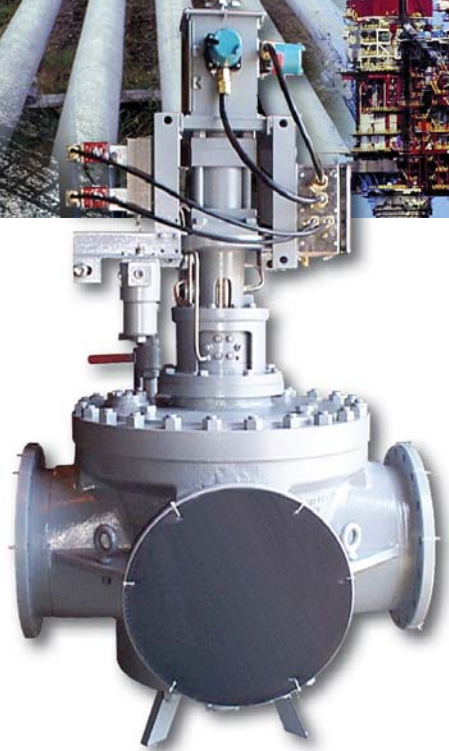


# M&J VALVE

AN SPX BRAND

## Installation, Operation & Maintenance Manual 4-Way Diverter Valve



# **M&J VALVE**

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**SPX - M&J Valve Facility, Houston, TX, is in conformance to ISO 9001:2000 for the design and manufacture of valves and related accessories under IAF scope Category 18.  
APIQR resister number 0093.**

SPX Corporation reserves the right to incorporate our latest design and material changes without notice or obligation. Design features, materials of construction and dimensional data, as described in this bulletin, are provided for your information only and should not be relied upon unless confirmed in writing.

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# INTRODUCTION

This manual contains specific installation, operating and maintenance information for the M & J 4-Way Diverter Valve.

The M & J 4-Way valve consists of the valve body, the diverter plug, S.I.D. gauge assembly, differential check valves, and the lift, turn and seat operating mechanism. All five components are treated as individual segments of the unit for purposes of clarity.

This manual is divided into four sections - general information, installation, operation, and maintenance.

Section I covers description, general characteristics and other pertinent data.

Section II - Installation.

Section III describes functional components and operation.

Section IV provides maintenance instructions for diagnosing SID problems, check valve repair, plug seal replacement, and lift-turn-seat operator instructions.

# M&J Valve 4-Way Valve

## Installation, Operation & Maintenance Manual

### I. General Information

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#### 1. Purpose

The M&J 4-Way Diverter Valve is designed primarily for Bi-Directional meter prover service where its function is to divert the flow streams in opposite directions thru the prover and to provide a means of proof that the flow streams are separated.

The requirements for consistent bubble-tight seal, frequent operation and fast operating times make this valve different than standard on/off valves.

#### 2. Description (See Fig. 1)

The M&J 4-Way Diverter Valve is a wide-angle, tapered, lift plug type 4-way valve with raised face flange ends. It is designed to operate with a lift/turn operator mechanism which may consist of a manual handwheel, electric motor, hydraulic motor, or electro-hydraulic (EH) with separate seat/unseat and rotary operators

#### 3. Characteristics

3.1 In meter prover service the diverter valve has two seated operating positions used in diverting flow through a Bi-Directional prover loop, first in right direction then in the opposite, or left direction.

(See Fig. 2)

3.2 The valve cycles within five to twelve seconds and possibly as often as hundreds of times a day.

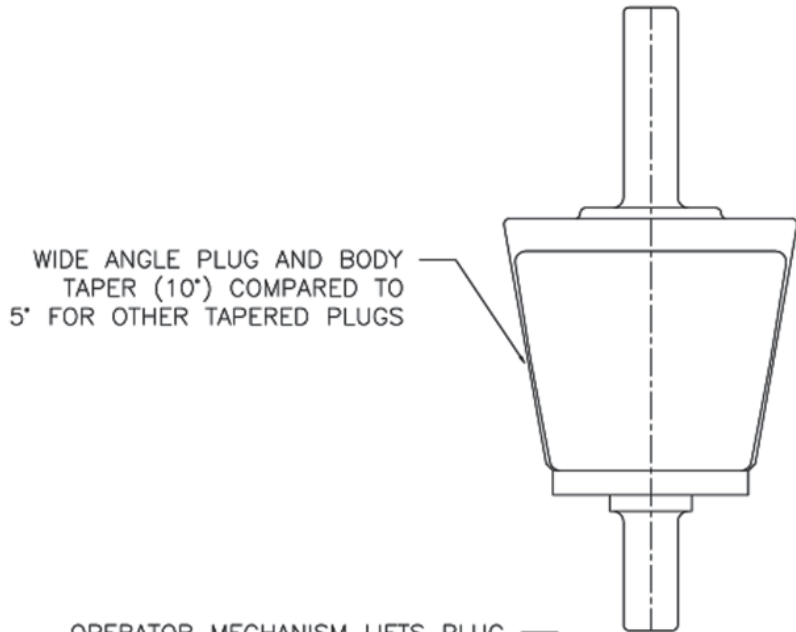
3.3 The diverter plug incorporates two separate resilient seals which separate and isolate the flow streams when the valve is fully seated. (See Fig. 2).

3.4 The plug seals are molded in one piece, interchangeable uniform cross section rings that are mechanically retained to facilitate field replacement. Viton is the standard seal material.

3.5 The M&J 4-Way Diverter Valve incorporates the Self Induced Differential (SID) gauge seating method to prove positive separation of the flow streams as out-lined in API Manual 2531.

3.6 The SID is indicated by use of a differential pressure gauge or, in some cases, by a differential pressure switch.

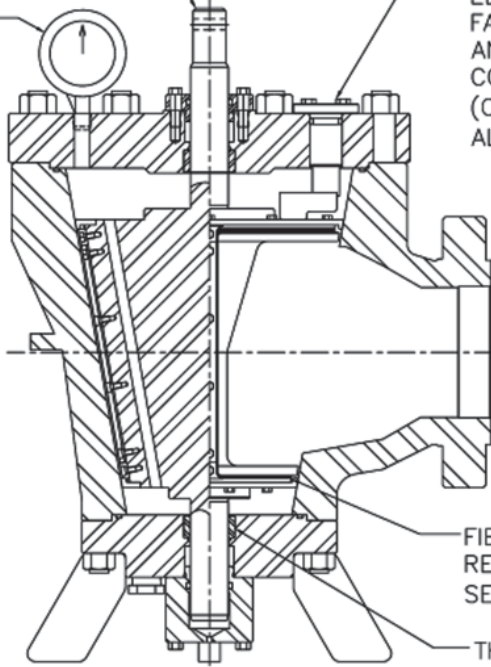
3.7 The SID or pressure gauge seating method has been used to comply with API 2531 for Bi-Directional and Uni-Directional provers since 1966. If 4-Way valves used in Bi-Directional provers were required to pass normal full API seal rating differentials (i.e.: 720 p.s.i. for ANSI 300) the actuators would be considerably larger and more expensive and, most important, much slower which could result in longer and more expensive meter provers. The industry-wide acceptance of the SID or pressure gauge seating method has resulted in a considerable saving to the users of meter provers. M&J uses differential pressure gauges to simplify the SID gauge readout.



OPERATOR MECHANISM LIFTS PLUG ROTATES (CLEARANCE ESTABLISHED BETWEEN RESILIENT PLUG AND BODY) AND SEATS PLUG)

PRESSURE GAUGE INDICATOR OF POSITIVE SEAL BETWEEN FLOW STREAMS (PROOF OF DOUBLE BLOCK AND BLEED TYPE SEAL.)

FIELD ADJUSTABLE MECHANICAL STOPS BETWEEN THE BODY AND PLUG ELIMINATE OPERATOR FAILURE. SEAT MISALIGNMENT AND LEAKAGE COMMON TO OTHER VALVES (ON VALVE SIZES UP TO 8" AND ALL VALVES WITH EH OPERATOR ONLY)



FIELD REPLACEABLE MECHANICALLY RETAINED RESILIENT SEAL (VITON STANDARD)

THIS VALVE HAS LARGE HEAVY DUTY STEMS AND BEARINGS

TAPERED LIFT-PLUG VALVE

Figure 1

## II. Installation

---

1. It is important that the valve ports marked “IN” and “OUT” be connected to the inlet and/or outlet ports of the prover. If the valve is installed 90 degrees out of phase it will cause severe flow restrictions and pressure drop in the mid-rotation position.
  - 1.1 If for some reason the “IN” or “OUT” ports cannot be identified the valve plug should be cycled to the mid-rotation position. Look through the ports, which can be seen through, these should be connected to the inlet and outlet ports.
  - 1.2 It is preferred that the differential check piping be to the inlet side of the prover.
- 2 The indicator flag will show which Direction the plug is diverting flow through the prover. This is helpful in locating the sphere in the prover.
3. The 4-Way valve is normally installed in the upright position for maintenance purposes; however, it can be installed and will work properly in the horizontal or inverted positions. If it is installed horizontally or inverted, the differential check assembly should be piped so the assembly is above the valve body.
4. Instructions for installing electric motor operators and setting limit switches are included in Maintenance’s Section 6.

## III. Operation

---

### 1. Plug Operation

- 1.1 When the valve is switched from one seated position to the other, the lift/turn operator automatically moves the plug through a three-step maneuver to complete its cycle. (See Fig. 2).
  - A. First, the plug is lifted axially to establish clearance between the resilient seals and the body.
  - B. Second, the plug is rotated 90 degrees to reverse the direction of the flow stream. There is not any contact between the resilient plug seal and body during rotation.
  - C. Third, the plug is lowered axially and the resilient seals are forcibly seated by compression against the body.
- 1.2 The complete cycle occurs within a time period of approximately twelve seconds or less.

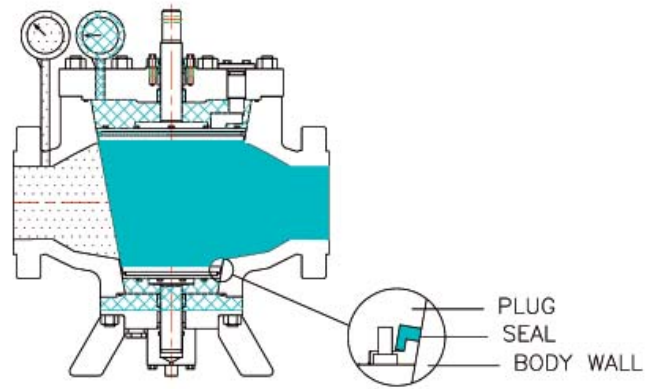
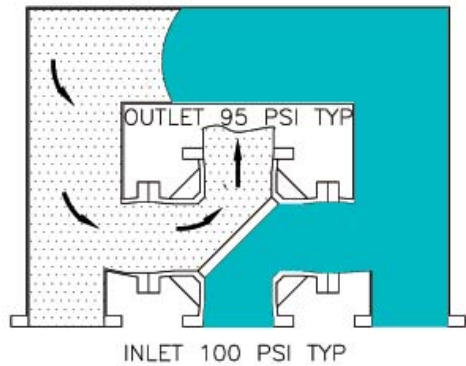
### 2. Proof of Seal Integrity

- 2.1 Proof of inlet and outlet flow stream separation is required in API Liquid Measurement Manual 2531. The M & J 4-Way Diverter Valve accomplishes this feature automatically each time the valve cycles by the SID (Self Induced Differential) pressure gauge method of assuring no leakage between flow streams.

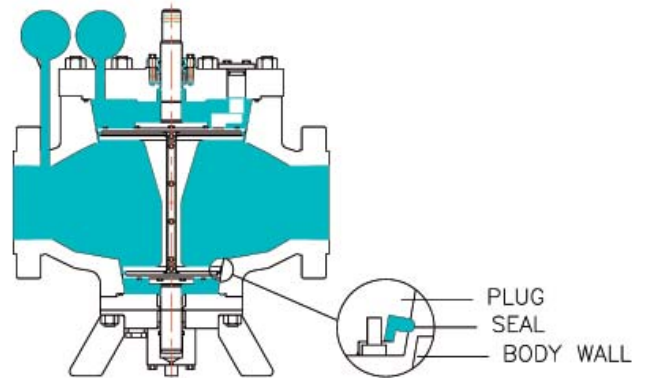
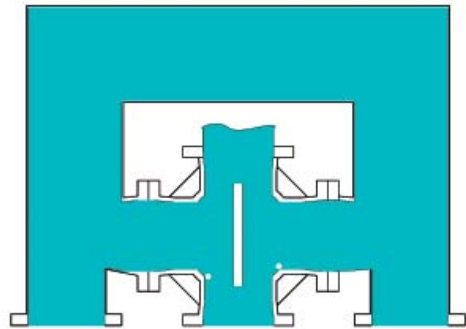
The SID pressure gauge method has been widely used and accepted in Bi-Directional and Uni-Directional provers.
- 2.2 By monitoring a differential pressure gauge or pressure switch that senses body cavity pressure, as it relates to line pressure, it is possible to determine the integrity of the plug seals with each actuation of the valve. (See Fig. 2).
- 2.3 The pressure sensor automatically indicates a drop in body pressure (approximately 25 p.s.i. under line pressure) each time the valve is seated. This occurs because of the inherent nature of the soft seated, tapered lift/plug valve which exhibits a self-induced differential (SID) when the plug is seated.
- 2.4 The pressure drops as the valve is being seated because the downward movement of the tapered plug and compression of the resilient seals create a net volume increase in the body cavity.
- 2.5 Pressure change begins at the interval when the plug seals first “kiss” the body seating surface and traps liquid in the body area between the two plug seals.
- 2.6 Body cavity net volume increases as the tapered plug moves downward and the resilient seals are compressed. Volume change discontinues when the plug is fully seated against the body and has stopped its downward movement. Any leakage past either plug seal will either not let the differential pressure initially rise or the differential pressure will rapidly decrease to 0.

NOTE: If a standard pressure gauge is used to measure differential, it will indicate a drop in body cavity pressure.

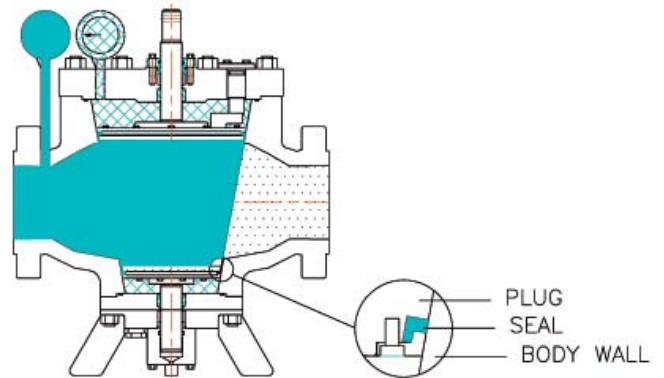
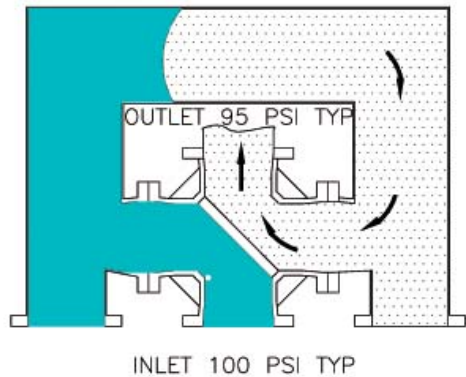
## Diverter Valve in Bi-Directional Prover



VALVE SEATED IN RIGHT POSITION: PRESSURE GAUGE AUTOMATICALLY INDICATES REDUCED BODY PRESSURE WHICH PROVES TIGHT SHUT-OFF AND POSITIVE SEPARATION OF FLOW STREAMS.



VALVE UNSEATED: PLUG IS RAISED TO EFFECT CLEARANCE BETWEEN RESILIENT SEALS AND BODY SEATS. PLUG TURNS AND HALFWAY THROUGH CYCLE FLOW PASSES DIRECTLY THROUGH VALVE (FROM INLET TO OUTLET PORT) WITH VERY LITTLE RESTRICTION.



VALVE SEATED IN LEFT POSITION: PLUG HAS BEEN LOWERED, SEALS COMPRESSED AND REDUCED BODY PRESSURE AGAIN INDICATES SEAL INTEGRITY, SEPARATION OF FLOW STREAMS AT LOWER DIFFERENTIAL PRESSURE.

**Figure 2**

### 3. Differential Check Valves

- 3.1 The volume change that occurs when rapidly seating the plug normally results in a substantial decrease in body cavity pressure. Example: Under typical 500 p.s.i. crude oil service conditions the decrease in pressure could be as much as 200 p.s.i. A differential check valve is used to limit SID to 25 p.s.i. When the valve is unseated rapidly, the body cavity volume vs. SID pressure situation reverses; i.e., the volume decreases and the pressure increases. Thus, a second differential check valve is used to limit the unseating SID to approximately 25 p.s.i. Twenty-five (25) p.s.i. was selected as enough pressure differential to actuate pressure switches and give a half-scale indication on 50 p.s.i. differential pressure gauges.
- 3.2 The check valves are housed in a special manifold block on the valve bonnet. (See Fig. 3, Item 15).
- 3.3 By limiting seating and unseating SID pressure to 25 p.s.i. the service life of the plug seals and the valve operator is significantly increased.
- 3.4 The differential check valve assembly also provides thermal relief protection for the valve body.

### 4. Mechanical Stops

- 4.1 3" thru 8" Valves and 10" and Larger Valves with EH operator have two independently adjustable mechanical stops between the plug and the body to insure proper alignment of the plug and the body when the plug is in the seated position. (See Fig. 4, Item 16).
- 4.2 The stops absorb most of the inertial forces generated by the rapid 90-degree rotation of the plug. Ordinarily the valve operator would have to absorb these forces; therefore, the stops help to extend operator life as well as prevent leakage due to plug misalignment.

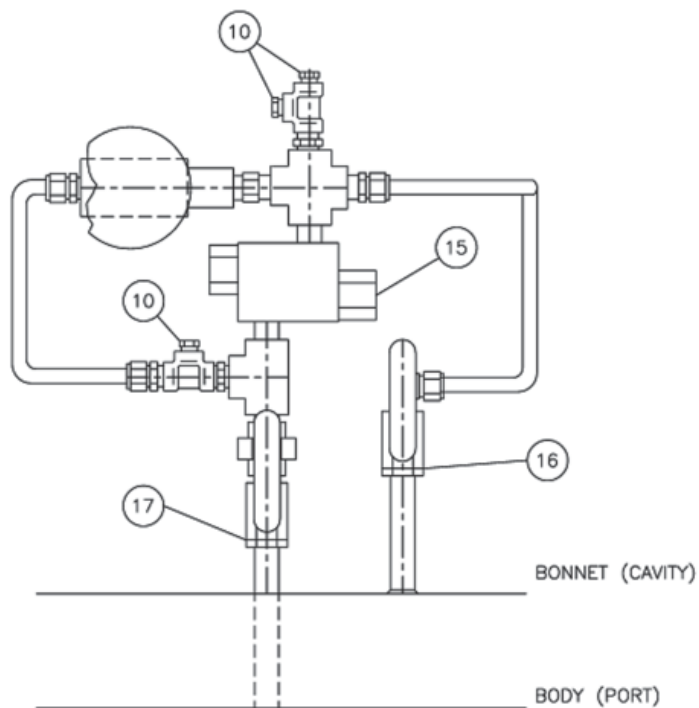
### 5. Position Indicator

- 5.1 The valve uses a position indicator with two curved arrows which indicate the direction of flow.
- 5.2 The indicator moves upward as the valve plug is unseated, rotates as the plug turns, and moves downward as the plug is re-seated. (See Fig. 3, Item 9).

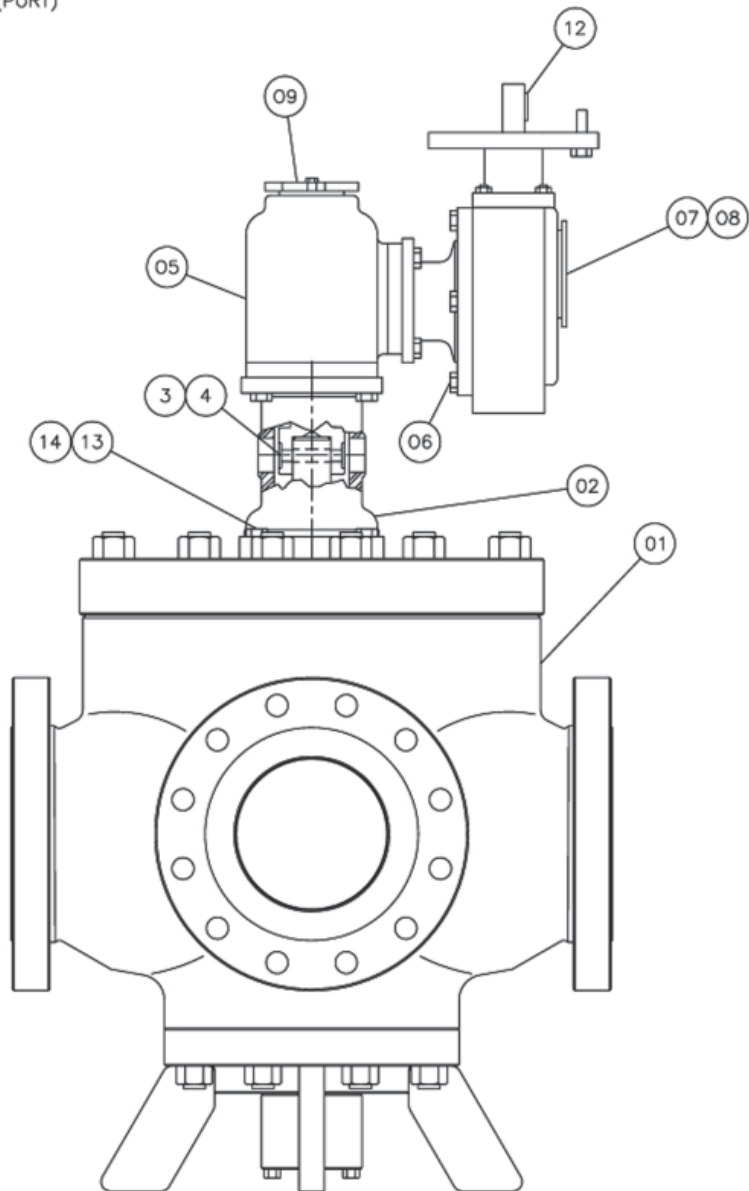
### 6. Valve Operator

There are two basic types of operators available that automatically lift, turn, and re-seat the plug.

- 6.1 The first is a mechanical type unit that can be operated with either a handwheel for local manual operation, or with an electric motor for remote operation. (See Fig. 3, Item 5). There are two Basic operators under this category. 5KW wiggle stick operator (Used on 3" through 8") and 30-KS Stem type operator (Used on 10" through 16" Valves)
- 6.2 The second type is an electro-hydraulic (EH) operator primarily for use on the larger valves. It combines a hydraulic rotary vane type actuator for the 90-degree rotation function and a hydraulic cylinder for the seating and unseating function. They are operated electrically and hydraulically via limit switches and solenoid operated pilot valves which perform the lift, turn, and re-seat operations in the proper sequence.



ITEM NO	PART NAME
1	4-WAY VALVE ASSEMBLY
2	YOKE
3	TRUNNION PIN RETAINER RING
4	TRUNNION PIN
5	5K OPERATOR
6	HEX HEAD CAPSCREW
7	WORM GEAR
8	KEY
9	POSITION INDICATOR FLAG
10	PIPE PLUG
11	HEX HEAD CAPSCREW
12	KEY
13	HEAD HEAD CAPSCREW
14	SOCKET HEAD CAPSCREW
15	THERMAL AND PRESSURE RELIEF MANIFOLD
16	BODY CAVITY ISOLATION VALVE
17	PORT ISOLATION VALVE



**Figure 3**

## IV. Maintenance

### 1. General

1.1 The M&J 4-Way Diverter Valve is a non-lubricated plug type valve. No seat lubrication or grease of any kind is required in the body/seat area. The lift/turn operator mechanism should be lubricated every six (6) months.

1.2 The diverter valve generally sees frequent operation and can be compared to a constantly operating pump and will require more periodic maintenance than shut-off valves for optimum performance.

### 2. Self Induced Differential (SID) Failure Procedures

When the valve is working normally, the body cavity pressure will drop and indicate approximately 25 p.s.i. pressure on the differential pressure gauge each time the plug is seated. This phenomenon is inherent to this type valve. (See Operation's Section 2 for further discussion).

If the pressure gauge or switch indicates that the SID fails to occur or fails to drop and hold repeatedly, steps must be taken to isolate the source of the problem.

2.1 Possible sources of the problem may be one of the following:

- A. External leaks in the body cavity area: i.e., stem packing leakage. (See Fig. 4, Item 17).
- B. Actuator not seating the plug fully or permitting the plug to drift off the seat due to drop in the hydraulic system pressure.
- C. Electric motor operator not set properly.
- D. Differential check valve leakage.
- E. Plug seals may be leaking.

2.2 Look for external leaks and changes in hydraulic cylinder pressure first.

2.3 Procedures for seating valve with electric motor operator with handwheel, etc. (Refer to section 6).

2.4 Air trapped in 4-Way body cavity or differential check valve piping can cause low SID gauge readings. If SID gauge reading is below 10 p.s.i. when plug is seated tightly, close isolation ball valves and bleed air per 3.3-B, G & H.

2.5 Then close the manual ball valves, which isolates the check valve manifold, just after the plug is seated. (See Fig. 3, Items 16 and 17) If the pressure dropped and remained down after closing the isolation ball valve it is likely that the problem is in the differential check valves and will require maintenance. (See Section 3).

NOTE: The valve should not be returned to normal operation with the isolation ball valves closed.

2.6 If SID is not holding, then the plug seals will need replacing. (See Section 4).

### 3. Procedures for Repairing Differential Check Valves

3.1 The differential check valve manifold block contains two identical check valve assemblies. (See Fig. 5).

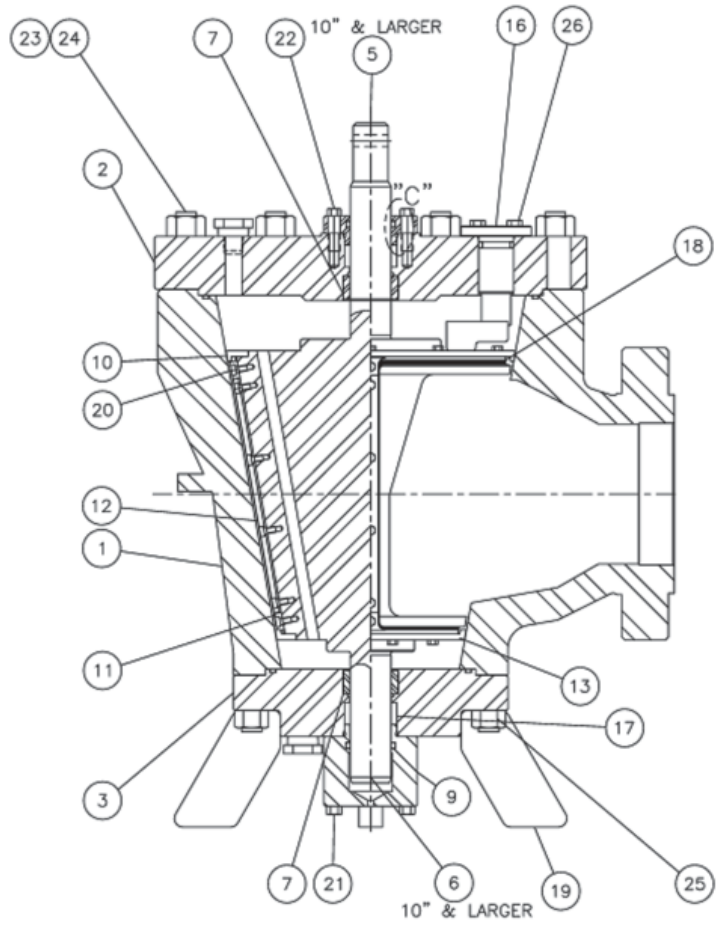
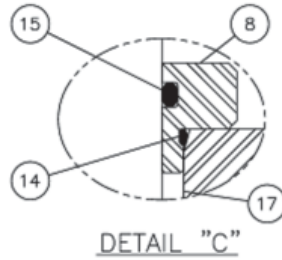
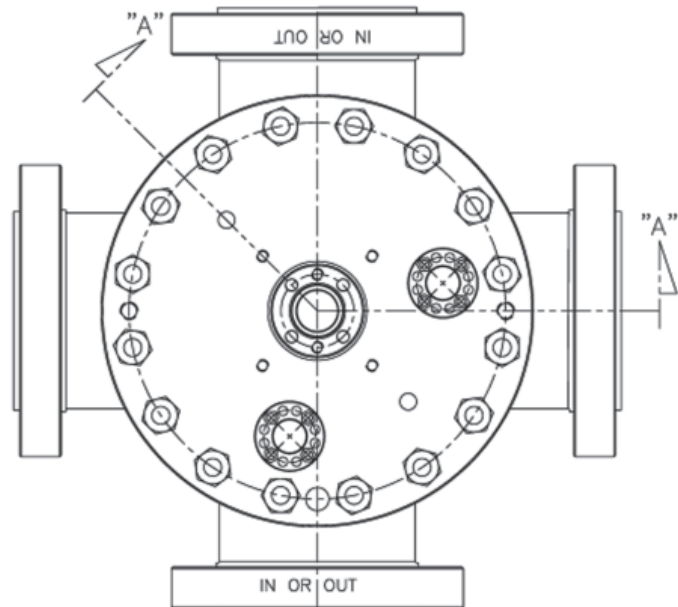
3.2 Each check valve has one dynamic seal (Fig. 5, Item 4) and one static seal (Item 7).

3.3 To replace the seals, perform the following procedures:

- A. Close both ball valves to isolate the check valves from the system. (See Fig. 3, Items 16 and 17).
- B. Bleed off the pressure trapped in the pipe between the two ball valves by loosening the pipe union sleeve nuts just above each ball valve.
- C. Loosen the retainer (Fig. 5, Item 8) approximately ¼" and check to see that it can be freely moved by hand. This insures that pressure has been fully bled off.
- D. Remove each check valve assembly from the manifold block and replace the seals by removing the cap screws (Item 2), retainer (Item 3) and removing the dynamic seal (Item 4).
- E. Reassemble the valves.
- F. Bleed air by removing pipe plug (Fig. 6, Item 5) and crack the inlet ball valve open slightly to expel air trapped in plumbing. When flow is clear of air, close ball valve and reinstall pipe plug. Trapped air will lower SID reading on gauge.
- G. Retighten pipe union sleeve nuts.
- H. Open both ball valves fully.

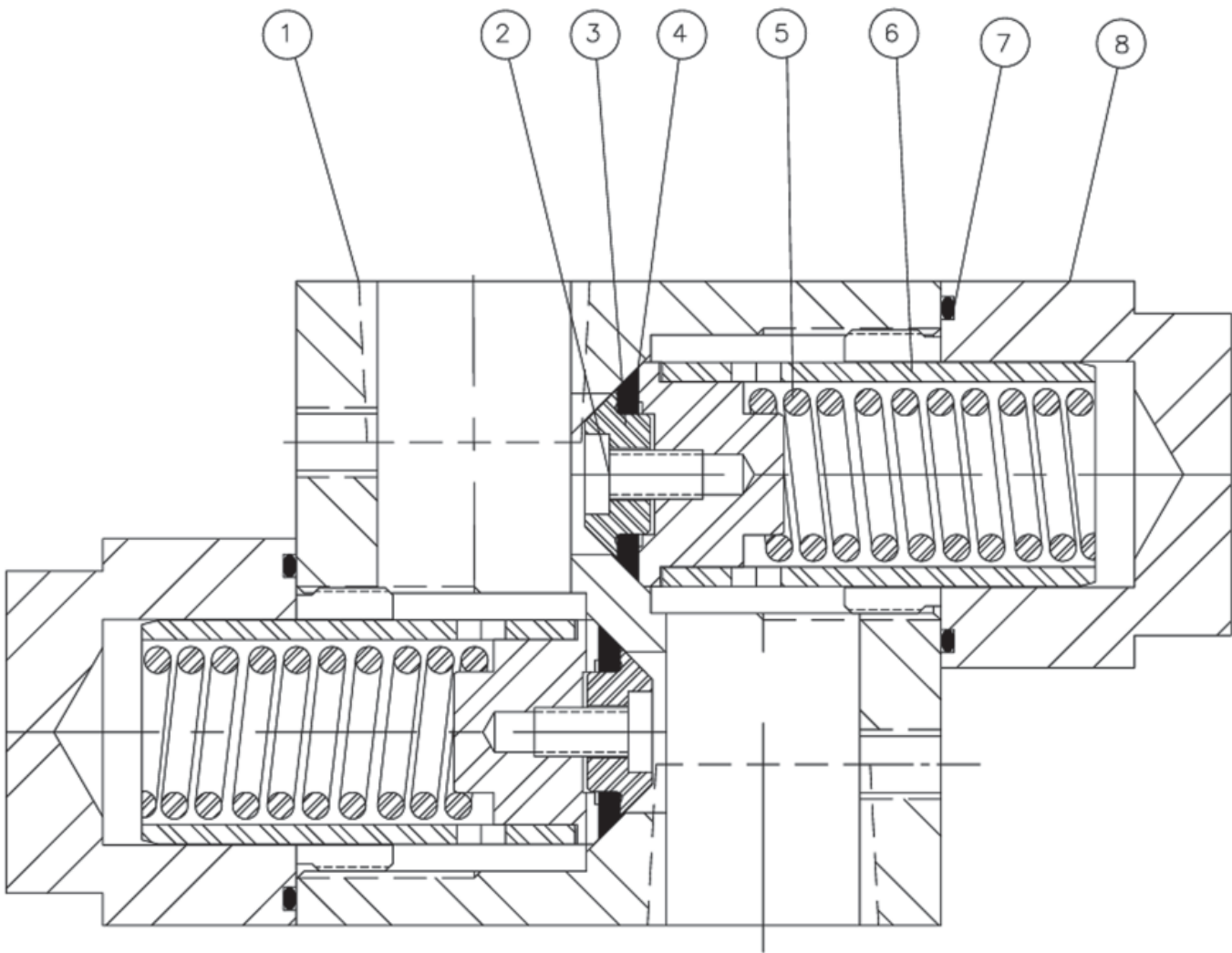
**Figure 4**

ITEM NO	PART NAME
1	BODY
2	BONNET
3	LOWER PLATE
4	PLUG
5	UPPER TRUNNION
6	LOWER TRUNNION
7	BEARING
8	PACKING GLAND
9	TRUNNION CAP
10	UPPER SEAL RETAINER
11	END SEAL RETAINER
12	MID SEAL RETAINER
13	LOWER SEAL RETAINER
14	PACKING GLAND "O" RING
15	STEM O'RING
16	ADJUSTABLE STOP
17	STEM PACKING
18	PLUG SEAL
19	LEG
20	SOCKET HEAD CAPSCREW
21	HEX HEAD CAPSCREW
22	HEX HEAD CAPSCREW
23	STUD
24	HEX NUT
25	HEX NUT
26	SOCKET HEAD CAPSCREWS



## 4. Plug Seal Replacement

- 4.1 To replace the plug seals the following procedure is performed:
- A. Relieve all pressure in the meter prover loop, up to the valve and in the valve body cavity.
  - B. Set the valve so it is lightly seated in one position or the other (left or right).  
NOTE: The plug will be easier to remove later if it is not seated tightly against the body seating surface.
  - C. Remove retainer ring (Fig. 3, Item 3) and remove operator trunnion pin (Fig. 3, Item 4).
  - D. Disconnect differential check valve plumbing to body.
  - E. Remove bonnet stud nuts.  
MARK THE BODY AND BONNET JOINT FOR ORIENTATION.
  - F. Note orientation of plug stop and mark body for later reference. Remove plug by straight upward lift.
  - G. Remove plug seal assembly. (See Fig. 4).
    - 1. Remove socket head cap screws (Item 20).
    - 2. Remove retainer rings and plates (Items 10, 11, 12 and 13).
    - 3. Remove seal (Item 18).
  - H. Clean seal area on plug and clean and dry screw holes. Clean body seal area and inspect for any visible sign of scratch, dent, rust or pitting. Any of this damage present must be ground smooth or if it is too deep to ground smooth, then it must be repaired by welding (contact M&J for repair instructions.)
  - I. Install new seal rings on plug (Fig. 4, Item 18).
    - 1. Insure that the seal's base, with L-shaped leg, is shouldered against the bottom of the seal groove.
    - 2. Check to insure that the side of the seal opposite the base leg is flush against the shoulder of the seal relief frame, around the plug flow passage.
  - J. Install upper seal retainer ring as follows (See Fig. 7):
    - 1. Tuck L-shaped leg of seal under inward angled retaining rim of ring with a thin tool with rounded end. Install screws loosely—do NOT tighten (Fig. 7-5).
    - 2. Install lower seal retainer ring (Fig. 7-6).  
NOTE: Retaining rim angles outward making entry of the seal leg easier.
    - 3. Install screws loosely – do not tighten.
    - 4. Install midsection seal retainer bars and hold in place loosely with two set screws. Insure that seal rings are not bunched up or stretched at any point along their periphery.
    - 5. Install end pieces of seal retainer loosely.  
NOTE: If any difficulty is encountered in evenly distributing the seal it may help to lower the plug (with seal and loose retainers) into the valve body until it seats – make sure no screw heads are high enough to rub or scratch the body seating surface, though. Four screws, 90 degrees apart, in the upper seal retainer ring may be tightened, then the plug assembly may be lifted from the valve body.
    - 6. When seal is evenly distributed, tighten screws (Fig. 4, Item 20) at opposite alternate locations of retainers as follows:
      - a. Upper retainer at center flow opening – Tighten lightly.
      - b. Lower retainer at center – Tighten lightly.
      - c. Midsection retainer bars, center screws – tighten lightly.
      - d. Finish lightly tightening upper and lower retainers, starting from end piece locations.
      - e. Finish lightly tightening midpoint screws until all are done.
      - f. Repeat sequences (a thru e) until all screws are tightened to 10 ft. lbs. torque. Do not exceed 15 ft./lbs. max.
  - K. Re-install plug into valve body, noting the orientation of the plug stop mentioned in Step F.  
NOTE: The stop boss on the plug should be positioned between adjustable mechanical stops in bonnet when assembly is complete.
  - L. After the assembly of valve, bleed air out through pipe plug (Fig. 7, Item 5). Trapped air in body cavity of differential check valve piping can cause low SID gauge reading.



ITEM NO	PART NAME
1	MANIFOLD BLOCK
2	SOCKET HEAD CAPSCREW
3	SEAL RETAINER
4	SEAL
5	SPRING
6	POPPET SUB-ASSY
7	"O" RING
8	RETAINER

DIFFERENTIAL CHECK VALVE ASSEMBLY WITH  
 $\frac{1}{2}$ " NPT PORTS FOR LOW TEMPERATURE SERVICE

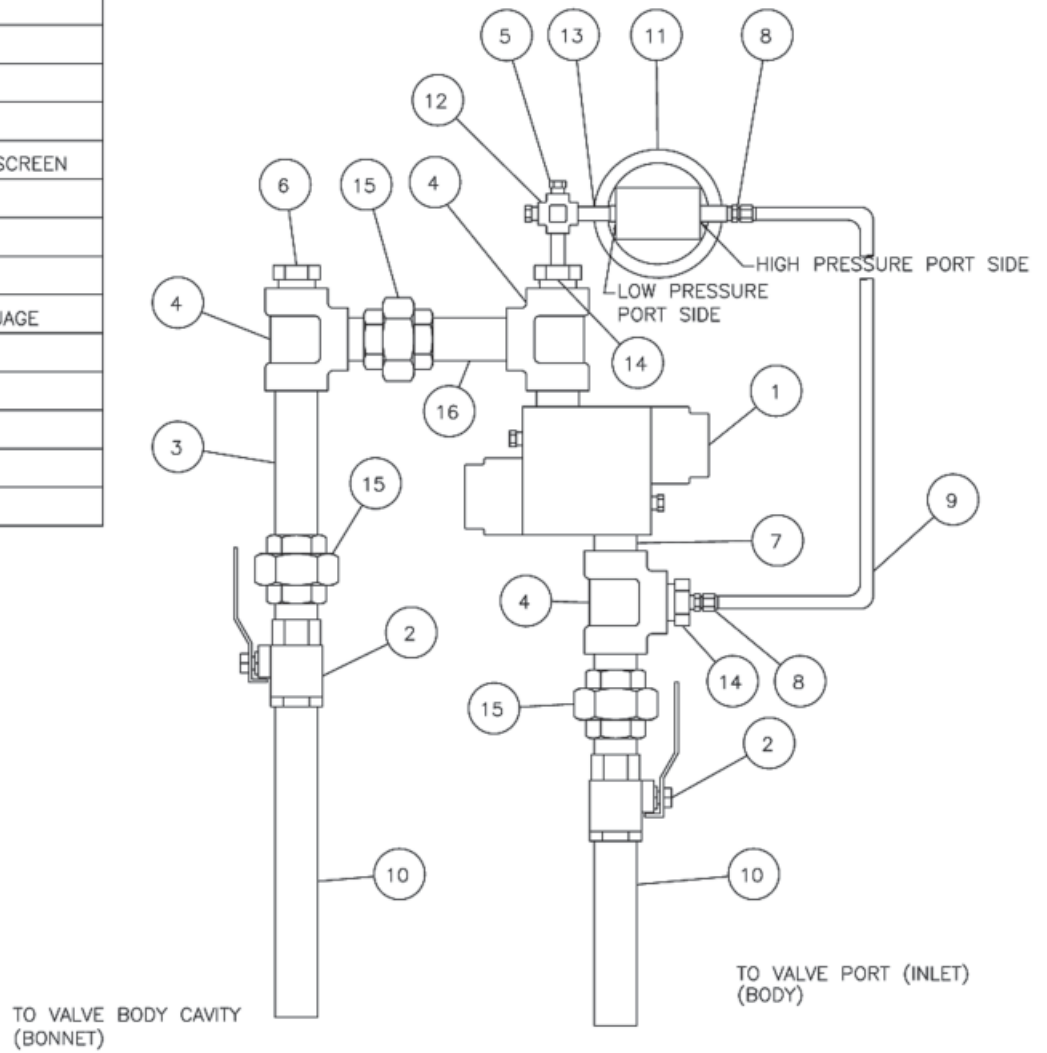
**Figure 5**

## 5. Stem packing Replacement (see figure 4 for item number identification):

Note: Stem packing can be replaced without removing bonnet & lower plate from the valve body by simply removing packing gland and lower trunnion cap by sliding them off over the plug trunnions and remove old packing from packing chamber using sharp objects which can plow into old packing ring and remove one packing ring at a time. Clean the packing chamber and plug trunnion seal surfaces using rag or other soft cleaning cloth and install new stem packing by sliding one packing ring at a time over the plug trunnion and carefully installing in the packing chamber and capping them off by reassembling packing gland/trunnion cap. **However in this method or process there is a great possibility exists for damaging the trunnion sealing surface by accidentally scratching the sealing surface during removal of old stem packing and therefore only experienced personnel should attempt to replace stem packing by this process. If personal isn't comfortable with this procedure, follow the procedure below (You will need new bonnet & lower plate o-rings).**

- 5.1 Remove operator assembly from top of the bonnet.
- 5.2 Remove bonnet bolting nuts (item 24) and loosen packing gland cap screws (item 22) and remove bonnet (item 2) by sliding over the plug trunnion. (MARK BODY & BONNET JOINT FOR ORIENTATION when bonnet has adjustable stop mounted on it)
- 5.3 Remove packing gland (item 8) from bonnet (leave the internal and external O-rings in place in the packing gland unless replacing them with new O-rings) and remove old packing from the bonnet packing chamber leaving trunnion bearing (item 7) in place.
- 5.4 Clean packing chamber and install new stem packing (if required use light film of grease on the ID of the packing chamber to slide the packing in place).
- 5.5 Install packing gland (install at this time new O-rings if replacing the packing gland O-rings) over the bonnet and hold it with cap screws but do not tighten cap screws at this time.
- 5.6 Re-install bonnet over the valve body by sliding over the plug trunnion. (note orientation of bonnet mentioned under step 5.2 if applicable).
- 5.7 Apply light coat of grease over the threaded studs and reinstall hex nuts and tighten all nuts evenly with proper torque for the bolt size. Tighten packing gland in place by tightening cap screws.
- 5.8 Loosen lower plate trunnion cap screws (item 21) and remove lower plate bolting nuts (item 25) (make sure lower plate is properly supported prior to removing all nuts to prevent it from free falling).
- 5.9 Carefully remove lower plate (item 3) by sliding down the lower plug trunnion and put it upside down on a sturdy flat surface.
- 5.10 Remove trunnion cap (item 9) from the lower plate (leave the internal and external O-rings in place in the trunnion cap unless replacing them with new O-rings) and remove old packing from the trunnion cap packing chamber leaving trunnion bearing (item 7) in place.
- 5.11 Clean packing chamber and install new stem packing (if required use light film of grease on the ID of the packing chamber to slide the packing in place)
- 5.12 Install trunnion cap (install new O-rings at this time if replacing the trunnion cap O-rings) over the lower plate and hold it with cap screws but do not tighten cap screws at this time.
- 5.13 Reinstall lower plate on to the valve body by sliding over the lower plug trunnion. (Make sure lower plate is properly supported during reinstallation to prevent it from falling back).
- 5.14 Apply light coat of grease over the threaded studs and reinstall hex nuts and tighten all nuts evenly with proper torque for the bolt size. Tighten trunnion cap in place by tightening cap screws.

ITEM NO	PART NAME
1	CHECK VALVE MANIFOLD ASSY
2	BALL VALVE
3	PIPE NIPPLE
4	PIPE TEE
5	PIPE PLUG
6	PIPE PLUG
7	PIPE NIPPLE W/FILTER SCREEN
8	MALE CONNECTOR
9	TUBING
10	PIPE NIPPLE
11	DIFFERENTIAL PRESS GAUGE
12	PIPE CROSS
13	HEX PIPE NIPPLE
14	REDUCER
15	PIPE UNION
16	PIPE NIPPLE



**Figure 6**

## 6. Instructions for Installing Motor Operators and Setting Switches

### 6.1 Installing motor operator:

- A. Make sure the adapter flange on gear housing is in the desired position to receive the electric motor operator so the motor operator controls, and handwheel will be in the desired location. (If the position must be changed, refer to M & J Operating and Maintenance Instructions for directions).
- B. Lubricate valve operator shaft and mount electric motor operator on it, using key and correct size studs.

### 6.2 Setting geared limit and torque switches<sup>1</sup>:

- A. **IMPORTANT!** Electric motor operators have OPEN and CLOSED positions push buttons, indicator Lights and Limit Switches. 4-Way valves have Left and Right seated positions and it is very important that the Open position (counterclockwise motor and handwheel rotation) Button/Switches be used for the Left seated position and the Closed (clockwise rotation) position correspond to the Right seated position.
- B. **IMPORTANT!** The M & J 4-Way Valve is a torque-seating design; however, in order to more accurately control the actual seating torque it is recommended that the motor action be controlled in both left and right position by the geared limit switches backed up by the torque switches.
- C. **IMPORTANT!** Some motor operators have additional gear ratio (power gain) when operated manually through their handwheel. During manual operation care must be taken not to overstress valve operator parts with too much torque.
  1. Place the valve in the full left position manually by turning electric motor handwheel, taking all the slack out of the gears and valve operator, while seating the valve.
  2. Differential gauge should start to indicate a drop in pressure<sup>2</sup>.
  3. Set left position limit switch per specific motor operator instructions.

4. Verify left position limit switch setting by manually operating the valve.
5. Use the electric motor operator handwheel to rotate the valve. The indicator flag will lift and rotate 90 degrees then begin to descend. When the indicator flag is rotating, the valve is in the intermediate position. Continue to rotate the valve with the motor handwheel to the full right position; then repeat Steps 2, 3 and 4 for the right position. After setting right position limit switch, return the valve to the intermediate position.
6. **IMPORTANT!** Caution should be exercised when initially operating the electric motor operator with power. In the event the wiring is incorrect, or the limit or torque switches are not operational, damage can be done if these switches fail to actuate correctly.
7. Actuate the right position button. The indicator flag will rotate clockwise toward the right seated position if the wiring is correct. (If the indicator flag begins to rotate toward the left position (counterclockwise) immediately actuate the stop button. Reverse the electric motor leads as incorrect rotation indicates motor is out of phase.)
8. Manually set the M & J 4-Way Valve in mid-position. Actuate left position button, manually depress the left torque switch to check its action. If it fails to stop motor, correct the wiring, referring to the motor operator wiring diagram.
9. Actuate the right position button, manually depress the right torque switch, and if the torque switch does not function immediately actuate the stop button. Correct the torque switch wiring, referring to the motor operator wiring diagram, so the torque switch will stop the motor operator when depressed, or, correct the reversing controller control wiring if the torque switch wiring appears to be correct per wiring diagram.

**1 See 6.3 for instructions on 4-way valve test flange piping requirements when installing motor operator and setting switches in shop.**

**2 Do not exceed 2 to 3 psid (Coasting of electric actuator motor will pull higher dP when cycling valve with electric actuator).**

**Figure 7**



**7-1**



**7-5**



**7-2**



**7-6**



**7-3**



**7-7**



**7-4**



**7-8**

## 6. Instructions for Installing Motor Operators and Setting Switches (Continued)

10. The torque switches have been set at the factory so the motor operator will put out enough torque to seat/unseat the valve. If, under unusual working conditions, additional torque should be required the torque switch settings can be increased slightly, but caution should be used. Too high a setting can damage either the valve operator or motor operator.
11. Actuate the left position button and make sure the flag begins to rotate thru the quarter turn to the left position. If so, allow the valve to come to the full left seated position automatically. Proper seating can be determined by the sound of the motor and by checking the differential pressure gauge to see that the valve is creating 15 to 25 p.s.i. differential and holding. If differential pressure drops off, set limit switch up slightly and check for seating and sealing again.
12. Repeat step 11 for right seated position.
13. Cycle M&J 4-Way Valve under power, depress torque springs manually during cycles to check their function. When valve seats in either position the torque switches should just show signs of beginning to function.

### 6.3 Instructions for 4-way Valve test flange piping requirements when installing motor operator and setting switches in shop.

- A. **IMPORTANT!** As discussed in Operation's Section 2, volume changes occur in the valve body cavity when seating or unseating the plug. This feature is useful in providing proof of seal integrity in service. When operating the valve in a shop test situation, with test flanges on all four valve ports and with the valve filled with water, the volume changes also occur in the valve port cavities. The following instructions on piping detail ensure that the resultant pressure change will be equal in all four ports.
1. Install test flanges on all four valve ports.
  2. Install water fill line in test flange on 4-way valve port stamped "IN" or "OUT".
  3. Install by-pass line between pair of test flanges at 90° to IN or OUT water-fill port. This ensures equal pressure in all ports whether plug is seated in left or right positions.

4. Using motor operator handwheel, place 4-way valve in mid-position by watching position indicator on valve.
5. Remove pipe plug, Item 5 shown in Fig. 6. This is highest point in piping and useful to bleed air out of valve. Trapped air will lower SID gauge readings.
6. Fill valve with water and reinstall plug (Item 5) when water runs free of air bubbles.
7. Close water fill valve and proceed with motor operator instructions.

**NOTE:** Normal shop water supply pressure (60 p.s.i. approximately) is adequate for this process, although pressures up to 4-way valve rating may be used if desired.

## 7. Adjustment- 5K Lift Turn Operators

All Lift Turn Operators are preset at the factory for best operation. However, minor adjustments may be necessary after the valve has been in service or if mounting bolts have come loose during shipment/installation. The 5K Lift Turn Operator is designed to lift the plug to unseat, rotate 90°, and lower the plug to seat. The adjustable mechanical stops in the bonnet are designed to take the high impact loads at the end of the 90° rotation. If the adjustable stops are not set properly, it can cause high torque in the seating/unseating action and abnormal wear on the Lift Turn Operator.

- 7.1 If the operator will not cycle smoothly on a new valve, it may be due to the plug stop hitting the adjustable stop prematurely.

**IMPORTANT NOTE: ALWAYS DEPRESSURIZE THE VALVE BEFORE LOOSENING BONNET-PLUG STOPS.**

- A. Loosen hex head bolts (Fig. 9, Item 8) holding the 5K operator assembly (Fig. 9, Item 5) to bonnet (Fig. 9, Item 2).
- B. Turn operator handwheel counter clockwise until plug goes into the left seating position. This is determined when the indicator (Fig. 9, Item 17) drops approximately 7/8 inch after rotation.
- C. Adjust 5K operator assembly (Fig. 9, Item 5) to cam stop B by rotating entire 5K operator counter clockwise against the left cam stop B (Fig. 10).
- D. Tighten hex bolts (Fig. 9, Item 8).
- E. If valve does not operate smoothly, proceed to 7.2.

ITEM NO	PART NAME
1	YOKE
2	STEM HOUSING
3	CRANK HOUSING
4	STEM
5	CRANK
6	GUIDE PIN
7	STEM ADAPTER
8	"O" RING
9	POSITION INDICATOR POINTER
10	HEX HEAD CAPSCREW
11	DU BEARING
12	HEX HEAD CAPSCREW
13	"O" RING
14	ROLL PIN
15	"O" RING
16	ROLL PIN
17	"O" RING
18	SNAP-IN PLUG
19	GREASE FITTING
20	LOCK WASHER
21	PIN ( TRUNNION )
22	KNOCK OUT PLUG
23	SNAP RING
24	HEX HEAD CAPSCREW

NOTE:  
FOR OTHER ITEMS SEE FIGURE 11

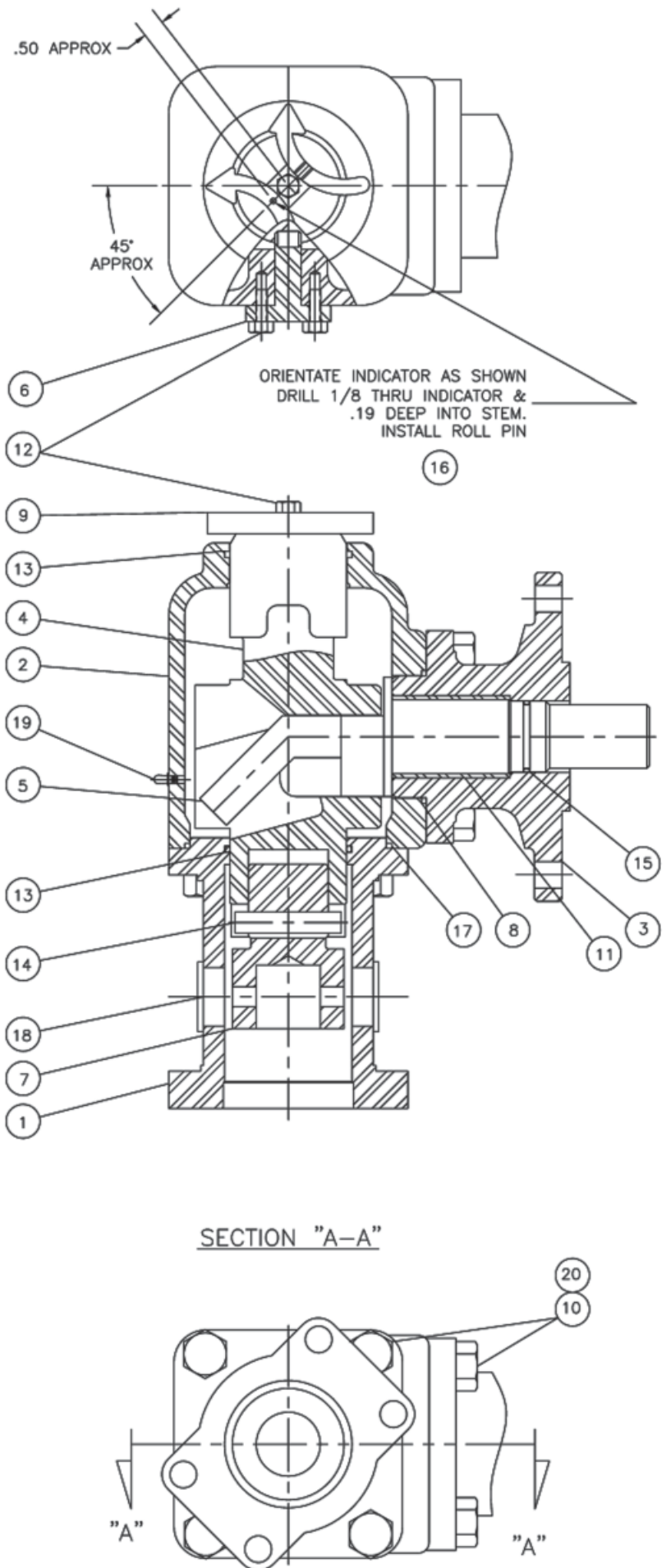


Figure 8

## 7. Adjustment- 5K Lift Turn Operators (Continued)

7.2 After the valve has been in service, if the motor operator sounds like it is “loading up” or if it torques out just before the plug seats, check internal stop adjustment.

**IMPORTANT NOTE: ALWAYS DEPRESSURIZE THE VALVE BEFORE LOOSENING BONNET-PLUG STOPS.**

- A. Turn the operator handwheel clockwise until the plug (Fig.9, Item 4) goes into the right seated position.
- B. Loosen jam nut or multiple capscrews (Fig. 10. Item 26) on right cam stop A<sup>1</sup> (Fig. 10).
- C. Turn the handwheel counter clockwise to unseat and partially rotate the plug. Then turn the handwheel clockwise and re-seat the plug (4). On 3” and 4” valves, place a screwdriver in the cam slot and rotate cam A counter clockwise until it comes in contact with the plug. On 6” and larger valves, re-insert two capscrews in a straight line opposite each other. Position a screwdriver or rod across them and turn cam A counter clockwise until it comes in contact with the plug.
- D. Tighten stop A.
- E. Using the handwheel, rotate the plug counter clockwise to the left seated position.
- F. Loosen jam nut or remove multiple capscrews on cam stop B1 (Fig. 10).
- G. Turn the handwheel clockwise to unseat and partially rotate the plug. Then turn the handwheel counter clockwise and re-seat the plug. On 3” and 4” valves, place a screwdriver in the slot, rotate cam B clockwise until it comes in contact with the plug. On 6” and larger valves, re-insert two capscrews in a straight line opposite each other. Position a screwdriver or rod across them and turn cam B clockwise until it comes in contact with the plug.
- H. Tighten stop B. Both stops should be set.
- I. Rotate the plug through several cycles using the handwheel. If the valve still has a hard spot, one of the adjustable stops may still need adjustment. If the valve leaks after both stops have been adjusted, the valve may be seating “out of index” or in the port area. To correct this situation, loosen both adjustable cam stops A & B and the operator/bonnet bolts (Fig. 9, Item 8). With the plug in the unseated position, turn the entire operator housing (Fig.9, Item5) slightly and tighten operator/bonnet bolts. While the adjustable stops are still loose, cycle the valve and check for tight seal. When a tight seal is obtained, adjust the stops as outlined in 7.2 (A through H).

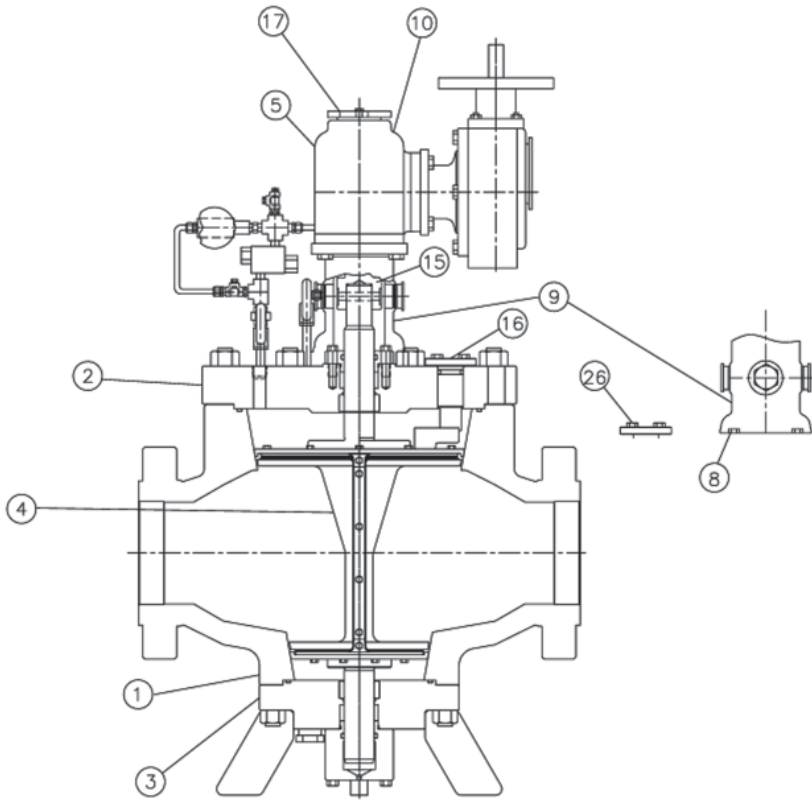
**IMPORTANT NOTE: ALWAYS DEPRESSURIZE THE VALVE BEFORE LOOSENING BONNET-PLUG STOPS.**

7.3 If the 5K (3”, 4”, 6” and 8” sizes) operator fails to lock SID in seated (down) position, check the 5K operator setting for proper plug seating depth. It’s adjustable.

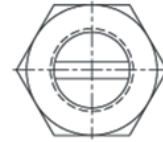
- A. Measure the distance from the bottom of the Indicator (Fig. 11, Item 9) to the top of the stem housing (Fig. 11, Item 2). The seated (down) position should read 5/16” - 3/8”. If the distance is less or more, proceed as follows.
- B. To adjust the plug seated(down) position: (See Fig. 11)
  1. Remove the snap-in plugs (22).
  2. Remove the snap ring and trunnion pin (23)
  3. Remove four hex bolts (24) and lift stem housing mechanism (2) off yoke housing (1).
  4. Remove roll pin (14).
  5. To seat plug deeper, turn stem adapter (7) counterclockwise one turn.
  6. To raise plug seated position, turn stem adapter (7) clockwise one turn.
  7. Drive in roll pin (14) and reassemble stem housing mechanism (2) and yoke housing (1) using bolts (24).
  8. Reinstall trunnion pin (21) and snap ring (23).
  9. Check for proper plug depth (See 7.3A). Adjust again if necessary.
10. Reinstall snap-in plugs (22).
11. Check 5K operator “stop” adjustment. See Section 7.1.

**NOTE:** If the line fluid is cold, the resilient plug seals may be hard which will restrict the plug from seating at normal depth. Low temperature seals will not be affected by low temperature fluid.

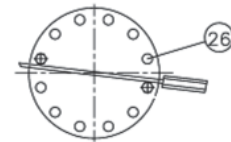
<sup>1</sup> 3” and 4” valve stops have slotted screw and hex head jam nut which requires tapping (downward) to release the tapered cam before it can be turned or repositioned. 6” and larger valves have multiple socket head capscrews which do not require tapping to loosen and reposition the cams.



**Figure 9**



ON 3" & 4" VALVES ADJUST JAMB NUT USING A SCREWDRIVER AND WRENCH

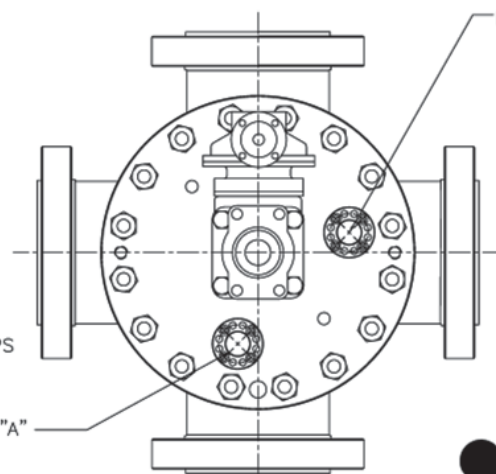


ON 6" & 8" VALVES & VALVES WITH EH OPERATOR REINSERT TWO CAPSCREWS (26) IN A STRAIGHT LINE OPPOSITE EACH OTHER. POSITION SCREW DRIVER ACROSS THEM AND TURN CAM

POSITIONING FOR THE DETERMINATION OF CAM STOPS

RIGHT CAM STOP "A"

LEFT CAM STOP "B"



TO DETERMINE RIGHT CAM STOP—A  
LEFT CAM STOP—B  
POSITION YOURSELF HERE

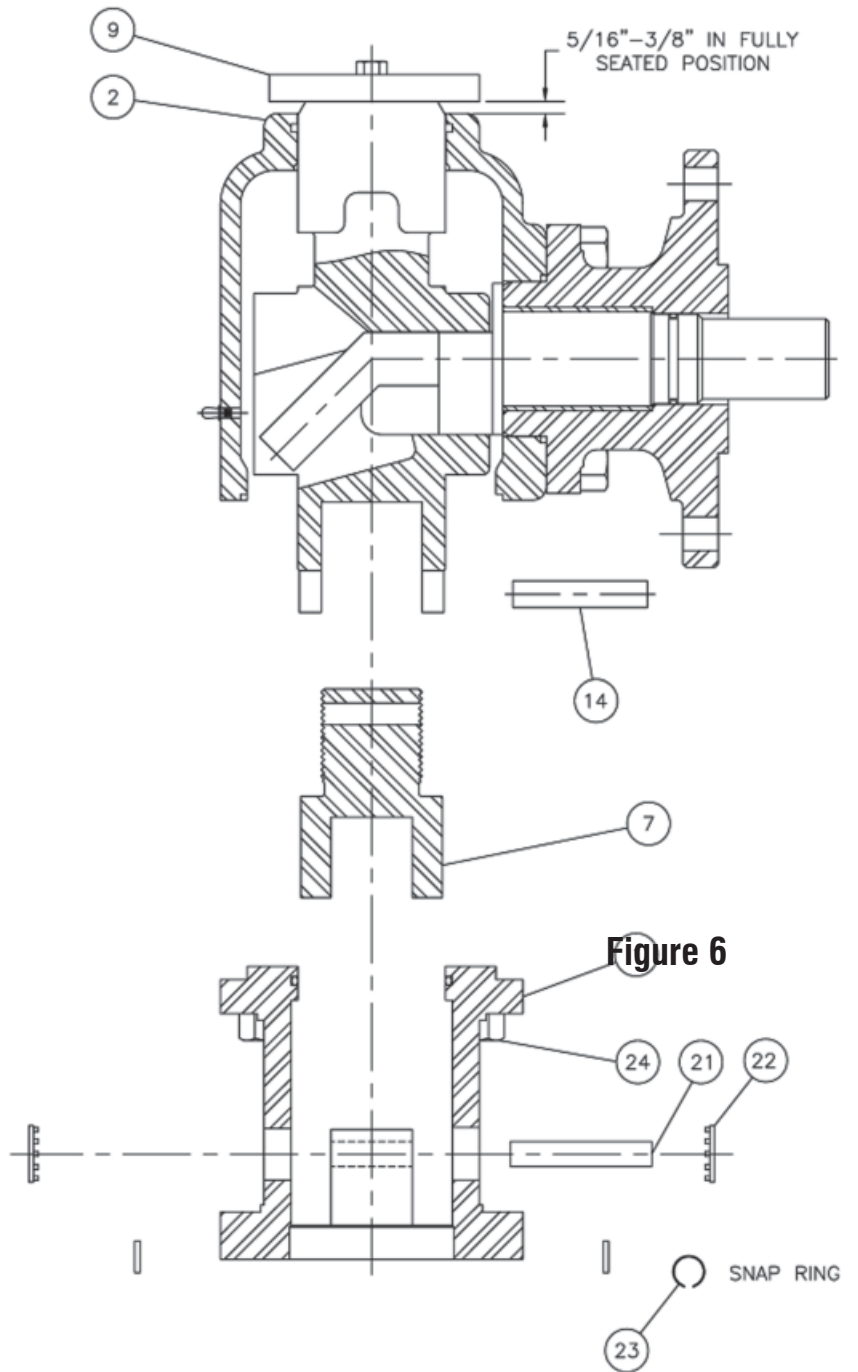
**Figure 10**

## 8. 30 KS Operator Assembly Instructions (Use Fig. 12)

- 8.1 Remove any burrs or sharp edges. Make sure parts are clean and free of grit or shaving.
- 8.2 Apply a liberal coating of recommended grease on all surfaces of the upper stem (5), and middle stem (6).
- 8.3 Thread upper stem (5) into middle stem (6) and middle stem (6) into lower stem (7) such that the stop pin on the O.D. of the upper stem and stop shoulder on middle stem rotate into engagement with mating shoulders on the top of the middle and lower stems (6 & 7). Make sure the detent recessed in the upper stem and middle stem are fully in line with the roller opening in the middle and lower stems. This operation may require several attempts as the threads are multiple start and not always assembled correctly on the first try. There should be approximately 9/16" engagement of the stop pin/shoulder mating against the stop shoulders. Check to see that the rollers (14) slide freely in slot to bottom of detent recess and is below the O.D. of the mating stems. Rotate upper stem and middle stem individually to see that each roller freely pops out of detent.
- 8.4 Insert indicator rod assembly (20) up through hole in upper stem and with flange shouldering in pocket in bottom of lower stem. Align hole in indicator flange with threaded hole in lower stem and fasten with setscrew (35).
- 8.5 Liberally lubricate with recommended grease and install the two bearings (15) onto exposed end of upper stem (5).  
**NOTE:** Install the bearings so that widest faces of the inner races are back to back as shown in the drawing. INCORRECT INSTALLATION WILL RESULT IN SERIOUS DAMAGE.
- 8.6 Install Retainer Ring (23).
- 8.7 Install O-ring (32) in yoke housing (3). Make sure groove is clean and free of burrs.
- 8.8 Install roller guide sleeve (13) into yoke housing (3). Make sure hole end of sleeve side is inserted first. Note orientation of holes in sleeve with respect to mating holes in housing.
- 8.9 Place rollers (14) in the side opening of middle and lower stems. A liberal application of heavy grease will hold rollers in place during assembly. Use recommended grease.
- 8.10 Insert the stem assembly (upper, middle & lower stems) into the housing (3), taking care to see that rollers (14) are aligned with roller groove in the sleeve (13). Push the entire assembly into housing until bearings (15) rest on the shoulder of sleeve (13).
- 8.11 Insert guide pin (10) in housing. Nose of pin will align with guide slot in lower stem as shown in Section EE of drawings.
- 8.12 Install hex head cap screws (25).
- 8.13 Install tapered roller bearing cup (22) in rear bearing recess of gear housing (1) with large diameter of taper facing outward. Seat bearing cup against shoulder with bearing cup seating tool.
- 8.14 Install tapered roller bearing cone (17) on each end of worm (8) with large diameter of tapered bearing against worm shoulder. Liberally grease cones and worm with recommended grease.
- 8.15 Insert worm assembly into gear housing (1). Make sure that rear bearing (17) cone has proper entry with rear bearing cup (22).
- 8.16 Insert tapered roller bearing cup (22) with large diameter of taper facing inward and mating properly with outward roller bearing cone.
- 8.17 Insert spacer (19) in gear housing.
- 8.18 Install O-ring (31) in Adapter Flange (12).

ITEM NO	PART NAME
1	YOKE
2	STEM HOUSING
3	CRANK HOUSING
4	STEM
5	CRANK
6	GUIDE PIN
7	STEM ADAPTER
8	"O" RING
9	POSITION INDICATOR POINTER
10	HEX HEAD CAPSCREW
11	DU BEARING
12	HEX HEAD CAPSCREW
13	"O" RING
14	ROLL PIN
15	"O" RING
16	ROLL PIN
17	"O" RING
18	SNAP-IN PLUG
19	GREASE FITTING
20	LOCK WASHER
21	PIN ( TRUNNION )
22	KNOCK OUT PLUG
23	SNAP RING
24	HEX HEAD CAPSCREW

NOTE:  
FOR OTHER ITEMS SEE FIGURE 8

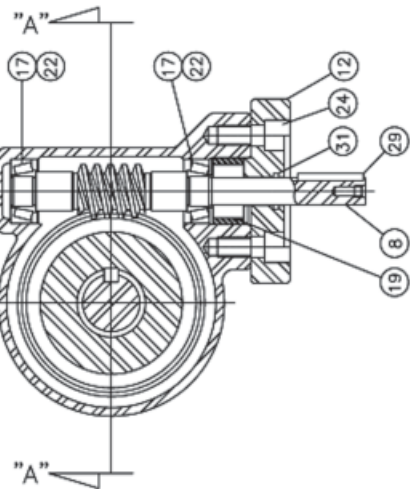


**Figure 11**

## 8. 30 KS Operator Assembly Instructions (Continued)

- 8.19 Install adapter flange (12) on gear housing and loosely secure with socket head cap screws (24). Use the following steps for shim selection and assembly.
- Step #1. Snug cap screws just enough to take up slack but loose enough to permit free rotation of worm shaft. Do not exceed 5 feet/pounds torque
  - Step #2. Measure gap between adapter flange (12) face and gear housing (1) face using feeler gauges.
  - Step #3. Select shim thickness that is .005 greater than measured gap, (shim increments available are 0.005, 0.010 and 0.030 thickness).
  - Step #4. Install shims and tighten socket head cap screws to approximately 180 ft/lbs torque, check to see that shaft remains free to rotate and it requires about 2 to 5 ft/lbs of torque. If not, increase or decrease shim thickness as required. (Increasing shim thickness will decrease torque to rotate the worm gear shaft and decreasing shim thickness will increase torque to rotate the worm gear shaft).
- 8.20 Place gear housing assembly on top of yoke housing assembly. Do NOT install hex head cap screws at this time.
- 8.21 Install key (28) in key slot of upper stem (7).
- 8.22 Assemble worm gear (4) onto end of upper stem (5) with hub side down and note key alignment. If required, slightly raise and shift gear housing (1) to one side to provide clearance between worm (8) and gear (4). It may be necessary to rotate worm slightly to cause teeth to mesh for additional clearance.
- 8.23 Align Gear Housing (1) as follows:
- STEP #1. Note lettered side of Yoke Housing (3) as front side.
  - STEP #2. Orient gear housing (1) with worm (8) toward front side of operator and with worm shaft pointing to right. Note that worm shaft will be parallel with trunnion pin hole cap (9) in lower portion of yoke housing (3) (gear housing with worm can be oriented in any position by rotating gear housing at 60° interval). Fasten gear housing (1) to yoke housing (3) using hex head cap screws (26) and (27). Assembly torque 180 ft/lbs.
- CAUTION: NOTE THAT THE SHORTER CAP SCREW (27) MUST BE INSTALLED DIRECTLY BENEATH CENTERLINE OF WORM (8).**
- 8.24 Lubricate with recommended grease and install bearing (16) on upper stem (5) and thread bearing retaining nut (18) on upper stem. Rotate worm shaft (8) clockwise until lower stem (7) shoulders on Guide Pin (10) and tighten worm to maximum of 15 ft/lbs torque. This makes sure bearings are fully seated on stem assembly. Tighten bearing retainer nut (18) approximately 50 ft/lbs to fully seat gear and bearing (16) on upper stem (5). Lock with brass nose or nylon tip setscrew (11).
- 8.25 Fill gear housing with recommended grease up to top of worm gear.
- 8.26 Install wiper ring (33) in housing cover (2). Lips of seal to extend outward.
- 8.27 Slide housing cover (2) over indicator shaft (20) and over bearing (16) and secure on top of gear housing, using hex head cap screws (25). Assembly torque 20 ft/lbs.
- 8.28 Install indicator Pointer (21) and secure with setscrews or roll pin (34). (NOTE: Will require readjustment of position indicator pointer after installing 30KS operator on the 4-Way Valve).
- 8.29 Install key (29) in worm shaft and wrap with tape to retain key for further use. Install grease fitting in top of gear housing (1) at each end of worm for further lubrication of worm bearings. Install trunnion pin hole cap (9) in lower end at yoke housing (3).

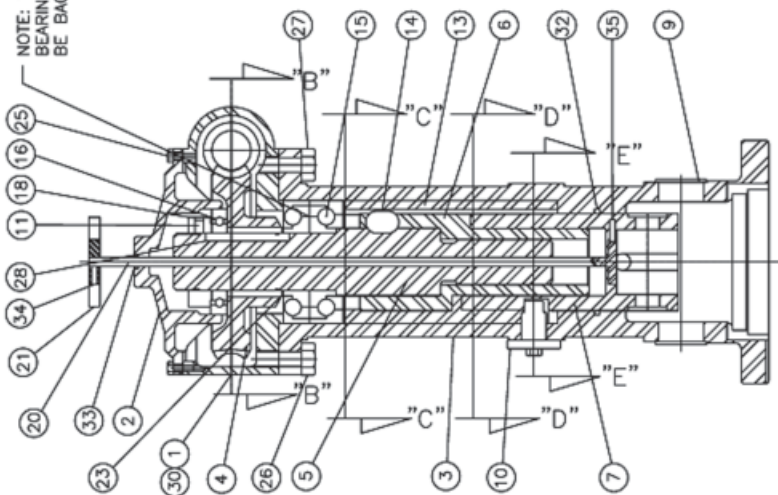
NOTE: For general purpose, use grease recommended per MS-1622. For low temperature application (below -20°F) use low temperature grease. For high temperature application (fire safe service) use "DESCO 330" high temperature grease.



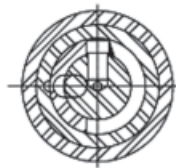
ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	GEAR HOUSING	11	SET SCREW	21	POSITION POINTER	31	O-RING
2	G HOUSING COVER	12	ADAPTER FLANGE	22	BEARING CUP	32	O-RING
3	YOKE HOUSING	13	GUIDE SLEEVE	23	RETAINING RING	33	WIPER RING
4	WORM GEAR	14	ROLLER	24	S HEAD CAPSCREW	34	S HEAD CAPSCREW
5	UPPER STEM	15	ROLLER BEARING	25	H HEAD CAPSCREW	35	S HEAD CAPSCREW
6	MIDDLE STEM	16	ROLLER BEARING	26	H HEAD CAPSCREW	36	SHIM
7	LOWER STEM	17	BEARING CONE	27	H HEAD CAPSCREW	37	KNOCKOUT SEAL
8	WORM	18	BEARING NUT	28	KEY		
9	SNAP-IN PLUG	19	SPACER	29	KEY		
10	GUIDE PIN	20	INDICATOR ROD	30	GREASE FITTING		

SECTION "B-B"

NOTE: WIDEST FACES OF BEARINGS INNER RACE MUST BE BACK TO BACK



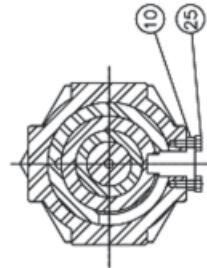
SECTION "A-A"



SECTION "C-C"



SECTION "D-D"



SECTION "E-E"

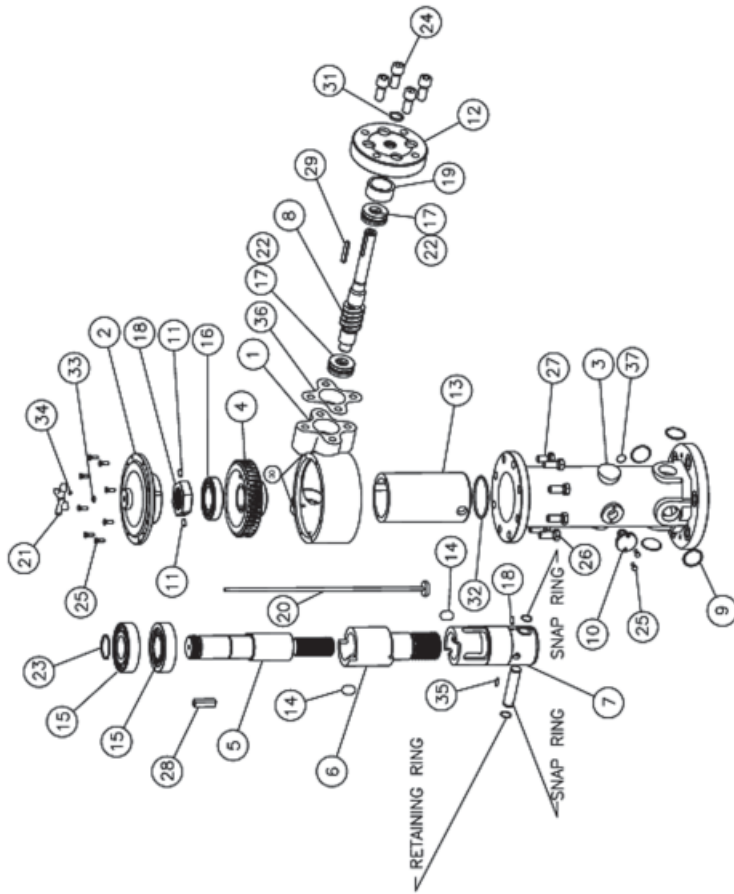


Figure 12

## 9. 30 KS Operator Disassembly Instructions (Use Fig. 12)

- 9.1 Remove handwheel, electric motor, or other drive means from worm shaft.
- 9.2 Unscrew setscrew or remove roll pin (34) and remove indicator pointer (21).
- 9.3 Unscrew hex head cap screws (25) and remove gear housing cover (2).
- 9.4 Unscrew socket head cap screws (24) and remove adapter flange (12).  
CAUTION: DO NOT DAMAGE PLASTIC SHIMS
- 9.5 Screw out worm shaft (8) (spacer 19, front bearing cone (17) and cup (22) and rear bearing cone (17) will come out with the worm shaft).
- 9.6 Back off soft nosed setscrew (11).
- 9.7 Remove bearing retainer nut (18).
- 9.8 Remove upper bearing (16).
- 9.9 Remove the worm gear (4).
- 9.10 Remove hex head cap screws (26) and (27) and remove gear housing (1).
- 9.11 Install the worm gear (4) with its key (28) on the upper stem upside down (hub up). Turn the gear (4) counter clockwise to raise the lower stem (7) as far as possible. Insert a 1-1/2" diameter bar through the two holes (trunnion pin holes for item #9) in the bottom of the housing (3). Using a pipe wrench on the gear hub, turn clockwise and jack the bearing (15) clear of the housing (3).
- 9.12 Unscrew hex head cap screws (25) and remove the guide pin (10).
- 9.13 Pull the upper stem (5), middle stem (6), lower stem (7), rollers (14), two bearings (15) and indicator rod assembly (20) out through the top of the housing (3). Remove rollers (14).
- 9.14 Remove the retaining ring (23).
- 9.15 Remove bearings (15) from the upper stem.
- 9.16 Remove the lower stem (7) and middle stem (6) from the upper stem (5).
- 9.17 Remove the setscrew (35) and push the indicator rod assembly (20) out through the bottom on the lower stem.
- 9.18 Remove lower stem (7) from the middle stem (6).
- 9.19 Remove roller guide sleeve (13) from the housing (3).
- 9.20 Inspect all parts for damage or wear and replace parts as needed.



Your local contact:



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