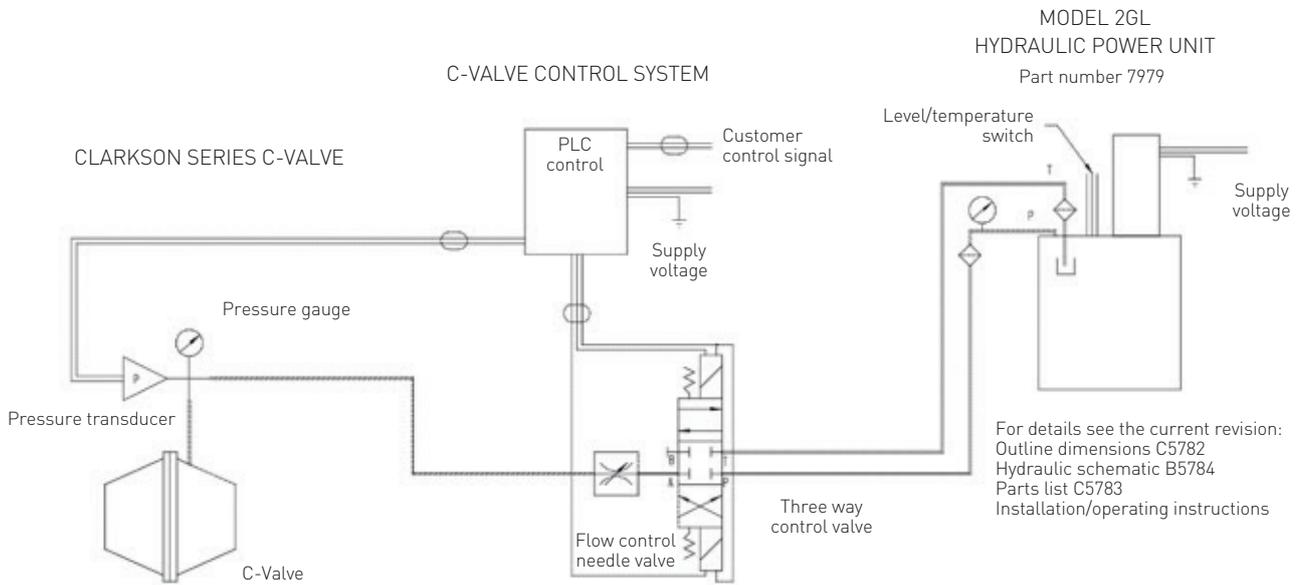
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# CLARKSON C-VALVE SLURRY CONTROL VALVES

## INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

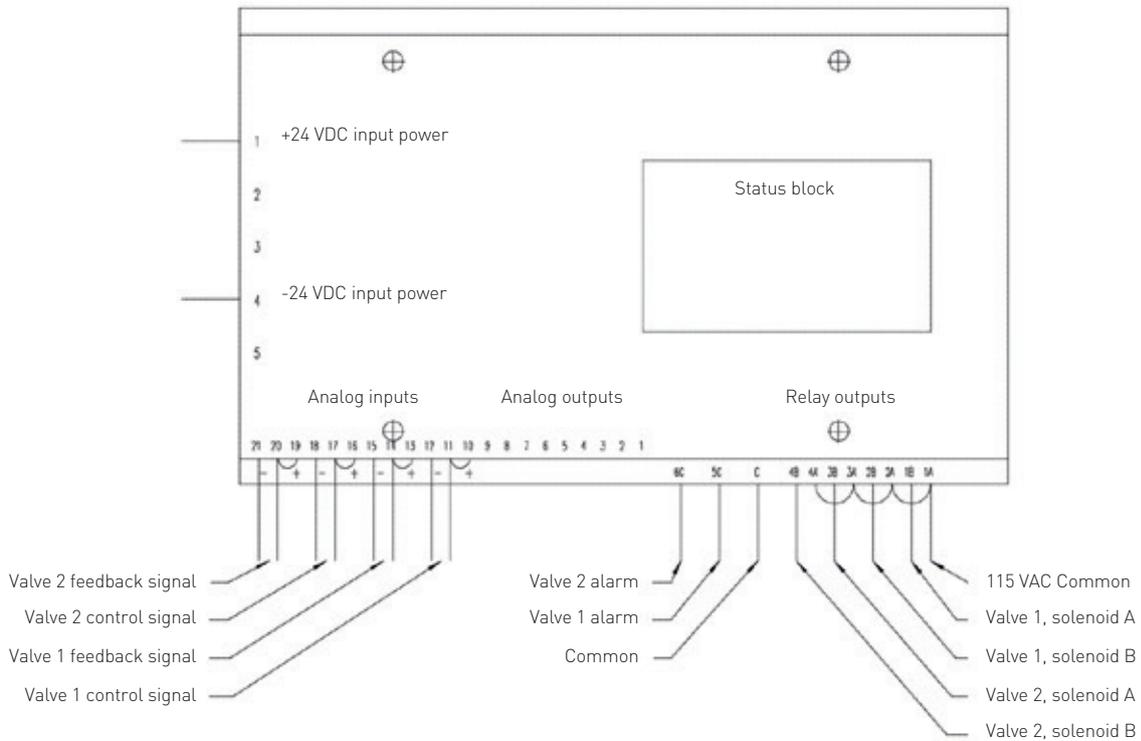
### 4.9 SCHEMATIC - C-VALVE WITH PLC CONTROL

FIGURE 9



### 4.10 DETAIL - WIRING PLC MODICON MICRO #61200

FIGURE 10



#### NOTES

1. All analog signals 4-20 mADC.
2. Shown for 2 C-Valve control.
3. Complete part number depends on program installed.

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