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HAGAN POWER POSITIONER TORQUE TYPE 6 x 10 INCH

Instruction Bulletin IB-102-207 Rev. 2
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ROSEMOUNT WARRANTY

Rosemount warrants that the equipment manufactured and sold by it will, upon shipment, be free of defects in workmanship or material. Should any failure to conform to this warranty become apparent during a period of one year after date of shipment, Rosemount shall, upon prompt written notice from the purchaser, correct such nonconformity by repair or replacement, F.O.B. factory of the defective part or parts. Correction in the manner provided above shall constitute a fulfillment of all liabilities of Rosemount with respect to the quality of the equipment.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES OF QUALITY WHETHER WRITTEN, ORAL, OR IMPLIED (INCLUDING ANY WARRANTY OF MERCHANTABILITY OF FITNESS FOR PURPOSE).

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Equipment supplied by Rosemount Analytical Inc. but not manufactured by it, will be subject to the same warranty as is extended to Rosemount by the original manufacturer.

PURPOSE

The purpose of this manual is to provide a comprehensive understanding of the Hagan 6 x 10 Power Positioner, components, functions, installation, and maintenance.

This manual is designed to provide information about the Hagan 6 x 10 Power Positioner. We recommend that you thoroughly familiarize yourself with the Description and Installation section before installing your power positioner.

The overview presents the basic principles of the power positioner along with the it's performance characteristics and components. The remaining sections contain detail procedures and information necessary for installation and servicing of the power positioner.

Before contacting Rosemount concerning any questions, first consult this manual. It describes most situations encountered in your equipment's operation and details necessary action.

DEFINITIONS

The following definitions apply to WARNINGS, CAUTIONS, and NOTES found throughout this publication.

WARNING

Highlights an operation or maintenance procedure, practice, condition, statement, etc., if not strictly observed, could result in injury, death, or long-term health hazards of personnel.

CAUTION

Highlights an operation or maintenance procedure, practice, condition, statement, etc., if not strictly observed, could result in damage to or destruction of equipment, or loss of effectiveness.

NOTE

Highlights an essential operating procedure, condition, or statement.

NOTE TO USERS

The P_____ number in the lower right corner of the illustrations in this publication are manual illustration numbers. They are not part numbers, and are not related to the illustration in any technical manner.

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SECTION I. DESCRIPTION

1-1. COMPONENT CHECKLIST OF TYPICAL SYSTEM (PACKAGE CONTENTS). A typical Rosemount 6 X 10 Power Positioner package should contain the following items shown in Figure 1-1.

1-2. MODEL NUMBER MATRIX. Use model number matrix, Table 1-1, to verify your style number. The first part of the matrix defines the model. The last part defines the various options and features of the power positioner. Copy your model number from data plate located on back of power positioner, into top of matrix Table 1-1. Check your model number against the features and options of the power positioner, making sure the options specified by this number are on this unit. Use this complete model number for any correspondence with Rosemount.

1-3. SYSTEM OVERVIEW.

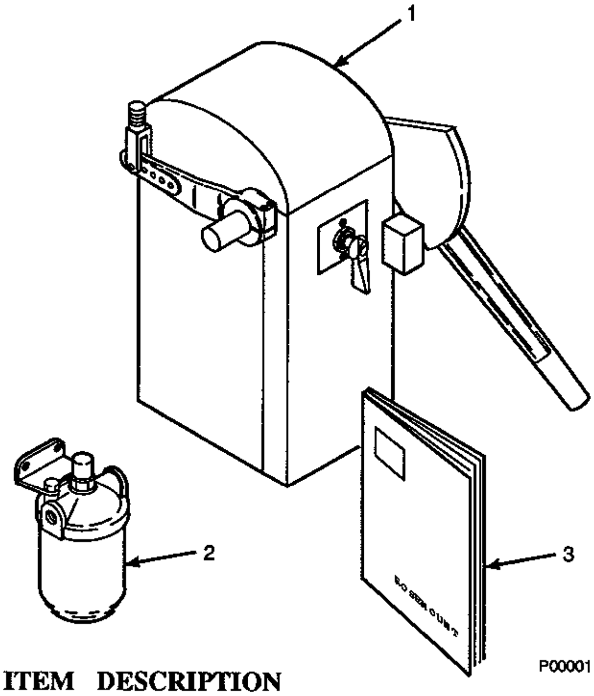
a. Scope. This Instruction Bulletin has been designed to supply details needed to install, operate, and service the Rosemount 6 X 10 Torque Type Power Positioner (Figure 1-1). The standard power positioner comes with manual lever, manual lock, bypass valve, current to pneumatic signal converter (I/P), pressure regulator/filter, supply air filter, clevis, and dust cover. Options for the power positioner include electric position transmitter, limit switches, heater/thermostat, air lock, and minimum limit stop. Service instructions for these options are covered in the appedices to this manual.

b. Power Positioner Features. The standard model power positioner includes the following features:

1. The manual lever provides leverage so operator can manually change the position of the device being controlled.

2. The manual lock allows operator to manually lock the piston and output shaft assembly in any position. This is done by clamping the sector with the manual lock handle, manually shutting-off supply air, and setting the by-pass valve to open.

3. A bypass valve provides a passage between top and bottom of piston to equalize air pressure on both sides of the piston, allowing manual positioning of device being controlled.



ITEM	DESCRIPTION
1	Model PP610TR Power Positioner
2	Air Filter
3	Instruction Bulletin

Figure 1-1. Typical System Package

4. The current to pneumatic signal converter (I/P) controls signal air to the power positioner through an electrical signal. This electrical signal can be either a direct 4 to 20 mA signal or an inverse 20 to 4 mA signal. The power positioner can be ordered with out the I/P converter. Without the I/P converter, an air signal controls the power positioner. This air signal can be direct or inverse, and have a range of either 3 to 15 psig or 0 to 30 psig.

5. The pressure regulator/filter maintains a stable and filtered air supply to the I/P converter.

6. The supply air filter will remove finely dispersed water or oil droplets from the supply air. Supply air must be free of oil and water to prevent pilot valve sticking.

Table 1-1. Model Number Matrix.

DESCRIPTION	PP610TR	TYPE	TYPE	INPUT	LIMIT SWITCH	HEATER	EPT/ STOP

PNEUMATIC POWER POSITIONER
6 x 10 TORQUE TYPE

FRAME DESCRIPTION (TYPE, first digit)

Standard/Brass Connections	1
Manual Lock/Brass Connections	2
Manual and Air Lock/Brass Connections	3
Standard/Stainless Steel Connections	4
Manual Lock/Stainless Steel Connections	5
Manual and Air Lock/Stainless Steel Connections	6

DRIVE SHAFT ASSEMBLY (TYPE, second digit)

Right Hand Drive	1
Left Hand Drive	2

SIGNAL RANGE (INPUT)

3-15 PSIG	1
0-30 PSIG	2
4-20 mA (I/P Mounted and Piped)	3

LIMIT SWITCH
Selection Based on TYPE.

None	0
Two Standard (Notes 1 and 6)	1
Two Standard (Notes 2 and 6)	2
Two Standard (Notes 3 and 6)	3
Two Heavy Duty (Notes 1 and 7)	4
Two Heavy Duty (Notes 2 and 7)	5
Two Heavy Duty (Notes 3 and 7)	6

HEATER

None	0
117 Vac, 150 Watt Heater	1

MISCELLANEOUS ACCESSORIES (EPT/STOP)
Selection Based on TYPE.

None	0
Electric Position Transmitter (See Note 4)	1
Electric Position Transmitter (See Note 5)	2
Electric Position Transmitter and Limit Stop (See Note 4)	3
Electric Position Transmitter and Limit Stop (See Note 5)	4
Minimum Limit Stop	5

NOTES:

(1) **For TYPE Codes 11, 12, 21, 31, 41, 42, 51, and 61.**
(2) **For TYPE Codes 22 and 52.**
(3) **For TYPE Codes 32 and 62.**
(4) **For TYPE Codes 21, 31, 51, and 61.**
(5) **For TYPE Codes 11, 12, 22, 32, 41, 42, 52, and 62.**
(6) **SPDT Switch Ratings**
15 Amps, 125, 250, or 480 Vac;
1/2 Amp, 125 Vdc.
(7) **National Acme DPDT Switch Ratings**

Volts	Amps
125 Vac	20
250 Vac	10
600 Vac	5
125 Vdc	5

7. The clevis provides a connection from power positioner to linkage so movement can be transferred to the device being controlled.

8. A dust cover provides a NEMA type 3 enclosure. It is removable and splash proof.

c. **Operational Description.** The Model PP610TR Torque Type Power Positioner is a pneumatic driven, double acting piston type power cylinder in which the operating lever is positioned to a specific setting for each input signal. The power positioner is mounted on a steel floor stand. The unit is covered and protected by a splash proof metal dust cover. The power positioner is used to position devices such as inlet vanes, control valves, and dampers.

1. Automatic Operation. Figure 1-2 depicts a direct acting power positioner. In this type

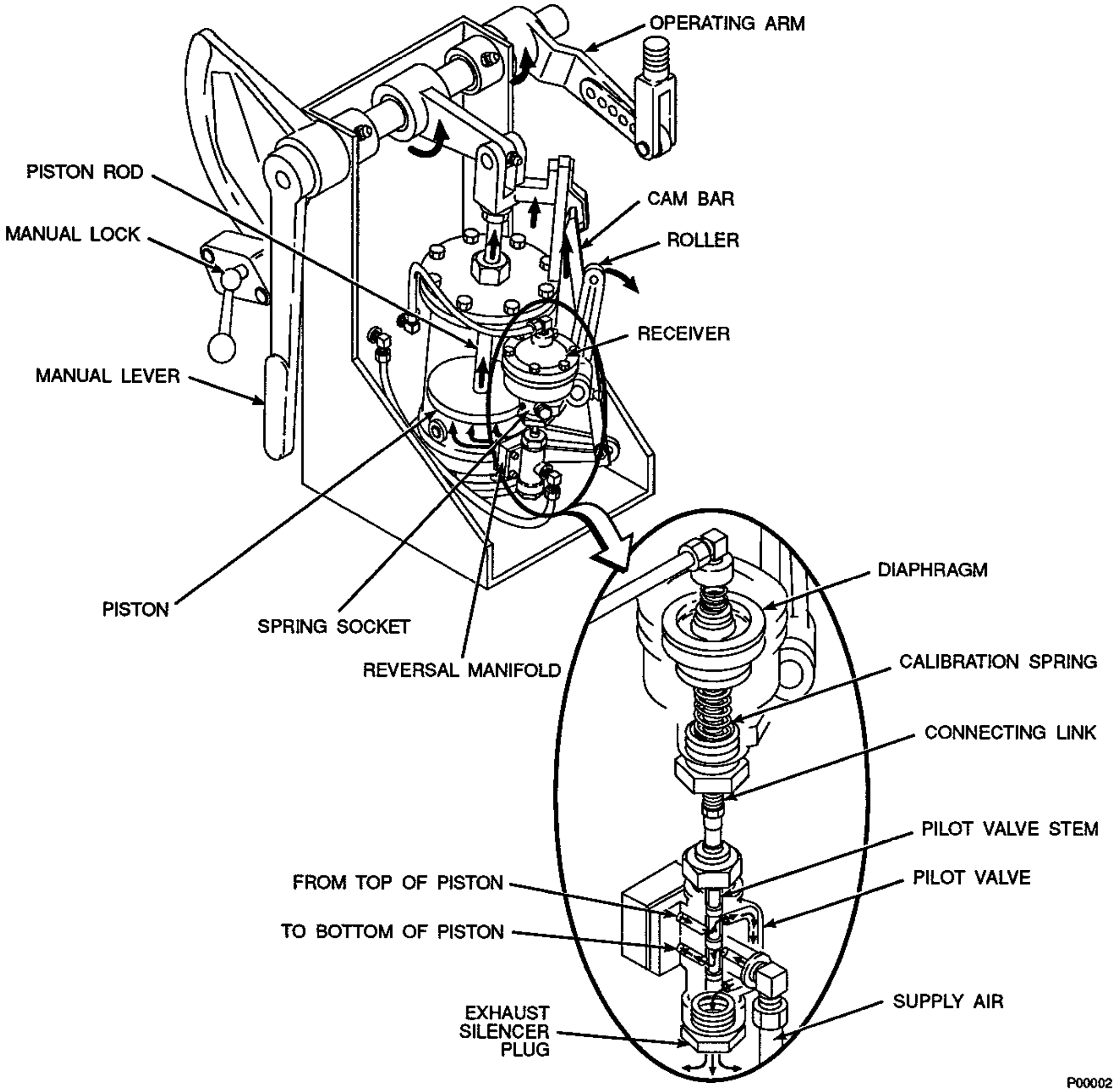


Figure 1-2. Power Positioner Operation

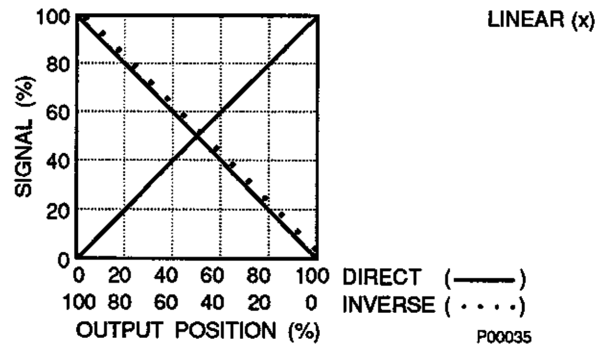
of positioner, an increase in signal air pressure to the receiver causes the diaphragm to overcome the tension of the calibration spring moving the diaphragm downwards. The downward motion is transmitted to the pilot valve through a connecting link. This positions the pilot valve stem to send supply air below the piston forcing the piston, piston rod, and operating arm upwards. Air from above the piston is exhausted through the pilot valves exhaust silencer plug.

The upward movement of the piston rod raises the cam bar. This causes the roller, riding on the cam bar, to lift the spring socket increasing pressure on the calibration spring. The increased pressure on the calibration spring returns the diaphragm to its neutral position, closing the pilot valve air ports. Without additional air, piston movement is stopped.

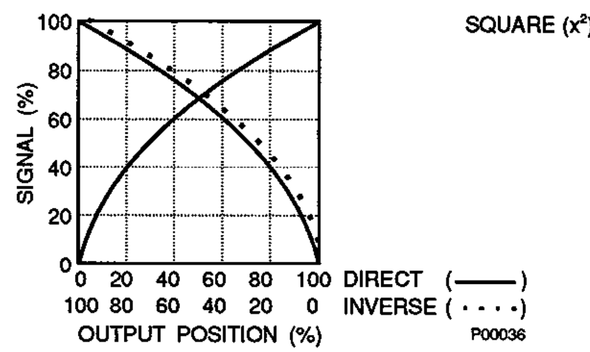
As signal air decreases the calibration spring pressure moves the diaphragm up. The upward movement of the diaphragm moves the pilot valve stem up directing air above the piston. This forces the piston, piston rod, and operating lever downward. The downward movement of the piston rod, working through the cam bar and roller, lowers the calibration spring socket and reduces pressure on the calibration spring. This decreased pressure on the calibration spring returns the receiver's diaphragm to a neutral position closing the pilot valve air ports.

2. Cam Bar. When a linear relationship between input signal and piston position is desired, the cam bar is straight. The cam bar can be shaped to produce either a square (x^2) shape or a square-root ($\sqrt{x}$) shape relationship between input signal and operating lever stroke. Refer to paragraph 2-6b2 for cam bar shaping.

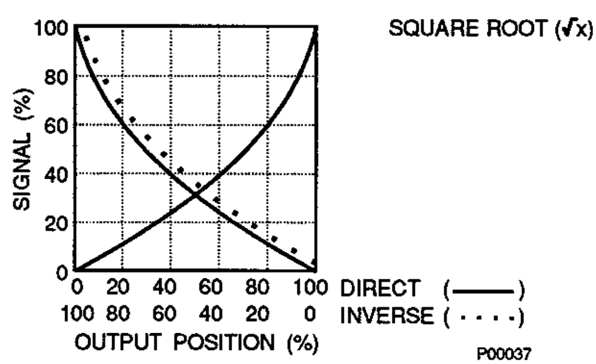
   (a) Straight Shape Cam Bar. A straight, non-characterized cam bar will produce a linear shape (1:1) relationship between the input signal and output response.



   (b) Squared Shape Cam Bar. The square (x^2) shape will produce a small output change for a large input change during the lower portion of the signal range. When operating in the upper portion of the signal range, a small input change will produce a large output change.



   (c) Square-Root Shaped Cam Bar. The square-root ($\sqrt{x}$) shape will produce a relatively large output change for small input changes during approximately the first 10% of signal range. When operating in the upper portion of the signal range, a large input change will be required to produce a small output change.



3. Inverse Operation. On inverse acting power positioners, the cam bar is reversed top to bottom and the reversal manifold is turned 90°. This causes the supply air to be directed to the top of the piston when signal air pressure is increased and to the bottom of the piston when signal air pressure is decreased. In this type of installation, piston movement is inversely related to the signal—as signal pressure decreases, the piston raises, as signal pressure raises, the piston lowers.

4. Manual Operation. The power positioner can be controlled manually through the manual lever. The movement of this lever directly controls the position of the device being controlled. To operate the manual lever, shut off supply air and open the bypass valve.

d. **System Considerations.** Prior to installation of your Rosemount 6 X 10 Power Positioner, check that you have all the components necessary to make the complete system installation.

Once you have verified that you have all the components, select mounting location. A typical installation is illustrated in Figure 1-3. Determine where power positioner will be placed in terms of serviceability, available power supply, ambient temperatures, environmental considerations, and convenience. Power positioner operating specifications are listed in Table 1-2. Become familiar with Section II, Installation, before installing unit.

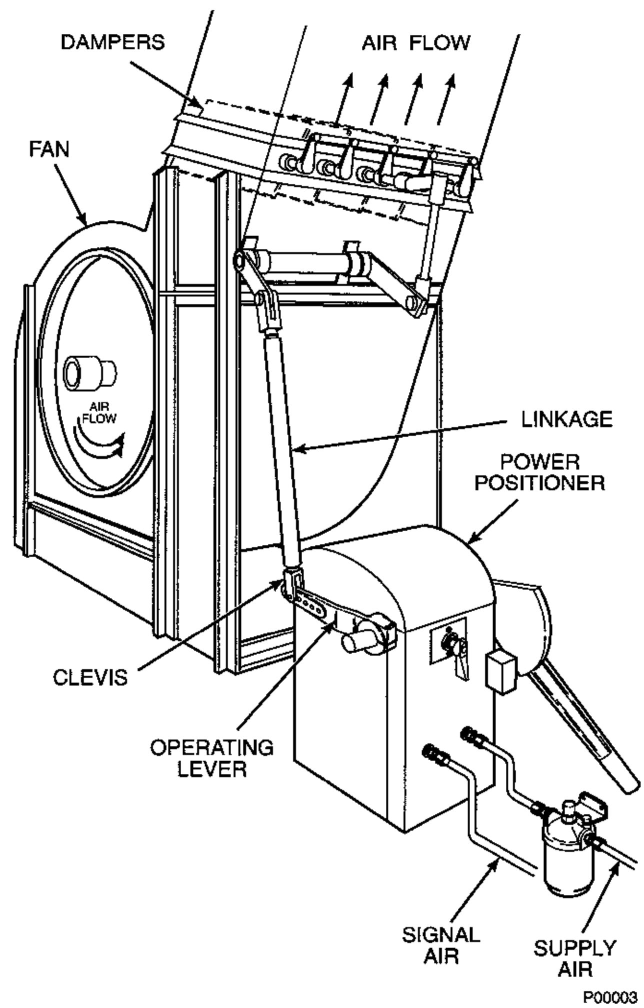


Figure 1-3. Typical Power Position Installation

1-4. MODEL PP610TR SPECIFICATIONS. Model PP610TR Power Positioner specifications contain information about the operating characteristics of the power positioner. Use Table 1-2 to make sure that available conditions are suitable for the power positioner before choosing mounting location.

Table 1-2. Specifications for Model PP610TR Power Positioner.

Signal Requirements	
Inputs:	
Direct: 4-20 mA/3-15 psig/0-30 psig	
Inverse: 20-4 mA/15-3 psig/30-0 psig	
Performance	
Repeatability	1% of full stroke or better
Full Stroke Time (unloaded)	5 seconds or less
Maximum Allowable Cylinder Air Pressure	120 psig
Supply Air Consumption	1 scfm free air
Control Torque	1050 ft-lbs
Maximum Friction Load	450 ft-lbs
Stall Torque	1800 ft-lbs
Outputs	84° shaft rotation
Physical Characteristics	
Weight	275 lbs, typical
Dust Cover	designed to meet NEMA Type 3 requirements
Supply Air Input Fitting	1/4 inch NPT female connection
Signal Air Input Fitting	1/4 inch NPT female connection
Environmental Requirements	
Ambient Temperature	
Limits:	
Without heater	40°F to 140°F (4.5°C to 60°C)
With heater	0°F to 140°F (-17.8°C to 60°C)
Relative Humidity	operable up to 100% RH
Air Supply Requirements	
Operating Air Supply Pressure	45 to 120 psig
Recommended Air Supply Pressure	100 psig

1-5. STORAGE INSTRUCTIONS. Use the following guidelines for storage of the power positioner.

a. **Storage Environment.** Store power positioner in a warehouse environment that maintains the following conditions:

1. Ambient temperatures above 45°F (7°C).

2. Humidity below 80% RH.

b. **Power Positioner Preparation for Storage.** Coat all non-painted surfaces and exposed metal with a rust-preventive compound (Tectyl 506 or a substitute with similar properties). The specifications for Tectyl 506 are included in Table 1-3.

WARNING

Keep Tectyl 506 away from heat, sparks, and open flames and use with adequate ventilation. Ventilation is required for cure and to prevent an explosive atmosphere from forming.

CAUTION

Use only approved thinning methods when applying rust-preventive compounds. Do not apply heat to compound. Fire or explosion may result. Refer to manufacture of rust-preventive compound for specific application, thinning, clean-up and removal instructions.

c. **Storage Preventive Maintenance.** If storing power positioner longer than six months, observe the following preventive maintenance guidelines.

1. Cycle cylinder and piston either manually or by air every 6 months.

2. Perform General Cleaning and Lubrication (paragraph 6-3), and Cylinder and Piston, Cleaning and Lubrication (paragraph 6-7), before installing power positioner.

Table 1-3. Specifications for Recommended Rust Preventive Compound.

REQUIREMENTS	PROPERTIES
Approximate air dry time	1 hour
Low Temperature Flexibility (90° bend with no flaking or cracking)	-10°F (-22.5°C)
Volatile Organic Content (V.O.C.)	3.24 lbs/U.S. Gallon 400 grams/liter
Accelerated Corrosion Tests: (5% Salt Spray (Hours))	
ASTM (see Note 1) B-117 at 1.3 mils (2 x 4 x 1/8 inch Polished Steel Panels)	2000
DIN (see Note 2) 50021 at 32.5 microns (125 x 200 mm DIN 1623 Panels)	168

NOTES:
(1) ASTM (American Society for Testing and Materials)
(2) DIN (Deutsche Industrie Normen)

SECTION II. INSTALLATION

2-1. OVERVIEW. The power positioner is designed to be installed upright. The floor stand is bolted to a prepared horizontal foundation. A minimum of 45 psig to a maximum of 120 psig supply air pressure is needed at the mounting location. The power positioner must be controlled by either an electrical signal or by an air signal. All wiring must conform to local and national codes.

2-2. SPECIAL INSTALLATION CONSIDERATIONS.

a. **Foundation.** The power positioner's torque is transmitted to the operating arm of the device, this torque is transferred to the mass of the positioner and its foundation. The foundation must be designed to handle the torque produced to keep the power positioner stationary. Refer to paragraph 2-3 for detailed foundation requirements.

b. **Supply Air Pressure Considerations.** A supply air pressure of 45 to 120 psig, minimum of 1 scfm, is required. A filter and regulator should be provided in the supply line.

c. **Linkage Design Considerations.** Final control components play a large part in a control system. Special characteristics of the device being controlled affect system response and must be regarded in design and set-up of a power positioning system.

Control valves and damper drives regularly allow large flow rate changes, compared to valve movement, near the closed position. Smaller flow rate changes compared to valve movement occur near the fully open position. In normal damper applications there may be no flow rate changes after damper has reached 70% open. This characteristic is represented by the following mathematical equation:

$$\textbf{Flow} = \textbf{k} \ (\textbf{Position})^2$$
$$\textbf{k} = \textbf{Constant}$$

This equation means that flow is proportional to square of valve position. As damper or valve opens, the rate at which flow changes per valve position is reduced. As valve or damper closes, the rate at which flow changes per valve position is increased.

Flow tests must be conducted before attempting to limit damper opening. Testing is necessary to confirm actual damper characteristics and to ensure control response throughout the entire flow range. When installing a new power positioning system, care must be taken to properly design the system for linkage size and action. In a properly designed system, a percentage change in control signal will produce the same percentage change in flow rate. Refer to paragraph 2-6 for detailed information on design and installation of a linearized control action power positioning system.

2-3. POWER POSITIONER MOUNTING INSTRUCTIONS.

a. **Footprint Foundation and Mounting Requirements.**

1. Foundation Dimensions. Dimensions for mounting base of stand assembly to foundation are found on Figure 2-1. Four mounting holes in base are drilled for 3/4 inch foundation bolts.

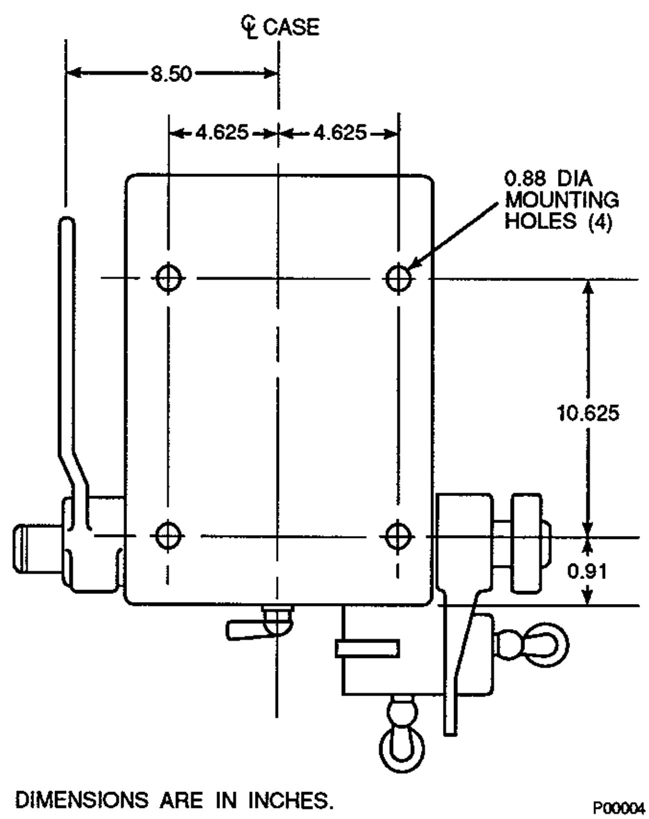


Figure 2-1. Mounting Dimensions

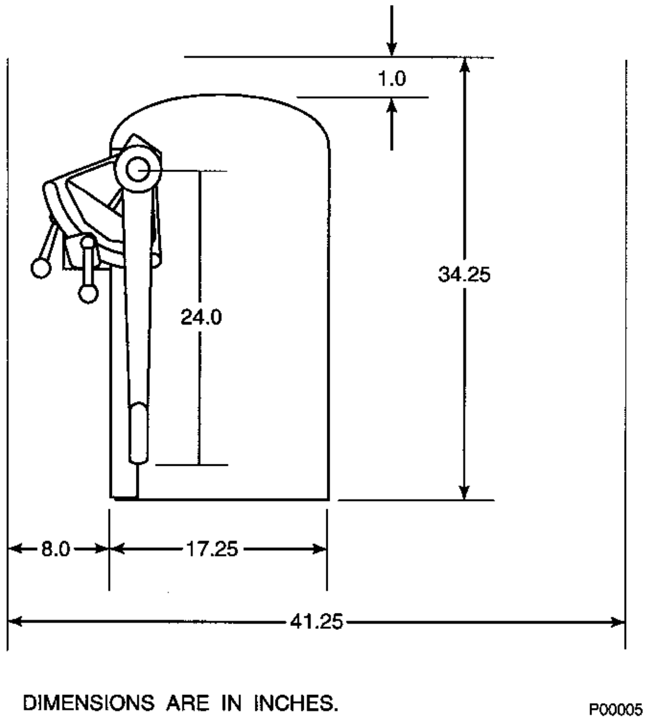


Figure 2-2. Clearance Requirements

2. Strength Requirement. Foundation must be able to withstand 1050 ft-lbs torque plus 250 pounds weight. Mount power positioner to the foundation with 3/4 inch bolts.

b. **Working Clearance Requirements.** Make sure area is clear of obstructions that will interfere with operation and maintenance. Allow adequate clearance (34.25 inches from foundation vertically, 41.25 inches front to back) for removal of dust cover and for full travel of operating and manual levers (Figure 2-2).

2-4. AIR SUPPLY INSTALLATION. Using Figure 2-3, match the torque load needed to position your device to the "maximum torque required" axis along the bottom of the graph. From this point, move vertically up to the control torque curve. From the point that intersects control torque curve, move horizontally to the left scale labeled "supply air pressure". This is the minimum supply air required to develop the required control torque. The stall torque curve represents the maximum amount of torque the power positioner will produce for given supply air pressure before stalling out.

a. **Air Line Requirements.** Installation of air filter is necessary for proper power positioner operation. A manual shutoff valve should be installed in the air supply line before the air filter, Figure 2-4. The air filter will remove finely dispersed water or oil droplets, preventing sticking of the pilot valve stem.

If your unit is not equipped with an I/P signal converter, a separate signal line must be installed as shown in Figure 2-4, View B. This signal line must be either 0 to 30 psig or 3 to 15 psig. Refer to your model number and model number matrix (Table 1-1) to determine type of air signal required.

b. **Supply Air and Signal Air Connections.** Basic schematics are shown in Figure 2-4. The installation of the air filter is as follows:

1. Mount bracket for air filter directly on the back of the stand assembly. If this is unsuitable, mount air filter within 15 feet of power positioner.

NOTE

Prior to connecting supply air line or signal air line, purge air systems until all moisture and debris are blown out.

2. Purge air supply system and connect air supply line to the air filter inlet. Run a second line from the air filter outlet to the power positioner supply air inlet connection. All fittings are 1/4 inch NPT.

3. Purge signal air line and connect to signal air connection on power positioner.

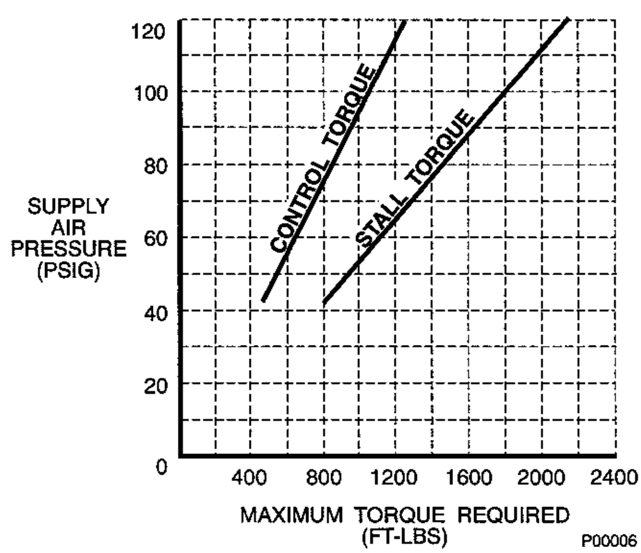
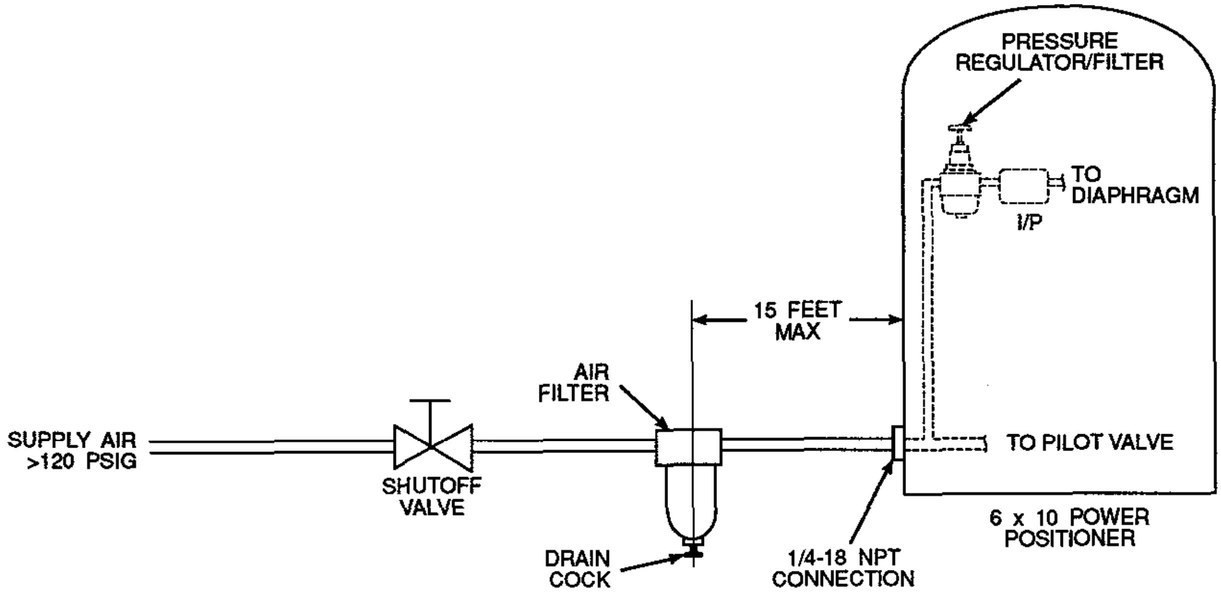
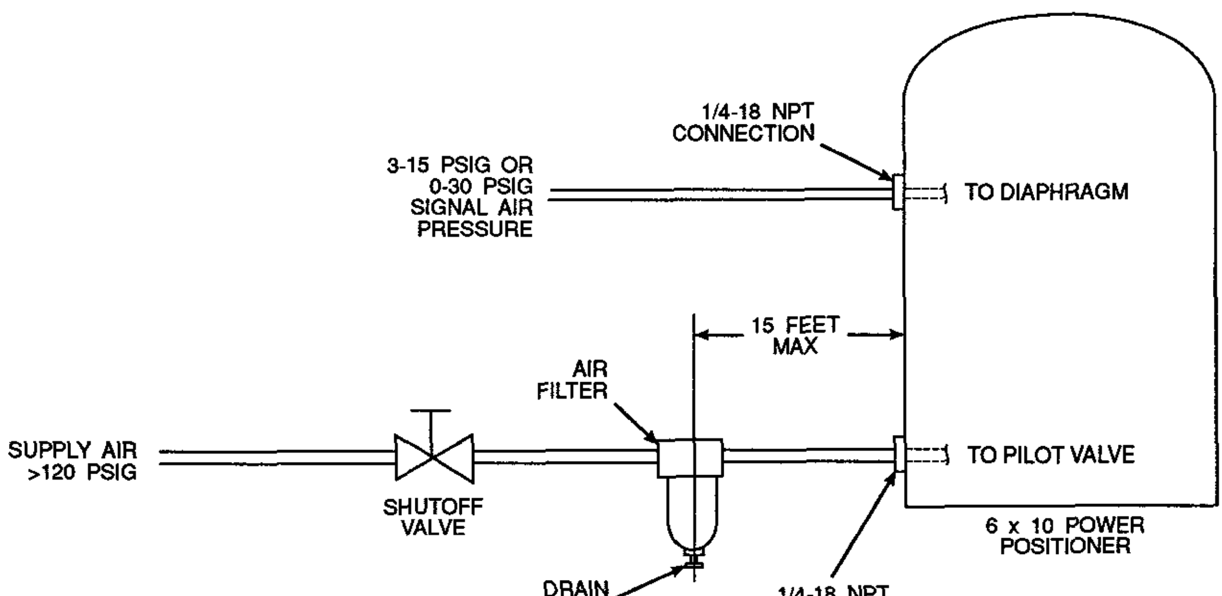


Figure 2-3. 6 x 10 Power Positioner Torque Chart



VIEW A
POWER POSITIONER WITH CURRENT TO PNEUMATIC SIGNAL COVERTER (I/P)



VIEW B
POWER POSITIONER WITH PNEUMATIC CONTROL SIGNAL

P00007

Figure 2-4. Air Piping Schematic

2-5. CURRENT TO PNEUMATIC SIGNAL CONVERTER (I/P) ELECTRICAL CONNECTIONS. Connect electrical signal input to I/P converter and calibrate if necessary, refer to paragraph 4-3 for calibration procedures. The connections must be made by screw terminals. If the I/P has pigtail leads instead of screw terminals, the connection must be made at a terminal block. Gage of wire required is 18 gage signal wire. The signal that will control the I/P should have a range of 4 to 20 mA at a voltage of 24 vdc.

a. Direct Acting. Connect positive signal to black lead and negative signal to white lead.

b. Reverse Acting. Connect positive signal to white lead and negative signal to black lead.

2-6. LINKAGE INSTALLATION. Install linkage for either a characterized flow control device, or linkage for a linear flow control device. Linkage described is pipe (1-1/4 inches diameter), maximum length is 21 feet, 9 inches.

a. Linkage Installation for a Characterized Flow Control Device.

1. Measure length of driven lever (Figure 2-5) on device to be controlled (R_1).

2. Attach the linkage clevis to the power positioner's drive lever so that distance R_2 is equal to R_1.

3. Close damper of device to minimum flow position.

4. Measure angle (θ_1) of device's driven lever from vertical.

5. Install power positioner's drive lever so its angle θ_2 is the same as the device's driven lever (θ_1).

6. Measure distance (ℓ) between operating levers connection holes. Cut linkage pipe to fit this measurement; allow for clevis length.

7. Install pipe (linkage) between operating levers, check for freedom of movement by operating power positioner's manual lever. Minor adjustments can be made to linkage length by turning linkage clevis fitting in or out as necessary.

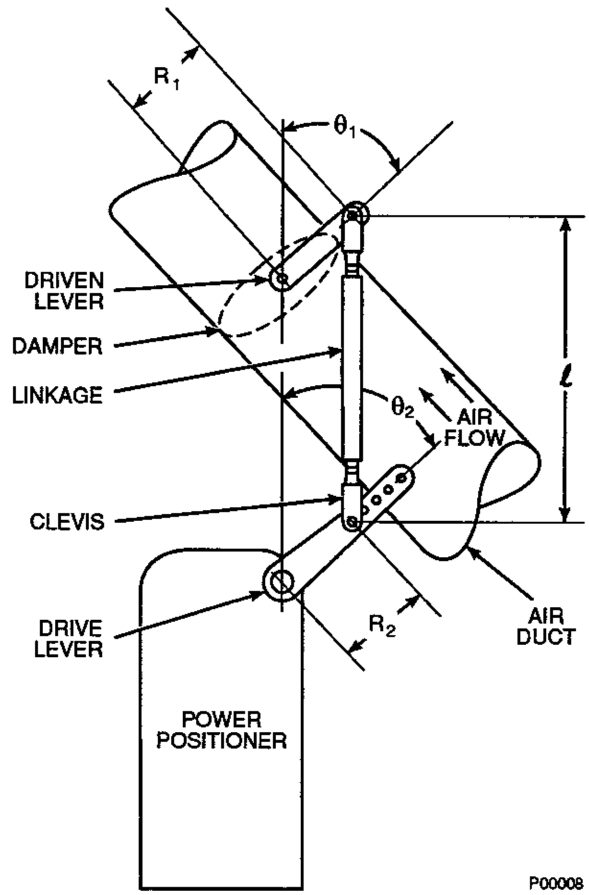


Figure 2-5. Linear Linkage Design

b. Linkage Installation for a Linear Flow Control Device. Linear flow control devices require a characterized control system. This can be accomplished by either characterizing linkage or the power positioner.

If greater torque is required at start of power positioner movement, characterize the linkage system. This is covered in step 1.

If this additional starting torque is not required, a linear linkage can be installed; the power positioner cam bar must be shaped to characterize the power positioner. This is covered in step 2.

NOTE

Linkage installation described in this section of the manual are for direct acting power positioners.

1. Characterized Linkage System.

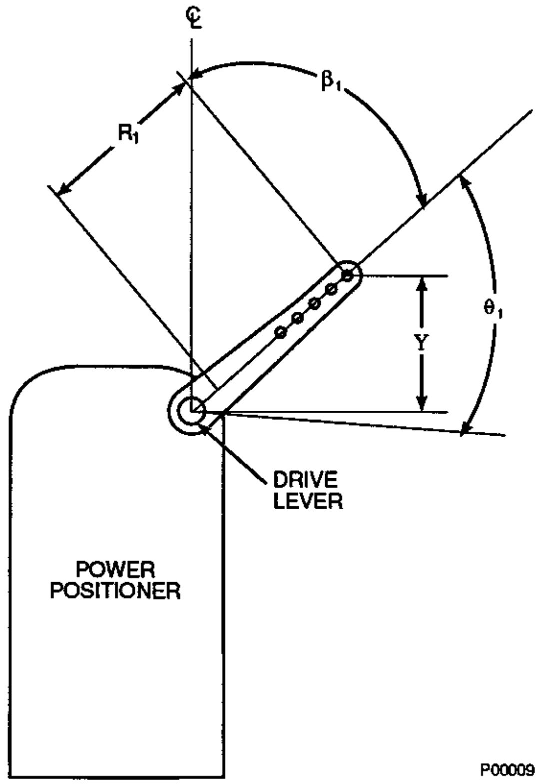


Figure 2-6. Vertical Arm Travel

(a) Make sure a straight cam bar is installed to get linear outputs from power positioner.

(b) Figure out how far vertically the operating lever travels using Figure 2-6 and the following equation:

$$Y=2R_1[Sin((\theta_1+\beta_1)/2.0)]^2-[Sin\beta_1/2.0]^2$$

NOTE

The following known values are used to calculate the vertical distance travelled by the drive lever, "Y":

R_1 = Length of the drive lever (from shaft center to clevis pin center)
θ_1 = Total angular rotation of the drive lever
β_1 = Angular measurement of drive lever from vertical centerline with piston fully extended.

To perform the following procedure, a calculator with basic functions, plus the following scientific functions, is necessary:

Sine Function (SIN)
Square Function (x^2)

Use the following procedure to determine Y, the vertical distance travelled by drive lever:

1 Add value of θ_1 to value of β_1.

2 Divide answer from step 1 by 2.0.

3 Enter answer from step 2 and press sine key (SIN).

4 Press square key (x^2).

5 Multiply answer from step 4 by length of drive lever (**R_1**).

6 Multiply answer from step 5 by 2.

7 Write down answer from step 6 and label it 6 for use later.

8 Clear calculator.

9 Enter value of β_1.

10 Press sine key (SIN).

11 Divide answer from step 10 by 2.0.

12 Press square key (usually key marked x^2).

13 Write down answer from step 12 and label it 12.

14 Clear calculator.

15 Enter value marked 6 and subtract value marked 12.

16 The value in step 15 is equal to vertical distance travelled by drive lever "Y".

(c) Since we know how far angularly the drive lever will move, determine the angular rotation of driven lever interms of drive lever rotation. The angular rotation follows Figure 2-7 and the relationship:

$$\theta_2=2[Sin^{-1}(R_1/R_2(Sin(\beta_1+\theta_1)/2)^2-(Sin\beta_1/2)^2 +(Sin\beta_2/2)^2)^{0.5}-\beta_2/2]$$

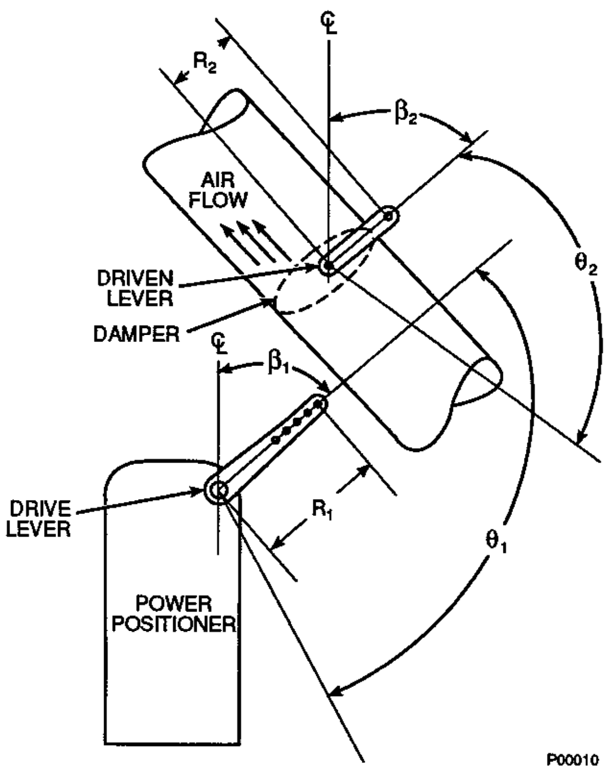


Figure 2-7. Driven Shaft Angular Rotation

NOTE

The following known values are used to calculate the total angular rotation of the driven lever, θ_2:

θ_1 = Total angular rotation of the drive lever
R_1 = Length of the drive lever (from shaft center to clevis pin center)
R_2 = Length of the driven lever (from shaft center to clevis pin center)
β_1 = Angular measurement of drive lever from vertical centerline with piston fully extended
β_2 = Angular measurement of driven lever from vertical centerline with damper fully closed.

To perform the following procedure, a calculator with basic functions, plus the following scientific functions, is necessary:

Sine Function (SIN)
Inverse Sine Function (SIN^{-1}) or (INV SIN)
Square Function (x^2)
Power Function (y^x)

Use the following procedure to determine θ_2, the angular rotation of the driven lever.

1 Add value of β_1 to value of θ_1.

2 Enter answer from step 1 and press sine key (SIN).

3 Divide answer from step 2 by 2.0.

4 Multiply answer from step 3 by length of driven lever (**R_2**).

5 Write down answer from step 4 and label it 4. Clear calculator.

6 Enter value for length of drive lever (**R_1**).

7 Divide value from step 6 by value marked 4.

8 Press square key (x^2).

9 Write down answer from step 8 and label it 8 for use later.

10 Clear calculator.

11 Enter value for β_1 and press sine key (SIN).

12 Divide answer from step 11 by 2.

13 Press square key (x^2).

14 Write down answer from step 13 and label it 13 for later use.

15 Enter value for β_2 and press sine key (SIN).

16 Divide answer from 15 by 2.

17 Press square key (x^2).

18 Write down answer from 17 and label it 17 for later use.

19 Clear calculator.

20 Enter value marked 8.

21 Subtract value marked 13 from value marked 8.

22 Subtract value marked 17 from step 21.

23 Press power function key (y^x).

24 Enter 0.5.

25 Press inverse sine (INV SIN or SIN^{-1}).

26 Write down answer from step 25 and label it 25.

27 Clear calculator.

28 Enter value for β_2.

29 Divide value from step 28 by 2.

30 Write down answer from step 29 and label it 29. Clear calculator.

31 Enter value from step 25.

32 Subtract value from step 29.

33 Multiply answer from step 32 by 2.

34 The value in step 33 is equal to total angular rotation of driven lever "θ_2".

(d) To calculate length of connecting linkage based on the length of drive lever, driven lever, and the initial offset of both, use Figure 2-8 and the following relationship:

$$\ell = [L-(R_1 Cos\beta_1 + R_2 Cos\beta_2)^2 + (R_1 Sin\beta_1 - R_2 Sin\beta_2)]^{0.5}$$

NOTE

The following known values are used to calculate the length of the linkage ℓ in inches:

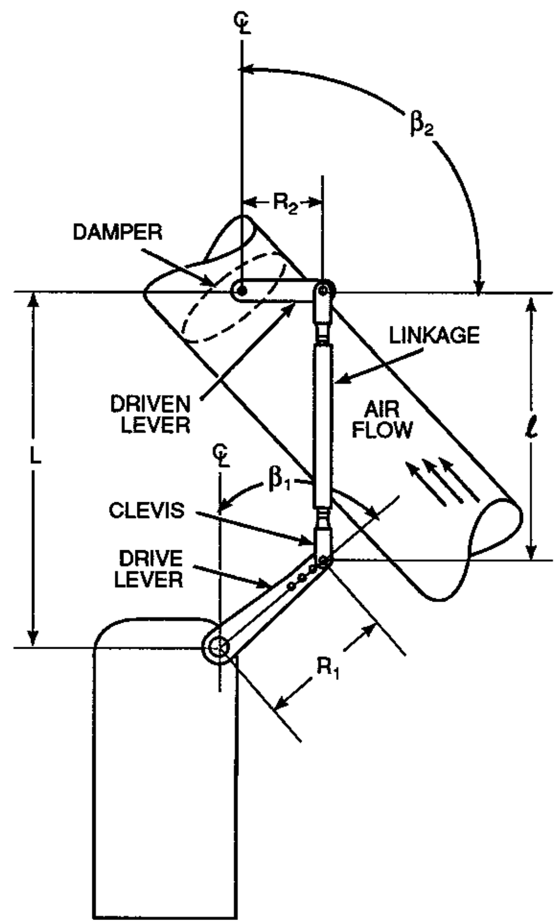
L = Length between drive and driven shaft center lines

R_1 = Length of the drive lever (from shaft center to clevis pin center)

R_2 = Length of the driven lever (from shaft center to clevis pin center)

β_1 = Angular measurement of drive lever from vertical centerline with piston fully extended

β_2 = Angular measurement of driven lever from vertical centerline with damper fully closed



Record setup dimensions and angles used.

β_1 _____ °

β_2 _____ °

ℓ _____ inches

R_1 _____ inches

R_2 _____ inches

P00011

Figure 2-8. Connecting Linkage Length

To perform the following procedure, a calculator with basic functions, plus the following scientific functions, is necessary:

Sine Function (SIN)
Cosine Function (COS)
Square Function (x^2)
Power Function (y^x)

Use the following procedure to determine ℓ, the length of connecting linkage in inches:

1 Clear calculator.

2 Enter value for β_1 and press cosine key (COS).

3 Multiply answer from step 2 by length of drive lever (R_1).

4 Write down answer from step 3 and label 3.

5 Clear calculator.

6 Enter value for β_2 and press cosine key (COS).

7 Multiply answer from step 6 by length of drive lever (R_1).

8 Write answer from step 7 down and label 7. Clear calculator.

9 Add answer from step 8 to value marked 3.

10 Press square key (x^2).

11 Write down answer from step 10 and label 10.

12 Clear calculator.

13 Enter distance between drive and driven shaft (L).

14 Subtract value marked 10 from step 13.

15 Write down answer from step 14 and label 14.

16 Clear calculator.

17 Enter value for β_1 and press sine key (SIN).

18 Multiply answer from step 17 by length of drive lever (R_1).

19 Write down answer from step 18 and label 18.

20 Clear calculator.

21 Enter value for β_2 and press sine key (SIN).

22 Multiply answer from step 21 by length of driven lever (R_2).

23 Write down answer from step 22 and label 22. Clear calculator.

24 Subtract value marked 22 from value marked 18.

25 Add answer from step 24 to value marked 14.

26 Press power function key (y^x).

27 Enter 0.5 into calculator.

28 The value in step 27 is equal to length of connecting linkage "ℓ ".

Design linkage system by using values for lengths of drive and driven levers, angular position of both levers from vertical (offsets), and distance between drive and driven levers centers to calculate length of linkage. These values were determined in the previous steps.

(e) Close damper to minimum flow position. Make sure driven lever is at angle (β_2) and drive lever is at angle (β_1).

(f) Cut linkage pipe to length (ℓ). Install linkage between operating levers.

(g) Check for freedom of movement by operating power positioner's manual lever. Minor adjustments linkage length can be made by turning pipe to clevis fitting in or out as necessary.

(h) Record values on Figure 2-8 for β_1, β_2, ℓ, R_1, and R_2.

2. Characterized Power Positioner.

(a) Determine open and closed positions of controlled damper.

(b) Install mechanical linkage so the power positioner will travel through its ten inch stroke while positioning the damper from minimum to maximum opening.

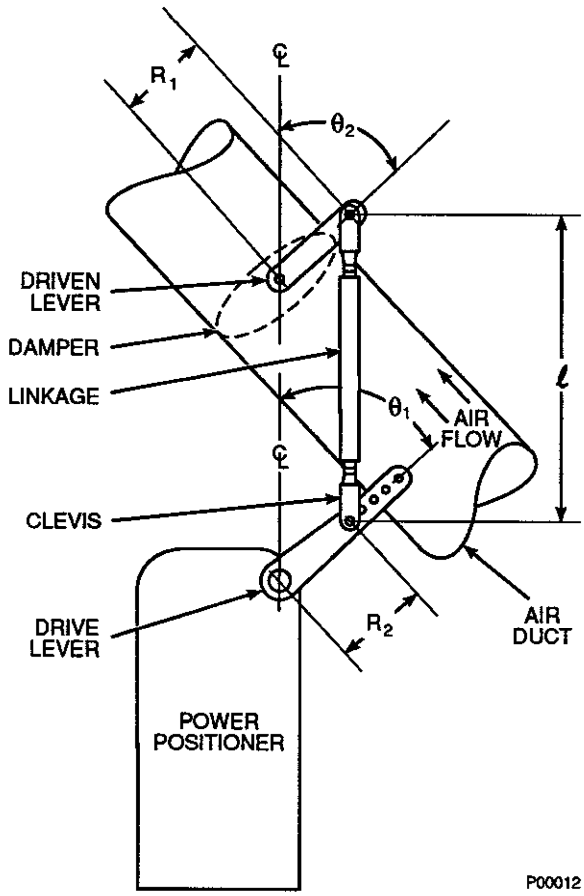


Figure 2-9. Characterized Linear Linkage Design

1 Measure length of driven lever (Figure 2-9) from its shaft center to center of clevis pin (R_2).

2 Attach the linkage clevis to the power positioner's drive lever so that distance R_2 is equal to R_1.

3 Close damper of device to minimum flow position.

4 Measure angle (θ_2) of device's driven lever from vertical centerline with damper closed.

5 Install power positioner's drive lever at the same angle as the device's operating lever (θ_1) with power positioner's piston fully extended.

6 Measure distance between operating levers connection holes (ℓ). Subtract distance of clevis and connection to the damper's operating lever. Cut pipe to fit this measurement.

7 Install pipe (linkage) between operating arms.

8 Check for freedom of movement by operating power positioner's manual lever. Minor adjustments to linkage length can be made by turning pipe to clevis fitting in or out as necessary.

NOTE

Follow calibration procedures carefully. Proper power positioner calibration is essential to accurately shape the cam bar.

(c) Calibrate the stroke of power positioner. Refer to paragraph 4-1. It is essential to calibrate carefully.

(d) Measure and record actual flow of system being controlled starting at zero input signal and increasing signal in 10% increments to 100%. Record these values in Table 2-1, System Flow Chart. These values will be used later to plot the shape of the cam bar.

Table 2-1. System Flow Chart.

INPUT SIGNAL	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
FLOW (SCFM)										

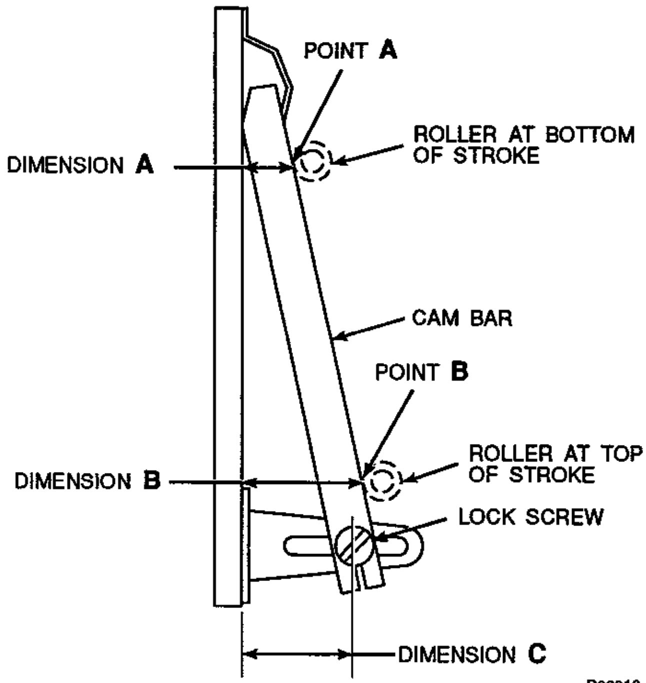


Figure 2-10. Cam Bar Shaping

(e) Measure and record dimensions A, B, and C as follows:

1 Using air pressure, move piston and clevis head to bottom of stroke. Mark point that roller touches cam bar. This is point "A" (Figure 2-10).

2 Measure distance from point "A" to face of guide bar to the nearest 1/64th inch. Record this as dimension "A".

3 Using air pressure, move piston and clevis head to top of stroke. Mark point that roller touches cam bar. This is point "B".

4 Measure distance from point "B" to guide bar to nearest 1/64th inch. Record this as dimension "B".

5 Dimension "C" is the distance between guide bar to center of lock screw. Measure to nearest 1/64th inch.

(f) Using signal air move piston to bottom of stroke and remove lock screw (Figure 2-10). Remove compensating bar from positioner.

(g) Near bottom of a sheet of graph paper, draw a base line (Graph 1). Draw a vertical line near left side of paper. Label this line "% of Input Signal".

(h) Mark point "A" to right of "% of Input Signal" line. This point is 10 inches up from base line and at dimension "A" from "% of Input Signal" line.

(i) Mark point "B" to right of input signal line. Point "B" is on base line at same distance from "% Input Signal" line as dimension "B".

(j) Lay cam bar on graph with lock screw hole at bottom. Point "A" and point "B" as marked on cam bar should line up with point "A" and point "B" as plotted on graph. Draw a heavy line thru points "A" and point "B" and label cam bar line.

(k) Refer to Graph 2. Mark input signal points, in 10% increments, on % of input signal line at right edge of graph. 0% will be at the top of the graph, Point A, and 100% will be at the base line, Point B. Each 10% signal will be one inch apart.

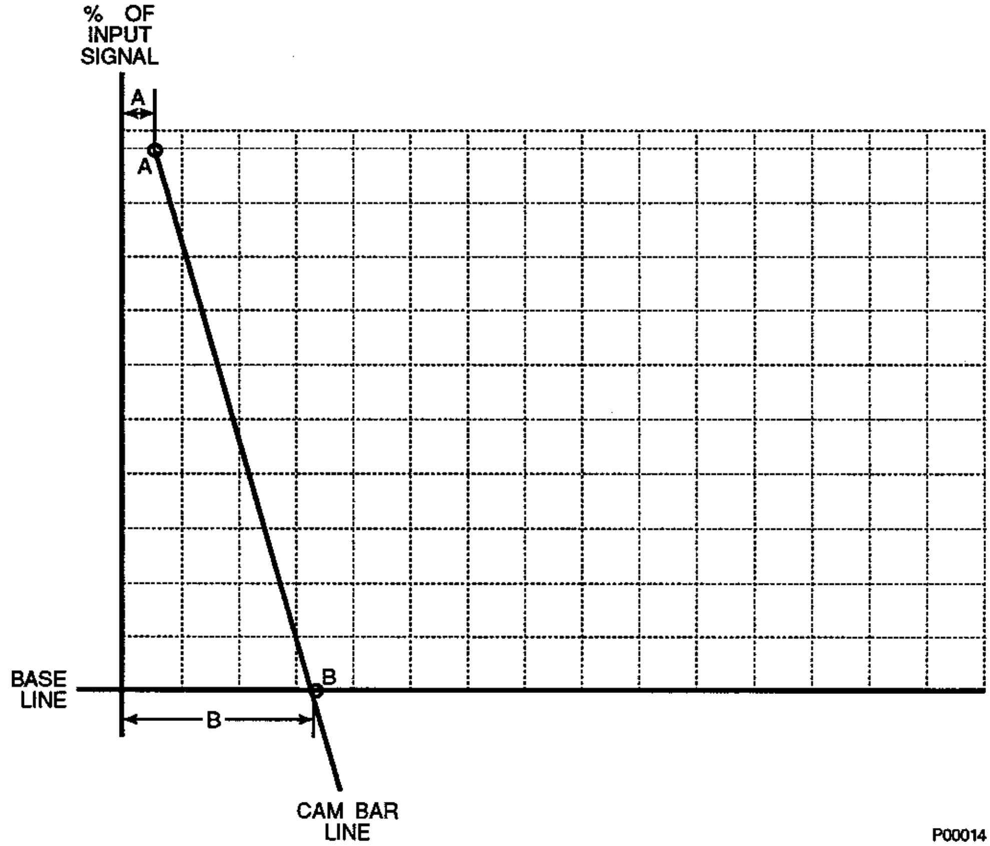
(l) Draw a line from each "% Input Signal" horizontally to cam bar line. From this point of intersection, draw a vertical line to top of graph. Label top of graph "% of Horizontal Roller Travel".

(m) On base line, label ten points recorded in step d that represent flow of ten different signal positions. Record these ten flow points along base line between 0 and 100% flow (Graph 3).

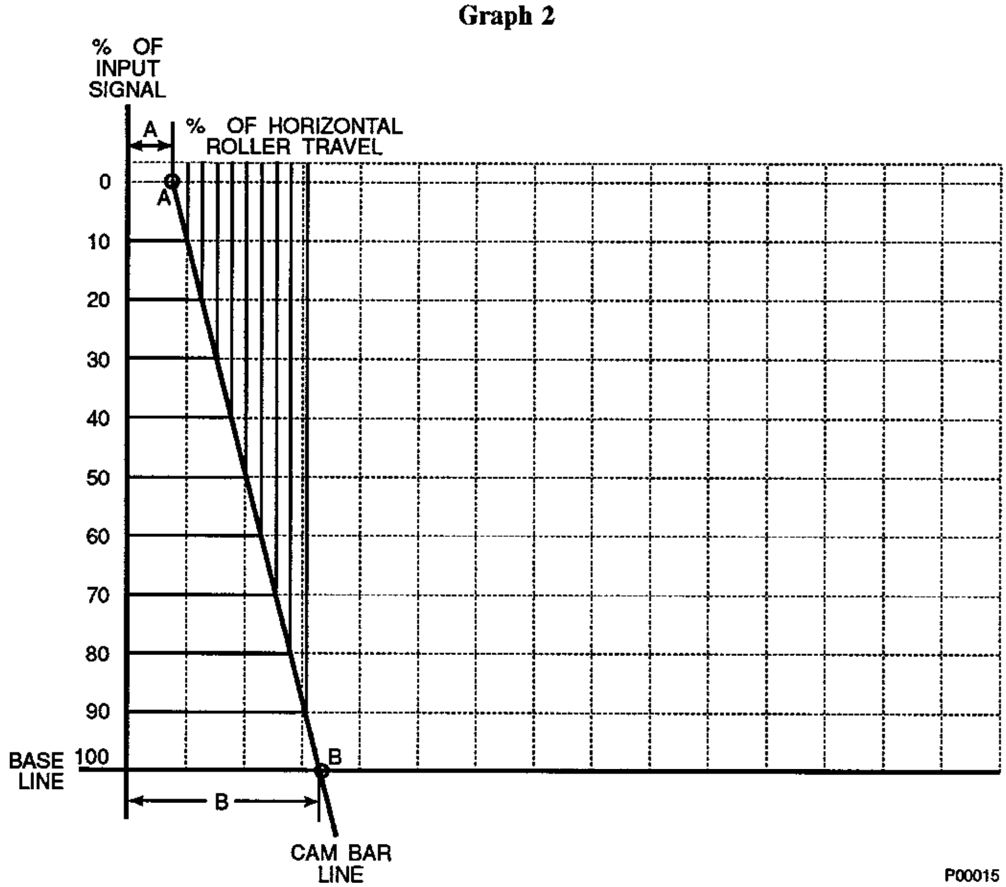
NOTE

For this purpose, we used a 100% flow of 7 scfm. At 10% input signal we had flow of 1.8 scfm, at 20% input signal we had flow of 3.1 scfm, etc. These values noted in the example flow chart on Graph 3.

Graph 1



Graph 2



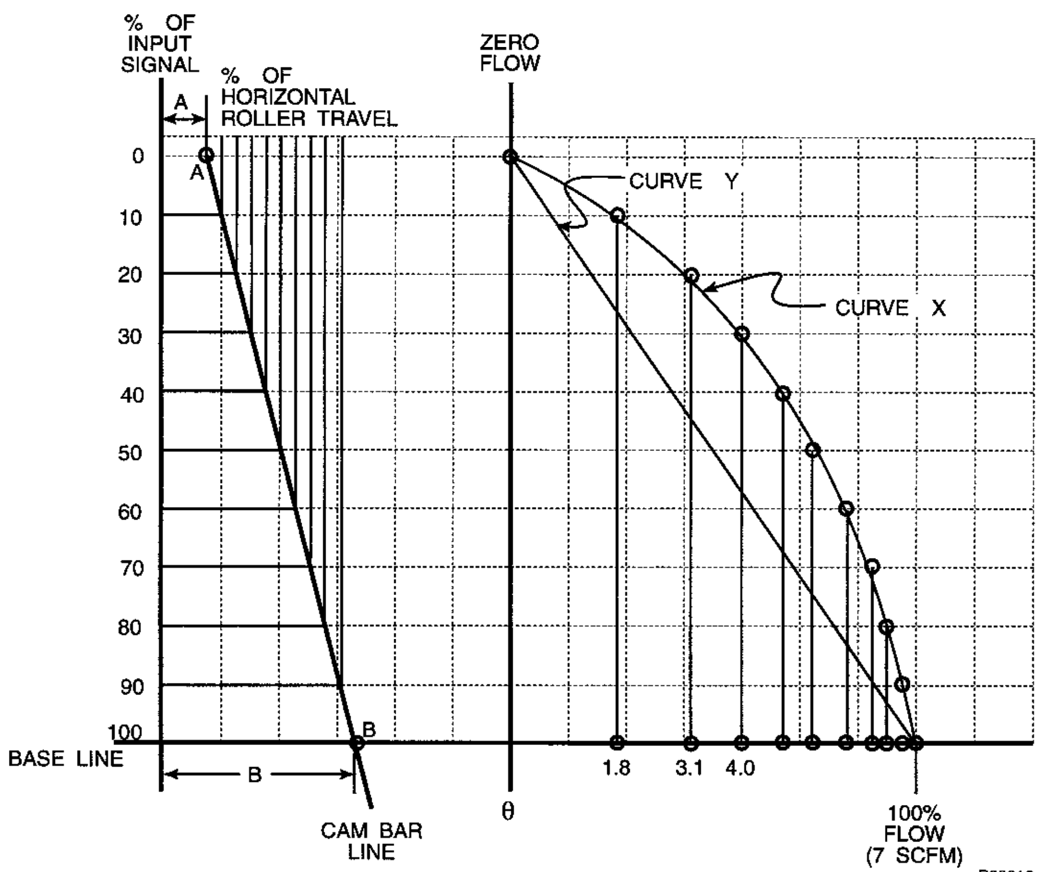
(n) From base line, draw a vertical line at 10% mark of 1.8 up to where a line would extendhorizontally from 10% "% of Input Signal" scale. Repeat for 20% mark of 3.1 to a line extending horizontally from 20% "% of input signal" scale. Continue in same fashion for others from 30% flow mark to 100% flow mark. Draw a smooth curve thru these points from 0% flow to 100%. Label curve "X".

(o) Draw a straight line from zero flow at zero "% of Input Signal" to 100% flow at 100% "% of Input Signal". Label curve "Y" (Graph 4).

(p) Draw a horizontal line from 10% "% of Input Signal" at cam bar line to curve "Y". Draw a line from this point vertically to curve "X". Draw a line from curve "X" horizontally back to 10% of "% of Horizontal Roller Travel" line plotted earlier. Place a mark on this 10% line as shown in Graph 4.

(q) Repeat step (p) procedure for 20% thru 90% lines. At each point that intersects with "% of Horizontal Roller Travel Line", put a mark as indicated in Graph 5.

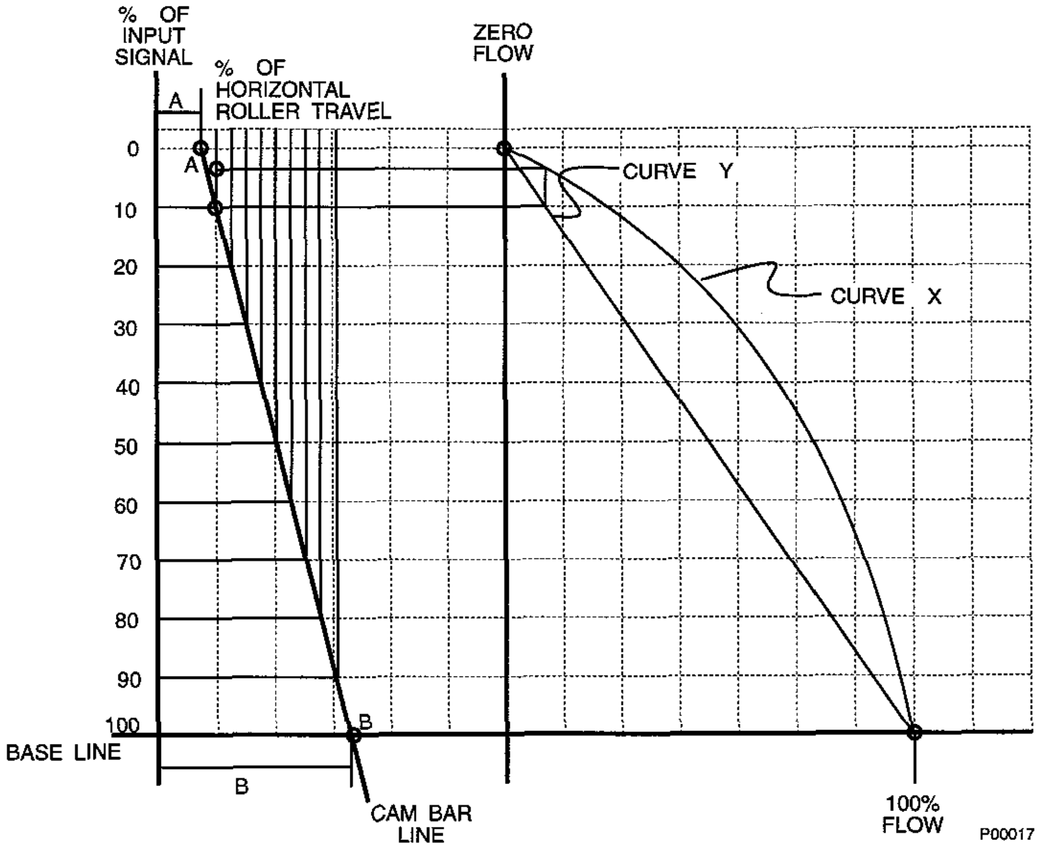
Graph 3



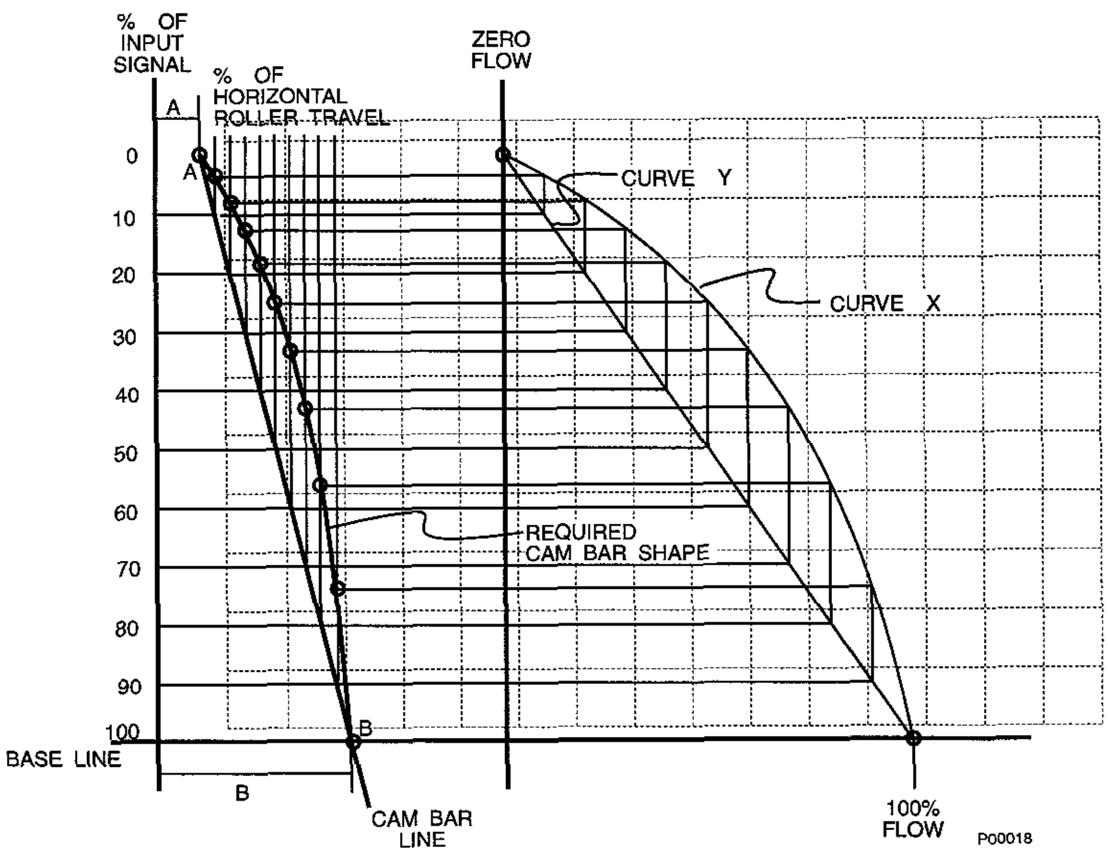
Example System Flow Chart

INPUT SIGNAL IN %	10	20	30	40	50	60	70	80	90	100
RECORDED FLOW	1.8	3.0	4.0	4.7	5.2	5.8	6.2	6.5	6.8	7.0

Graph 4



Graph 5



2

(r) Connect marks with a smooth curve from point "A" to point "B" thru each mark recorded. This will be the required cam bar shape.

(s) Construct a template from the plotted curve. Mark points A and B on template.

(t) Bend cam bar to match template. Points A and B on template must align with Points A and B marked on cam bar earlier.

(u) Draw file face of cam bar as necessary to obtain a smooth curved surface. Do not remove marked points A and B.

(v) Install cam bar on power positioner with lock screw positioned at point C recorded in step (e). Make sure dimensions for points A and B match those recorded in step (e); if necessary adjust position of lock screw to make dimensions A and B recorded in step (e).

(w) Check results by setting 10% increments of input signal from 0% to 100%. The flow must change in 10% increments for 0 flow to 100% flow. For example; with a 100% of 7 SCFM, a 10% input signal will flow at 0.7 SCFM, 20% at 1.4 SCFM, etc. Adjustments to the cam bar can be made by minor bending or draw filing.

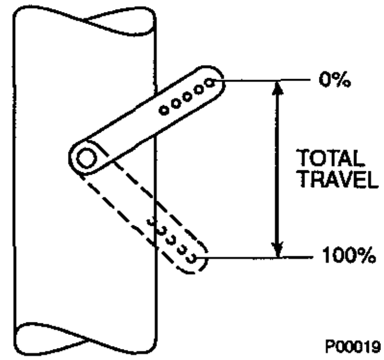


Figure 2-11. Driven Lever Travel

(x) Set input signal to 0%. Measure distance controlled devices driven lever, Figure 2-11, travels for each 10% increase in input signal; up to 100% input signal. Record these values in Table 4-1, Characterized column as percent of total travel. These values are necessary for verifying calibration.

(y) Set input signal to 0%. Measure distance clevis head travels for each 10% increase; up to 100% input signal. Measurement should be taken from packing nut to bottom edge clevis head. Record values measured in Table 4-2, Calibration Schedule D in the respective columns. These values are necessary for verifying calibration.

SECTION III. REVERSE OPERATION

3-1. OPERATIONAL DESCRIPTION. In reverse acting positioners, the piston and rod operate the same as when setup for direct acting (Figure 1-2). The cam bar is reversed top to bottom and the reverse manifold is turned 90°. The repositioned manifold causes supply air to be directed to the top of piston when signal air pressure is increased and to the bottom of piston when signal air pressure is decreased. In this case, piston movement is inversely related to the signal. A falling signal air pressure raises the piston and an increasing signal air pressure lowers the piston.

3-2. PROCEDURES FOR REVERSING OPERATION. To reverse the operation of the cylinder, refer to Figure 3-1 and use the following procedures:

a. Reverse Compensating Assembly.

1. Close the supply air valve.

2. Set signal air to 0.

3. Remove screw (1) securing spring clip (2) to compensating assembly (4). Remove spring clip.

4. Remove two screws (3) securing compensating assembly (4) to clevis head (5). Remove compensating assembly.

5. Reinstall compensating assembly (4) in a reversed position with stroke adjustment screw (6) at the top. Secure compensating assembly to clevis head (5) with two screws (3).

6. Reinstall spring clip (2).

b. Rotate Reverse Manifold.

1. Remove screws (7, Figure 3-1) securing pilot valve (8) and reverse manifold (10) to cylinder assembly (17). Remove pilot valve and reverse manifold.

2. Rotate reverse manifold (10) and its gasket (11) 90° clockwise. The arrow, stamped on reverse manifold, should point down. Install pilot valve (8) and its gasket (9) in the same position as it was when removed. Secure pilot valve and reverse manifold in place with mounting screws (7).

c. Calibrate Stroke.

1. Disconnect operating lever (12, Figure 3-1) from device being controlled at clevis (13).

WARNING

Use caution when applying supply air to the pilot valve. The air pressure will cause the piston, rod, and operating lever to move when the piston travels to the top of its stroke. Personnel injury or damage to equipment may occur during sudden applications of compressed air.

2. Open supply air valve. This will cause piston rod (14) to move to top of its stroke. Set signal air to minimum.

3. Using an allen wrench, loosen lock screw (15) holding spring socket (16).

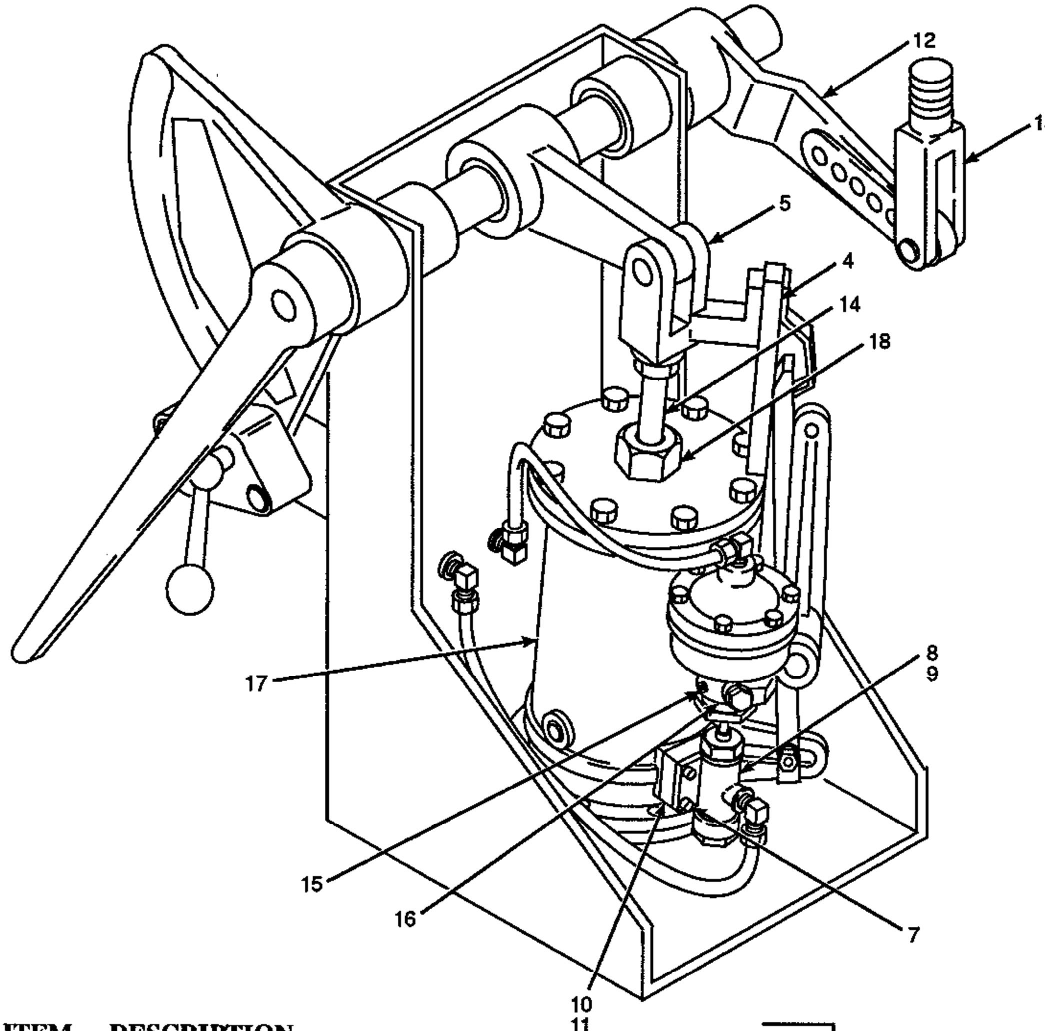
4. Turn spring socket (16) counterclockwise until piston rod (14) starts to move downward.

5. Turn spring socket (16) slowly clockwise until piston rod (14) reaches maximum position.

6. Tighten lock screw (15) to hold spring socket (16) firmly in place.

7. Set signal air to its maximum amount and check movement of piston rod (14) for full stroke. The piston rod should just reach bottom of stroke with maximum signal to pilot. If necessary, turn the stroke adjustment screw (6) counterclockwise very slowly until full stroke is reached.

8. Reconnect operating lever (12) to device being controlled at clevis (13).



ITEM	DESCRIPTION
1	Screw
2	Spring Clip
3	Screw
4	Compensating Assembly
5	Clevis Head
6	Stroke Adjustment Screw
7	Screw
8	Pilot Valve
9	Gasket
10	Reverse Manifold
11	Gasket
12	Operating Lever
13	Clevis
14	Piston Rod
15	Lock Screw
16	Spring Socket
17	Cylinder Assembly
18	Packing Nut

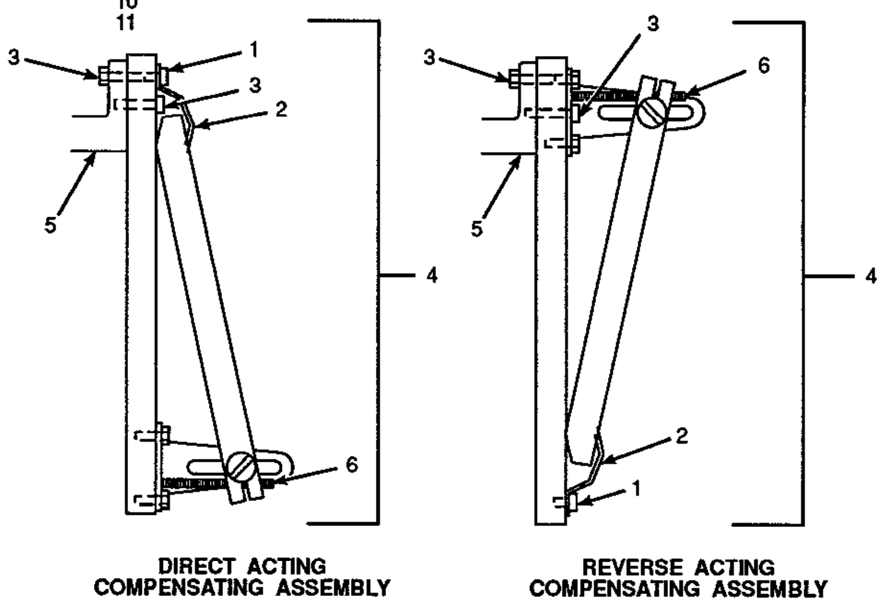


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Figure 3-1. Reverse Operations

SECTION IV. CALIBRATION

4-1. CHECK POWER POSITIONER CALIBRATION.

Use the following procedure to check calibration of power positioner. Figure 4-1, Calibration Flowchart is provided as a quick reference guide.

NOTE

If cam bar was shaped (characterized), values of percent output desired must be recorded upon installation in Table 4-1 Schedule D. This is necessary to check calibration. If values were not recorded, refer to 2-6b2 and calculate correct positions using formulas.

a. Device Travel.

1. Measure distance that the controlled device's driven lever arm travels from 0% signal air to 100% signal air. Record this as total distance.

2. Set signal air to 0%.

3. Measure controlled device's driven lever arm travel from 0% to a 10% signal air. Divide measurement by total distance from step a. Record this as the percentage of output travel for 10% signal air. Measure and record percentage of output travel in the same fashion in 10% increments up to 100% signal air.

4. Compare recorded readings with percent driven lever travel in Table 4-1. Use respective columns for characterized systems, linear, square root, or square cam bars. If recorded percentages of travel are equal to those in Table 4-1 the system does not need calibration. If recorded readings do not equal those in Table 4-1 continue checking procedure.

b. Piston Travel.

1. Set signal air to 0%.

2. Measure distance from top surface of packing nut (18, Figure 3-1) to bottom surface of clevis head (5). Label this distance "A".

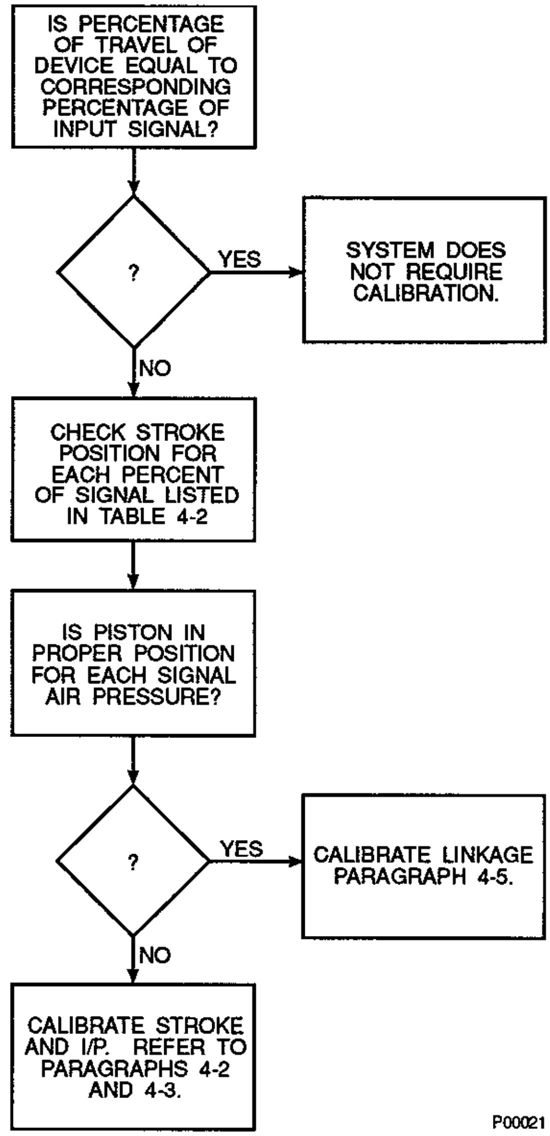

Figure 4-1. Calibration Flowchart

3. Increase signal to 100%.

4. Measure distance from surface of packing nut (18) to bottom surface of clevis head (5). Label this distance "B".

5. Subtract distance "A" from distance "B". This is total stroke travel of the power positioner. Record this distance as total stroke travel.

6. Set signal air to 0%.

Table 4-1. Device Travel (%).

PERCENT SIGNAL AIR PRESSURE	PERCENT DRIVEN LEVER TRAVEL			
	LINEAR (x)	SQUARE ROOT ($\sqrt{x}$)	SQUARE (x^2)	CHARACTERIZED
0	0	0.0	0.0	
10	10	31.6	1.0	
20	20	44.8	4.0	
30	30	54.8	9.0	
40	40	63.25	16.0	
50	50	70.7	25.0	
60	60	77.5	36.0	
70	70	83.7	49.0	
80	80	89.4	64.0	
90	90	94.9	81.0	
100	100	100.0	100.0	

7. Measure the piston travel (stroke) when a 10% signal is sent to the power positioner. Record this as stroke travel for 10% signal air. Measure and record percentage of output travel in the same fashion in 10% increments up to 100% signal air.

NOTE

Values for characterized stroke measured in inches and percent corresponding to input pressures are recorded in Table 4-2 Schedule D. If values were not recorded, refer to 2-6b.2. and calculate correct positions using formulas.

8. Compare actual stroke movement with desired stroke movement. Desired stroke movements appear in Table 4-2, Calibration Schedule. Schedule "A" is for a linear cam bar, "B" for a square root cam bar, "C" for a square cam bar, and "D" for a characterized cam bar. If actual stroke of power positioner is equal to desired value in Table 4-2, refer to paragraph 4-5 and calibrate linkage. If it is not equal, calibrate stroke (paragraph 4-2) and then calibrate I/P (paragraph 4-3).

4-2. <u>STROKE CALIBRATION.</u> Use the following procedures to adjust a power positioner's stroke.

a. <u>Direct Acting Power Positioner.</u>

1. Purge air lines to remove any water or debris.

2. Making sure that by-pass valve is closed, set signal air to minimum stroke position (0%). Refer to Table 4-3 for percent stroke to signal air conversion.

3. Loosen lock screw (1, Figure 4-2) holding spring socket (2) in place. Turn spring socket counterclockwise until piston rod (3) begins moving up from bottom of stroke. Turn spring socket slowly clockwise until piston rod moves to lowest position. Tighten lock screw.

4. Increase signal air to maximum (100%). Refer to Table 4-3 for percent to signal air conversion.

Table 4-2. Piston Travel (Stroke) Calibration Schedule.

0-60 psig (I/P)	3-15 psig	0-30 psig	Percent of Signal	Inches	Percent of Full Stroke
	INPUT SIGNAL			DESIRED STROKE	
CALIBRATION SCHEDULE "A" - LINEAR CAM BAR					
0	3.0	0	0%	0.00	0%
6	4.2	3	10%	1.00	10%
12	5.4	6	20%	2.00	20%
18	6.6	9	30%	3.00	30%
24	7.8	12	40%	4.00	40%
30	9.0	15	50%	5.00	50%
36	10.2	18	60%	6.00	60%
42	11.4	21	70%	7.00	70%
48	12.4	24	80%	8.00	80%
54	13.8	27	90%	9.00	90%
60	15.0	30	100%	10.00	100%
CALIBRATION SCHEDULE "B" - SQUARE ROOT CAM BAR					
0	3.0	0	0%	0.00	0.00%
6	4.2	3	10%	3.16	31.60%
12	5.4	6	20%	4.48	44.80%
18	6.6	9	30%	5.48	54.80%
24	7.8	12	40%	6.325	62.25%
30	9.0	15	50%	7.07	70.70%
36	10.2	18	60%	7.75	77.50%
42	11.4	21	70%	8.37	83.70%
48	12.4	24	80%	8.94	89.40%
54	13.8	27	90%	9.49	94.90%
60	15.0	30	100%	10.00	100.00%
CALIBRATION SCHEDULE "C" - SQUARE CAM BAR					
0	3.0	0	0%	0.00	0%
6	4.2	3	10%	0.10	1%
12	5.4	6	20%	0.40	4%
18	6.6	9	30%	0.90	9%
24	7.8	12	40%	1.60	16%
30	9.0	15	50%	2.50	25%
36	10.2	18	60%	3.60	36%
42	11.4	21	70%	4.90	49%
48	12.4	24	80%	6.40	64%
54	13.8	27	90%	8.10	81%
60	15.0	30	100%	10.00	100%
CALIBRATION SCHEDULE "D" - CHARACTERIZED CAM BAR					
0	3.0	0	0%		
6	4.2	3	10%		
12	5.4	6	20%		
18	6.6	9	30%		
24	7.8	12	40%		
30	9.0	15	50%		
36	10.2	18	60%		
42	11.4	21	70%		
48	12.4	24	80%		
54	13.8	27	90%		
60	15.0	30	100%		

ITEM	DESCRIPTION
1	Lock Screw
2	Spring Socket
3	Piston Rod
4	Lock Bolt
5	Stroke Adjustment Screw

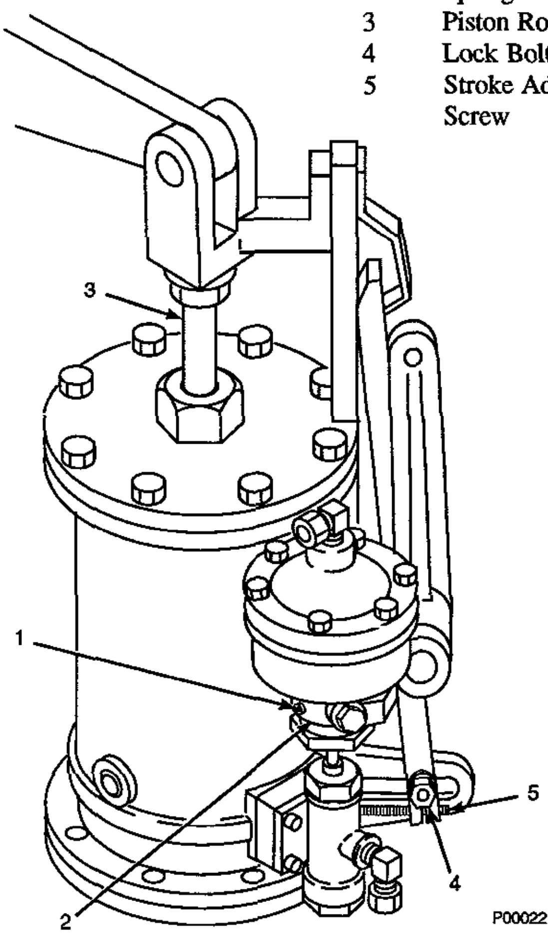

Figure 4-2. Stroke Adjustment

NOTE

If stroke length needed is less than standard 10 inches, adjustment of stroke adjustment screw can decrease stroke length to seven inches.

5. Loosen stroke adjustment screw lock bolt (4, Figure 4-2). Turn stroke adjustment screw (5) clockwise until piston rod moves downward. Turn screw in opposite direction until piston rod moves to maximum position or to desired length of travel. Tighten lock bolt (4).

b. <u>**Inverse Acting Power Positioner.**</u>

1. Purge air lines to remove any water or debris.

2. Making sure that by-pass valve is closed, set signal air to maximum (100%). Refer to Table 4-3 for percent to signal conversion.

3. Loosen lock screw (1, Figure 4-2) holding spring socket (2) in place. Turn spring socket clockwise until piston rod (3) begins moving up from bottom of stroke. Turn spring socket slowly clockwise until piston rod moves to lowest position. Tighten lock screw.

4. Decrease signal air to minimum (0%). Refer to Table 4-3 for percent to signal conversion.

Table 4-3. Direct and Inverse Calibration Signal Pressures.

STROKE POSITION	POWER POSITIONER ACTION					
	DIRECT			INVERSE		
	PNEUMATIC		I/P	PNEUMATIC		I/P
	0 - 30 psig	3 - 15 psig	0 - 60 psig	0 - 30 psig	3 - 15 psig	0 - 60 psig
0%	0	3	0	30	15	60
100%	30	15	60	0	3	0

NOTE

If stroke length needed is less than standard 10 inches, adjustment of stroke adjustment screw can decrease stroke length to SEVEN inches.

5. Loosen stroke adjustment screw lock bolt (4). Turn stroke adjustment screw (5) counterclockwise until piston rod (3) moves downward. Turn screw in opposite direction until piston rod moves to maximum position or to desired length of travel. Tighten lock bolt (4).

4-3. **<u>CURRENT TO PNEUMATIC (I/P) SIGNAL CONVERTER CALIBRATION</u>.** Calibrate current to pneumatic signal converter after mounting, changing mounted position, or when loss of control is noticed (refer to Troubleshooting, Section V). Use the following procedures to calibrate the signal converter:

a. Remove plastic caps from "Zero" and "Span" adjustment holes (Figure 4-3).

NOTE

Make sure the input pressure rating of the power positioner is the same as the pressure rating stamped on the current to pneumatic signal converter.

b. Set signal value to 4 mA (20 mA if I/P is in an inverse setup) and adjust "zero" screw until output pressure is at 0 psig. Turn screw counterclockwise to increase pressure, clockwise to decrease pressure. If output pressure does not change when screw is turned, turn screw counterclockwise until pressure starts to rise.

c. Set signal value to 20 mA (4 mA if I/P is in an inverse setup). Adjust "Span" screw until output pressure is at 60 psig.

d. Repeat steps b and c until no further adjustment is needed.

e. Replace protective caps.

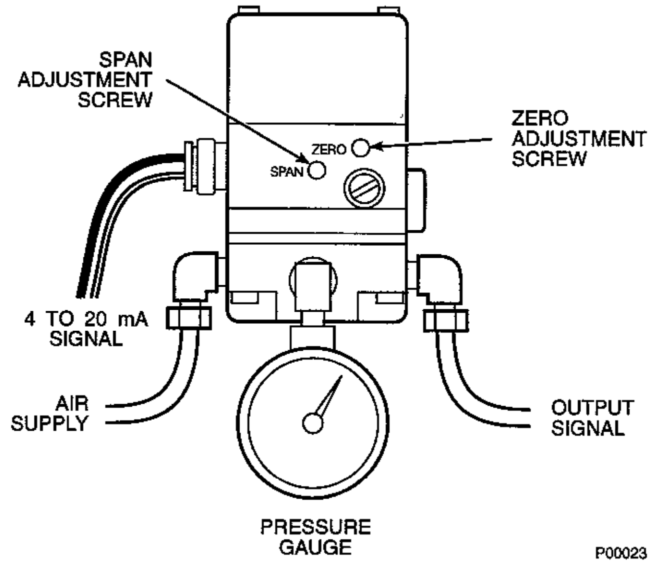

Figure 4-3. Current to Pneumatic Signal Converter

4

4-4. **<u>LINKAGE CALIBRATION</u>.**

a. **<u>Linear</u>.** Check angular travel of power positioner's drive lever at clevis. Compare this to device's driven lever angular travel. If angular distances are not the same, use the following procedure to adjust offset of power positioner's drive lever to the same angle as the device's driven lever. When adjustment is complete, both operating levers must be parallel with each other.

1. Measure angle β_1 from vertical line extending from shaft hub, to power positioner's drive lever (Figure 4-4). This is the power positioner's drive lever offset.

2. Measure angle β_2 from vertical line extending from device lever's hub, to driven lever of device being controlled. This is the driven lever offset.

3. Compare angle β_1 and angle β_2. Adjust length of linkage for minor adjustments by threading pipe in or out of clevis. Change drive lever angle β_1 for major adjustments.

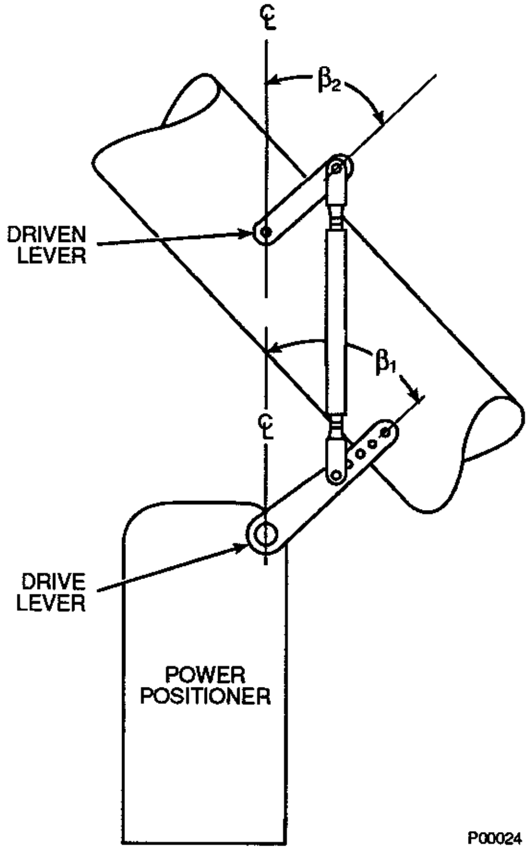

Figure 4-4. Linear Linkage Calibration

b. Characterized. Verify linkage design angles and length against actual installation. Use the following procedure, Figure 4-5, and adjust angles and lengths as necessary.

1. Measure angle β_1 from vertical line extending from shaft hub to power positioner's drive lever. This is the power positioner's drive lever offset.

2. Measure angle β_2 from vertical line extending from device lever's hub to driven lever of device being controlled. This is the driven lever offset.

3. Measure length between connecting levers. This distance is represented by the letter ℓ.

4. Measure length of power positioner's drive lever (R_1) from shaft center to center of clevis pin.

5. Measure length of device's driven lever (R_2) from shaft center to center of clevis pin.

6. Compare angle β_1, β_2, distance ℓ, and lengths R_1 and R_2 with setup dimensions and angles recorded in Figure 2-8. If setup dimensions and angles were not recorded, use formula's in Section II to calculate correct design for the positioning system and record on Figure 2-8. Adjust length of linkage for minor adjustments by threading pipe in or out of clevis. Change operating arm angle β_1 for major adjustments.

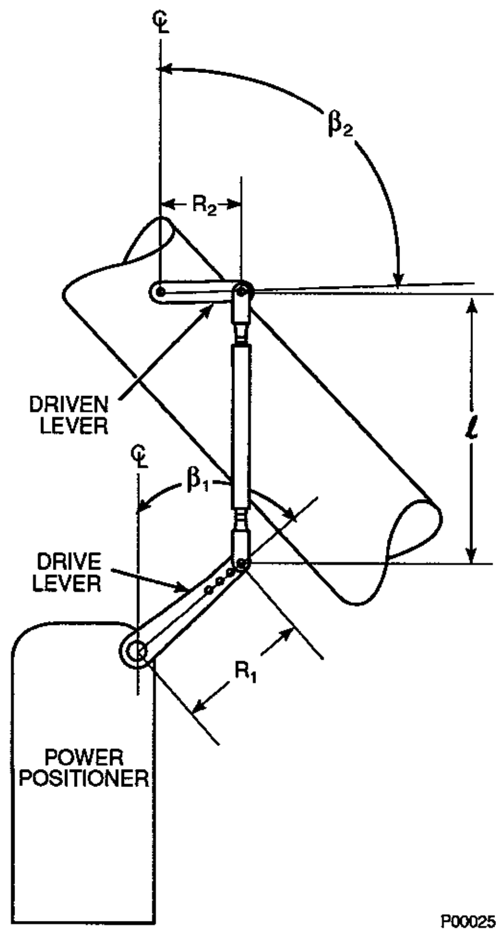

Figure 4-5. Characterized Linkage Calibration

SECTION V. TROUBLESHOOTING

5-1. OVERVIEW. Troubleshooting of common problems is provided for in troubleshooting chart (Table 5-1). The chart describes common problems, followed by the related probable cause, and finally by what action is necessary to correct the defect.

5-2. TROUBLESHOOTING CHART. Refer to Table 5-1.

Table 5-1. Troubleshooting Chart.

PROBLEM	CAUSE	CORRECTION
1. Erratic operation	Pilot valve sticking.	Clean or replace pilot valve. Refer to paragraph 6-4 for cleaning procedures and paragraph 7-2c for replacement procedures.
	Linkage binding or loose.	Linkage pivot joints corroded, dirty, or worn. Clean and lubricate or replace parts.
2. No response from power positioner to a signal air pressure change	Manual lock engaged.	Disengage manual lock.
	Air supply shutoff valve closed.	Open air supply valve.
	Ruptured receiver diaphragm.	Replace diaphragm. Refer to paragraph 7-2d.
3. Power positioner does not remain at set-point; continues to cycle	Cylinder head gasket leak.	Replace leaking gasket. Refer to paragraph 7-2e.
	Bypass valve air connection loose.	Tighten or replace air connection.
	Bypass valve leaking internally.	Replace bypass valve.
4. System over shoots or under shoots set-point	I/P out of calibration.	Calibrate I/P. Refer to paragraph 4-3.
	I/P failure.	Replace I/P per paragraph 7-2b.
	Piston stroke travel not properly set.	Calibrate stroke travel of piston. Refer to paragraph 4-2.
	Cam bar bent.	Replace cam bar. Refer to paragraph 7-2h.
	Pin hole in diaphragm.	Replace diaphragm. Refer to paragraph 7-2d.
5. Sluggish operation	Air filter/separator full of water, oil, or sediment.	Drain air filter/separator. Refer to paragraph 6-5.
	Air filter dirty.	Replace filter element. Refer to paragraph 7-2a.
	Ambient temperature is lower than the power positioner is designed for.	Install power positioner heater.
6. Power positioner operates normally but flow that is being controlled remains unchanged	Device being controlled has a broken valve stem or connection to the linkage.	Repair or replace controlled device.

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SECTION VI. PERIODIC MAINTENANCE

6-1. OVERVIEW. This section describes preventive maintenance for the Rosemount Model PP610TR Power Positioner. Preventive maintenance is necessary at specific intervals to reduce wear and tear on the power positioner.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to the power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

6-2. MAINTENANCE SCHEDULE. Use the maintenance schedule, Table 6-1, as a guideline for preventive maintenance. The frequency of this maintenance varies directly with plant conditions and operational load on the power positioner. Extremely dusty conditions or high temperatures will require more frequent maintenance on the power positioner.

6-3. GENERAL CLEANING AND LUBRICATION. Clean power positioner's exterior of all grease buildup with commercial dry cleaning solvent. To lubricate power positioner, refer to Figure 6-1, Lubrication Chart.

WARNING

Clean power positioner in a well ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Follow all instructions on the Material Safety Data Sheet (MSDS) of the solvent being used. Severe injury or death may result from improper usage.

6-4. PILOT VALVE CLEANING AND INSPECTION. In normal service, the pilot valve assembly (Figure 6-2) requires cleaning and inspection at intervals of approximately six months, or upon any indication of sticking.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to the power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

a. Remove power positioner from service.

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Table 6-1. Maintenance Schedule.

Time Interval (Approximate)	Maintenance Action
6 months	Perform general cleaning and lubrication. Refer to paragraph 6-3.
6 months	Clean and inspect pilot valve. Refer to paragraph 6-4.
6 months	Clean and drain air filters. Refer to paragraph 6-5.
2 years	Clean and inspect diaphragm. Refer to paragraph 6-6.
2 years	Lubricate and clean cylinder and piston assemblies. Refer to paragraph 6-7.

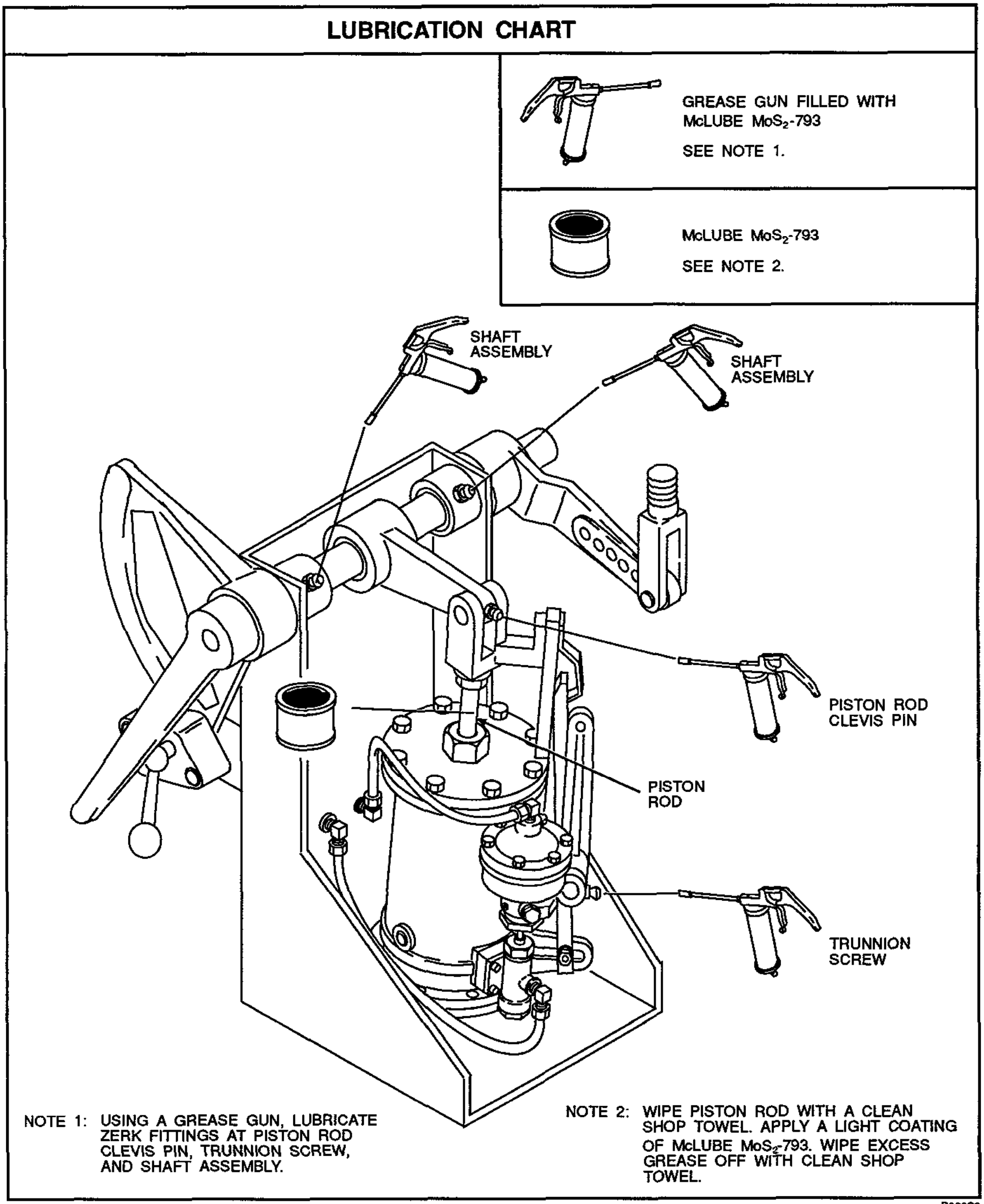
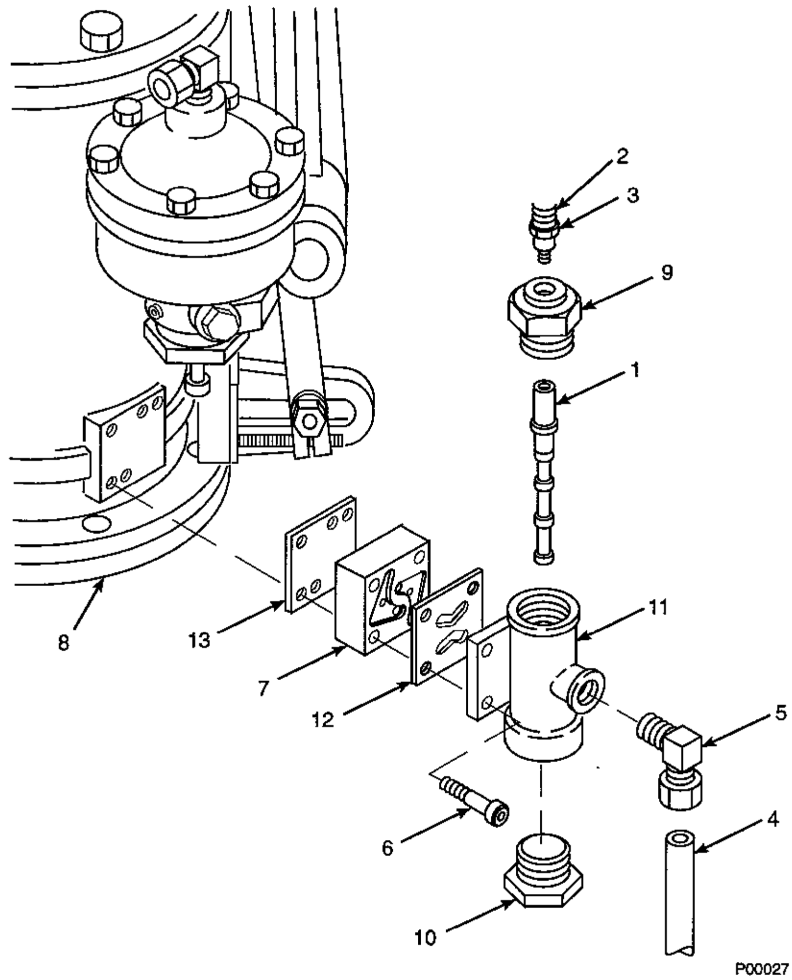


Figure 6-1. Lubrication Chart



ITEM	DESCRIPTION
1	Stem Assembly
2	Connecting Link
3	Ball Socket Nut
4	Air Supply Tubing
5	Elbow
6	Cap Screws
7	Reverse Manifold
8	Cylinder Assembly
9	Valve Cap
10	Exhaust Silencer Plug
11	Pilot Valve Body
12	Pilot Valve Gasket
13	Reverse Manifold Gasket

Figure 6-2. Pilot Valve Exploded View

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b. Carefully hold upper end of pilot valve stem assembly (1, Figure 6-2). Free connecting link (2) from pilot valve stem by turning connecting link ball socket nut (3) counterclockwise.

c. Disconnect air supply tubing (4) from elbow (5).

d. Remove cap screws (6), that secure pilot valve and reverse manifold (7) to cylinder assembly (8). Remove pilot valve and reverse manifold. Note alignment of pilot valve, arrow on reverse manifold, and cylinder.

CAUTION

Do not use an abrasive for cleaning the valve stem assembly or valve body. Abrasives even as fine as crocus cloth will cause scratches in the stem assembly and air to leak by pilot valve stem assembly.

e. Remove valve cap (9), stem assembly (1), and exhaust silencer plug (10) from pilot valve body (11).

WARNING

Clean pilot valve in a well ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvent. Follow all instructions on the Material Safety Data Sheet (MSDS) of the solvent being used. Severe injury or death may result from improper usage.

f. Thoroughly clean pilot valve body (11), valve cap (9) and stem assembly (1) in commercial dry cleaning solvent. Allow pilot valve to completely air dry. Do not use abrasive of any kind on stem.

g. Thoroughly clean exhaust silencer plug (10) in commercial dry cleaning solvent, making sure it's exhaust ports are open.

NOTE

Pilot valve stem and body are a matched set. If either is damaged or worn to a non-serviceable condition, entire pilot valve must be replaced.

h. Inspect stem assembly (1) and pilot valve body (11). If any signs of wear or damage are found, replace pilot valve.

i. Install stem assembly (1) into valve body (11).

j. Install exhaust silencer plug (10) and valve cap (9) on pilot valve body (11).

k. Install reverse manifold (7) and assembled pilot valve with pilot valve gasket (12) and reverse manifold gasket (13), securing with cap screws (6). Make sure arrow stamped on reverse manifold (7) is pointing in the direction that the piston rod moves with an increasing signal air pressure.

l. Carefully hold upper end of pilot valve stem assembly (1). Attach connecting link (2) to pilot valve stem assembly by turning connecting link ball socket nut (3) clockwise.

m. Calibrate stroke of power positioner (refer to paragraph 4-2).

n. Return power positioner to service.

6-5. AIR FILTER CLEANING AND DRAINING. In normal service, supply air filter and signal air filter/regulator require draining of water and debris at least every 6 months. The frequeny of this maintenance will depend on supply system air quality. After installation, drain both filters by slowly opening filter and filter/regulator petcock valves. Initially drain monthly, gradually increasing time between draining. Schedule periodic draining when filters are approximately 1/4 full. Continue draining water and debris at this interval unless plant supply air conditions change. If element in air filter is dirty, refer to Section VII for replacement procedure.

6-6. DIAPHRAGM CLEANING AND INSPECTION. Disassemble, clean, and inspect diaphragm assembly approximately every two years or if power positioner is not reaching set points. Refer to Figure 6-3 and use the following procedure.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to the power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

a. Remove power positioner from service.

b. Remove screws (1, Figure 6-3) securing diaphragm cover (2) to receiver body (3).

c. Remove zero balance spring (4) from top of diaphragm.

d. Using a clean shop towel, thoroughly wipe off any dirt or debris on upper side of diaphragm (5).

e. Visually inspect diaphragm. Replace if nicks, cuts, or hardened rubber areas (from excess heat) are visible. Refer to Section VII for replacement procedures.

f. Clean diaphragm cover (2) and zero balance spring (4) with commercial dry cleaning solvent and allow to air dry.

g. Align the edges of diaphragm (5) with stop ring (6) to make an air tight seal. Replace zero balance spring (4).

h. Making sure the diaphragm is not folded or pinched, replace diaphragm cover (2) and align sealing edge of diaphragm cover on top of edge of diaphragm.

i. Secure diaphragm cover (2) with screws (1). Tighten all screws hand tight. Snug screws down making sure that all screws get tightened evenly. Finally complete installation by torquing to 39 foot-pounds (5.39 kg-m), tightening in an across the diaphragm cover sequence.

j. Test for air leakage around diaphragm cover and receiver body. Use a leak detector, such as "Snoop", and apply an air signal to power positioner. If leak is detected, repair as necessary.

ITEM	DESCRIPTION
1	Screw
2	Diaphragm Cover
3	Receiver Body
4	Zero Balance Spring
5	Diaphragm
6	Stop Ring

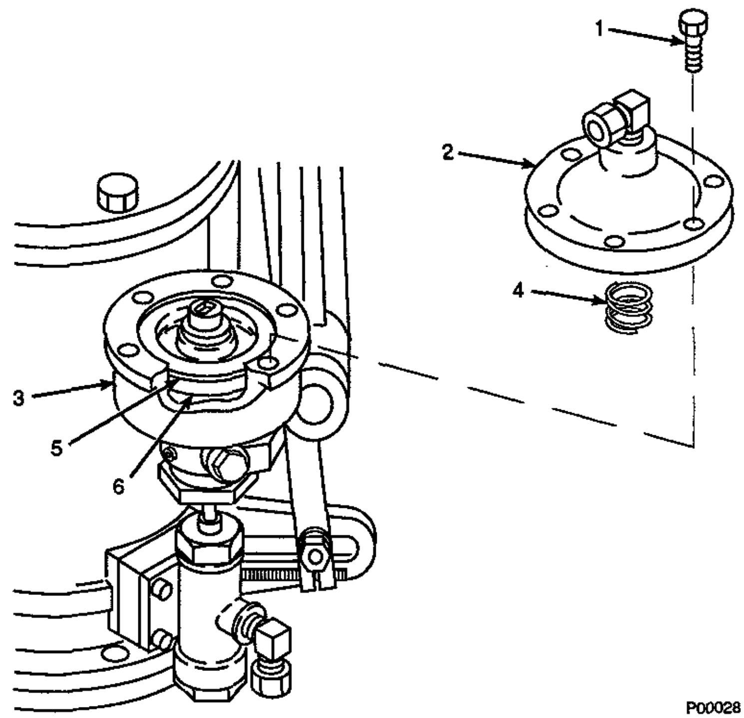


Figure 6-3. Diaphragm Exploded View

k. Return power positioner to service.

6-7. CYLINDER AND PISTON, CLEANING AND INSPECTION. Disassemble, clean and lubricate piston and cylinder assembly approximately every two years. Refer to Figure 6-4 and use the following procedure.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to the power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

a. Remove power positioner from service.

b. Shut supply air valve and set signal air pressure to 0 psig. Open bypass valve.

WARNING

Residual air must be bled off of piston cylinder before removal of cylinder head. If air is not bled off, eye injury may result.

c. Bleed residual air from cylinder through pilot valve supply air connection.

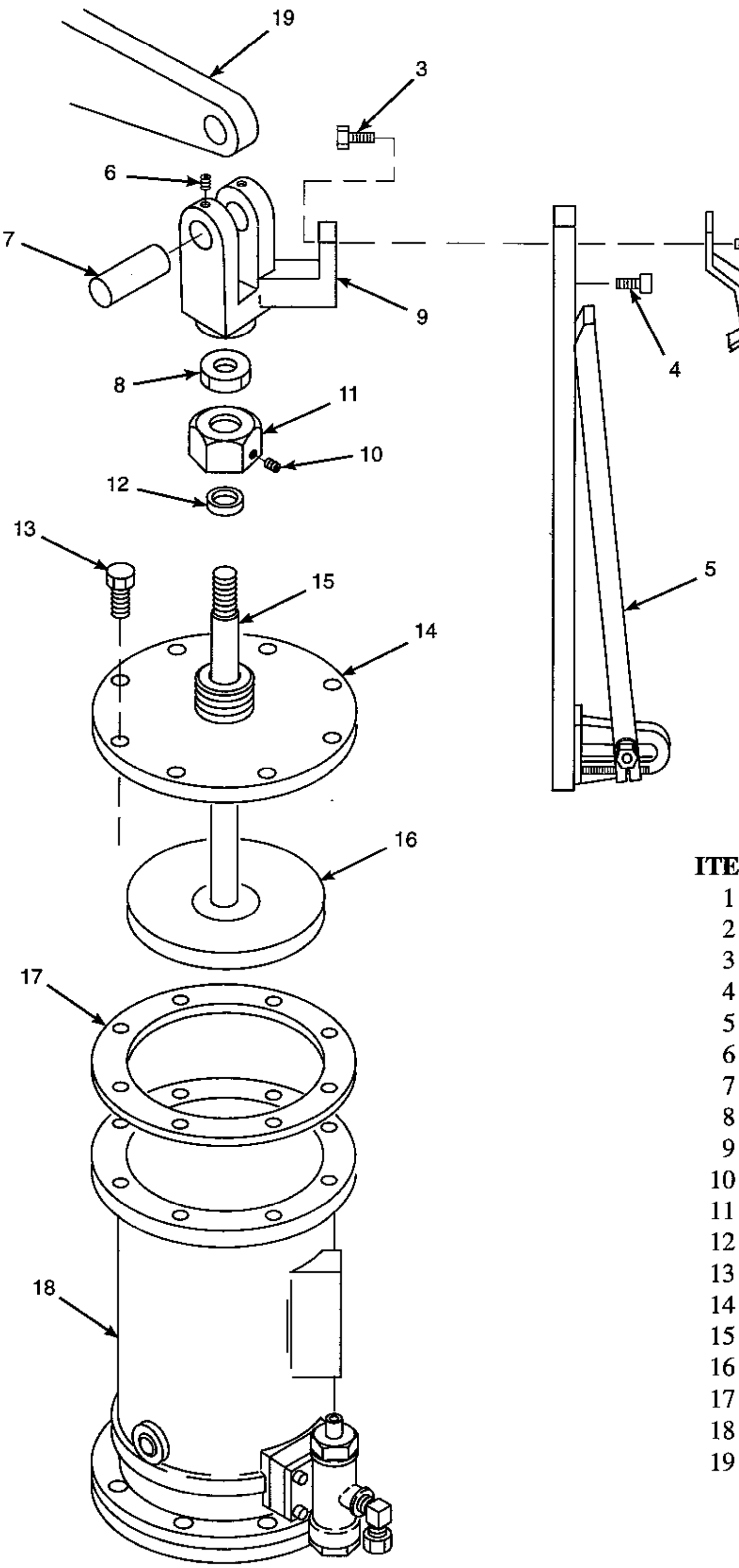
d. Remove hex head cap screws (1, Figure 6-4) and spring clip (2).

e. Remove hex head cap screw (3), socket head screw (4), and remove compensating assembly (5) from clevis head (9).

f. Remove set screws (6) securing clevis head pin (7).

g. Support cylinder assembly (18) with 2 x 4 inch board long enough to provide leverage. This will prevent it from tipping over when clevis pin is removed. Remove clevis pin and move shaft lever (19) out of the way.

6



ITEM	DESCRIPTION
1	Hex Head Cap Screw
2	Spring Clip
3	Hex Head Cap Screw
4	Socket Head Screw
5	Compensating Assembly
6	Set Screws
7	Clevis Head Pin
8	Clevis Nut
9	Clevis Head
10	Set Screw
11	Packing Nut
12	Wiper
13	Screws
14	Top Cylinder Head
15	Piston Head
16	Piston
17	Top Cylinder Head Gasket
18	Cylinder Assembly
19	Shaft Lever

P00029

Figure 6-4. Cylinder Exploded View

h. Remove screws (13) securing top cylinder head (14) to cylinder assembly (18).

i. Pulling on clevis head (9), pull piston assembly and top cylinder head out of cylinder assembly. Remove and discard top cylinder head gasket (17).

CAUTION

Do not pull piston and shaft assembly out of cylinder head. Damage to gland bushing and V-packing may occur.

j. Clean old grease off of piston (16) and piston rod (15). Wipe with dry cleaning solvent and pack concave area of piston with McLube MoS_2-793.

k. With a clean shop towel and commercial dry cleaning solvent, wipe interior surface of cylinder assembly (18). Allow to air dry completely before reassembling cylinder.

l. Wipe piston rod (15) with a clean shop towel and apply a light coating of McLube MoS_2-793. Wipe excess grease off with clean shop towel.

m. Remove setscrew (10) securing packing nut (11) and remove packing nut. Pack area around wiper (12) with McLube MoS_2-793.

n. Replace gland bushing if it appears damaged or was leaking. Refer to Section VII for replacement procedures.

o. Screw packing nut (11) onto top cylinder head and secure with setscrew (10).

p. Install top cylinder head (14) and piston assembly with new top cylinder head gasket (17), onto cylinder assembly (18). Secure top cylinder head to cylinder with screws (13).

q. Insert end of shaft lever (19) into slot of clevis head (9).

r. Align holes in clevis head with hole in shaft lever. Drive clevis head pin (7) in securing clevis head (9) to shaft lever (19). Lock clevis head pin in position with setscrews (6).

s. Install compensating assembly (5) to clevis head (9) with socket head screw (4) and hex head cap screw (3). Install spring clip with hex head cap screw (1).

t. Open supply air valve and test for air leakage around top cylinder head (14). Use a leak detector, such as "Snoop", and send an air signal to power positioner. If leak is detected, repair as necessary.

u. Calibrate power positioner stroke; refer to Section IV. Return power positioner to service.

SECTION VII. CORRECTIVE MAINTENANCE

7-1. **OVERVIEW.** This section describes corrective maintenance of the Rosemount PP610TR Power Positioner. If specific cause of problem is not known, refer to Section V, Troubleshooting. Spare parts referred to are available from Rosemount. Refer to Section VIII of this manual for part numbers and ordering information.

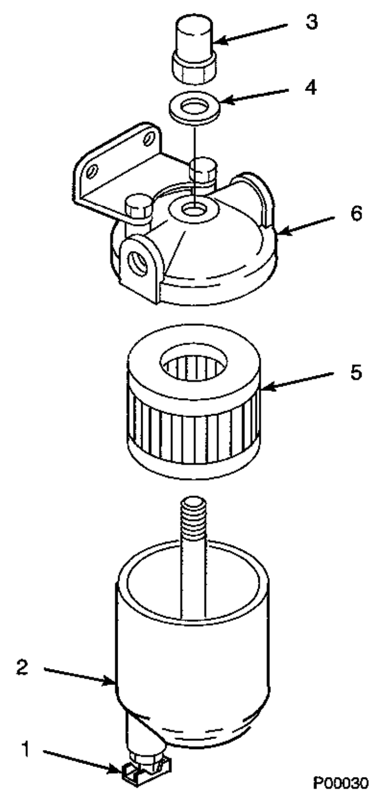
WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to the power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

7-2. **PARTS REPLACEMENT.**

a. **Air Filter.** Regularly inspect disposable filter elements as needed according to plant air supply quality. If filter element needs to be replaced, new elements are available from the factory. Use the following procedure to replace the filter element.

1. Remove power positioner from service.
2. Open air filter's drain valve (1, Figure 7-1) and bleed any air pressure and moisture remaining in the system.
3. Remove air filter's sump (2) by removing cap nut (3) and cap nut gasket (4) on top of air filter. Save cap nut gasket for installation.
4. Remove used filter element (5) by grasping and pulling it downward.
5. Install new filter element (5).



ITEM	DESCRIPTION
1	Drain Valve
2	Sump
3	Cap Nut
4	Cap Nut Gasket
5	Filter Element
6	Filter Housing

Figure 7-1. Air Filter

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6. Install air filter sump (2) on to body. Secure sump with cap nut (3) and cap nut gasket (4).
7. Open supply air shut off valve and check for leaks.
8. Return system to service.

b. **I/P Converter.** Use the following procedure for replacement of the current to pneumatic signal converter (I/P).

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to the power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

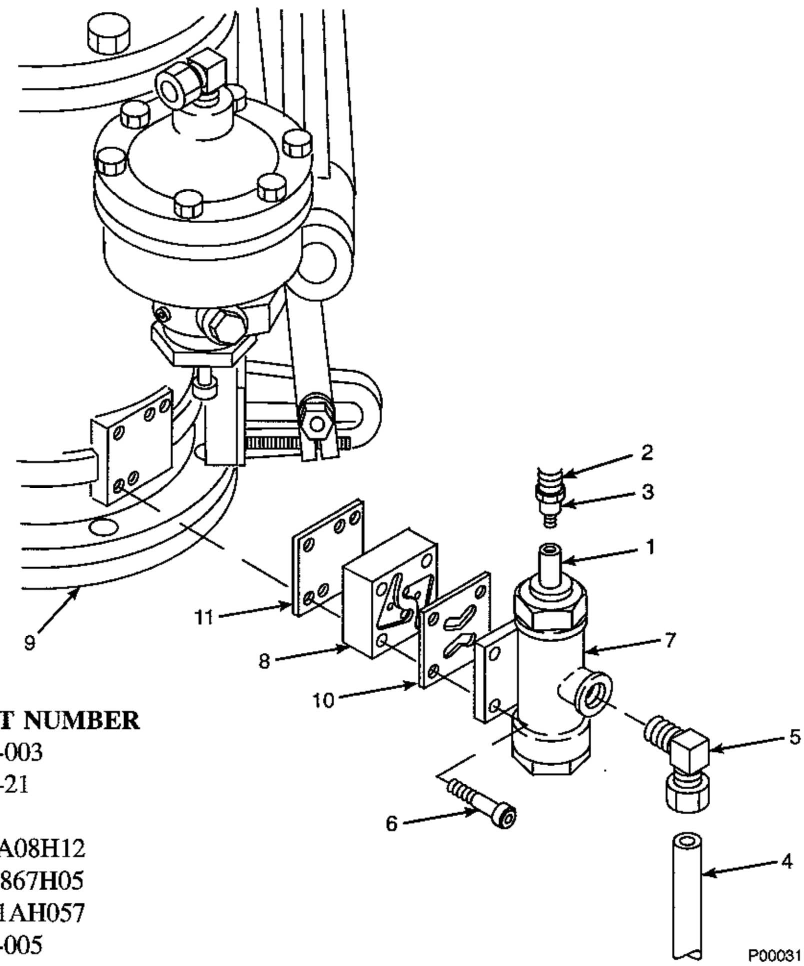
1. Remove power positioner from service.
2. Turn electrical signal transmitter off and make sure no voltage or current is being applied to the I/P.
3. Bleed off air pressure through connection of signal tubing to I/P.
4. Remove inlet and outlet piping to I/P.
5. Remove input signal leads from I/P's screw connectors. If screw connectors are not installed on I/P, remove I/P pigtails from screw connectors.
6. Remove screws securing old I/P converter to mounting bracket and discard I/P.
7. Attach inlet and outlet piping to respective ports on I/P.
8. Connect leads to electrical signal wires. For direct acting power positioners connect the positive signal to black lead and negative signal to white lead. For reverse acting power positioners, connect positive lead to white signal and negative lead to black signal.
9. Install new I/P to same mounting location, securing with screws.
10. Open supply air valves and test for leaks using "Snoop" type leak detector.
11. Calibrate I/P and return unit to service. Refer to paragraph 4-3 for calibration procedures.

c. **Pilot Valve.** Use the following procedures to replace the pilot valve.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to the power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

1. Remove power positioner from service.
2. Carefully hold upper end of pilot valve stem assembly (1, Figure 7-2) with pliers. Free connecting link (2) from pilot valve stem assembly by turning connecting link's ball socket nut (3) counterclockwise.
3. Disconnect supply air tubing (4) from elbow (5).
4. Remove cap screws (6) that secure pilot valve (7) and reverse manifold (8) to cylinder assembly (9). Remove pilot valve and reverse manifold. Note alignment of pilot valve, arrow on reverse manifold, and cylinder.
5. Install reverse manifold (8) and pilot valve (7) with pilot valve gasket (10) and reverse manifold gasket (11), securing with cap screws (6). Make sure arrow stamped on manifold is pointing in the direction that piston rod moves with an increasing signal air pressure.
6. Carefully hold upper end of pilot valve stem assembly (1). Attach connecting link (2) to pilot valve stem assembly by turning connecting link ball socket nut (3) clockwise.
7. Refer to Section IV and calibrate stroke of power positioner.
8. Return power positioner to service.



ITEM	DESCRIPTION	PART NUMBER
1	Stem Assembly	6639-003
2	Connecting Link	7791-21
3	Ball Socket Nut	
4	Supply Air Tubing	6292A08H12
5	Elbow	771B867H05
6	Cap Screws	70041AH057
7	Pilot Valve	6639-005
8	Reverse Manifold	225920
9	Cylinder Assembly	263C3387G01
10	Pilot Valve Gasket	5057-002
11	Reverse Manifold Gasket	125909

Figure 7-2. Pilot Valve

d. Diaphragm and Calibration Spring. Use the following procedure for replacement of the receiver's diaphragm and replacement of calibration spring. If replacing the diaphragm only, skip steps 6 and 7. If replacing calibration spring only, skip steps 8 and 9.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to the power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

1. Remove power positioner from service.

2. Disconnect signal air tubing (2, Figure 7-3) and remove elbow (1).

3. Remove screws (3) securing diaphragm cover (4) to receiver body.

4. Remove zero balance spring (5) from top of diaphragm.

5. Carefully hold upper end of pilot valve stem assembly (25) with pliers. Free spring connecting link (12) from pilot valve stem by turning ball socket nut (13) counterclockwise.

ITEM	DESCRIPTION	PART NUMBER
1	Elbow	771B867H05
2	Signal Air Tubing	6292A08H13
3	Screw	120088-015
4	Diaphragm Cover	5014-4
5	Zero Balance Spring	175464-348
6	Diaphragm Stud	5290-7
7	Diaphragm	9351-7
8	Stop Ring	5014-019
9	Shield	5015-027
10	Nut	70200CAB1A
11	Ball Socket Nut	--------
12	Spring Connecting Link	7791-021
13	Ball Socket Nut	--------
14	Compensator Assembly	226898
15	Roller	5015-2
16	Fillister Head Screw	120093-031
17	Hex Head Cap Screw	120088-5013100
18	Receiver Body	5014-6
19	Trunion	5015-7
20	Trunion Screw	5015-15
21	Set Screw	120121-001
22	Calibration Spring	Refer to Section 9.
23	Spring Washer	5973-7
24	Spring Nut	5015-14
25	Stem Assembly	6639-003

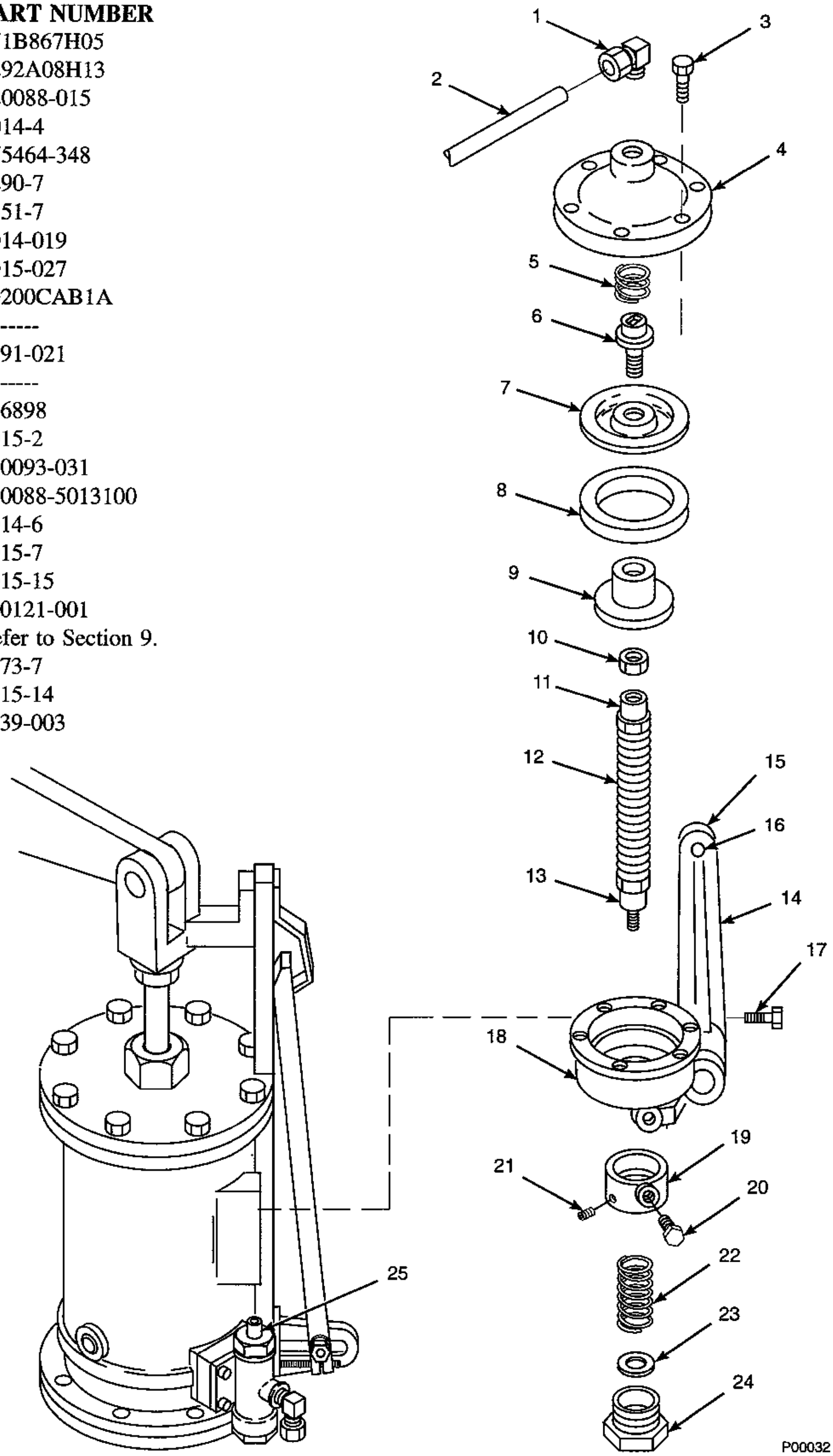


Figure 7-3. Receiver Exploded View

6. Pulling up on diaphragm (7), remove diaphragm and connecting link assembly from the receiver body.

7. Remove calibration spring (22).

8. Install new calibration spring (22). Make sure spring washer (23) is in bottom of spring nut (24).

9. Remove spring connecting link (12) from diaphragm by turning ball socket nut (11) counterclockwise.

10. Remove nut (10) from diaphragm stud (6). Separate diaphragm (7), stop ring (8), and shield (9).

11. Assemble new diaphragm (7) with stop ring (8) and shield (9). Secure in place with diaphragm stud (6) and nut (10).

12. Install spring connecting link (12) on new diaphragm assembly securing with ball socket nut (11).

13. Place diaphragm assembly and connecting link in receiver so connecting link is aligned with pilot valve stem assembly (25).

14. Align the edges of diaphragm (7) with the stop ring (8) to make an air tight seal.

15. Making sure the diaphragm is not folded or pinched, replace diaphragm cover (4) and align sealing edge of diaphragm cover on top of edge of diaphragm.

16. Secure diaphragm cover (4) with screws (3). First tighten screws until hand tight. Then, snug screws down and finally complete installation by torquing to 39 foot-pounds (5.39 kg-m).

17. Reinstall elbow (1) and signal air tubing (2).

18. Test for air leakage around diaphragm cover and receiver body. Use a leak detector, such as "Snoop", and send an air signal to power positioner. If leak is detected, repair as necessary.

19. Referring to Section IV and calibrate power positioner.

20. Return power positioner to service.

e. Upper Cylinder Head Gasket and Piston. Use the following procedures to replace upper cylinder head gasket and replacement of the piston. If only replacing upper cylinder head gasket, skip steps 8 and 9. If replacing piston, complete entire procedure.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to the power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

1. Remove power positioner from service.

2. Shut off supply air valve and set signal air pressure to 0 psig. Open bypass valve.

WARNING

Residual air must be bled off of piston cylinder before removal of cylinder head. If air is not bled off, eye injury may result.

3. Bleed residual air from cylinder through pilot valve supply air connection.

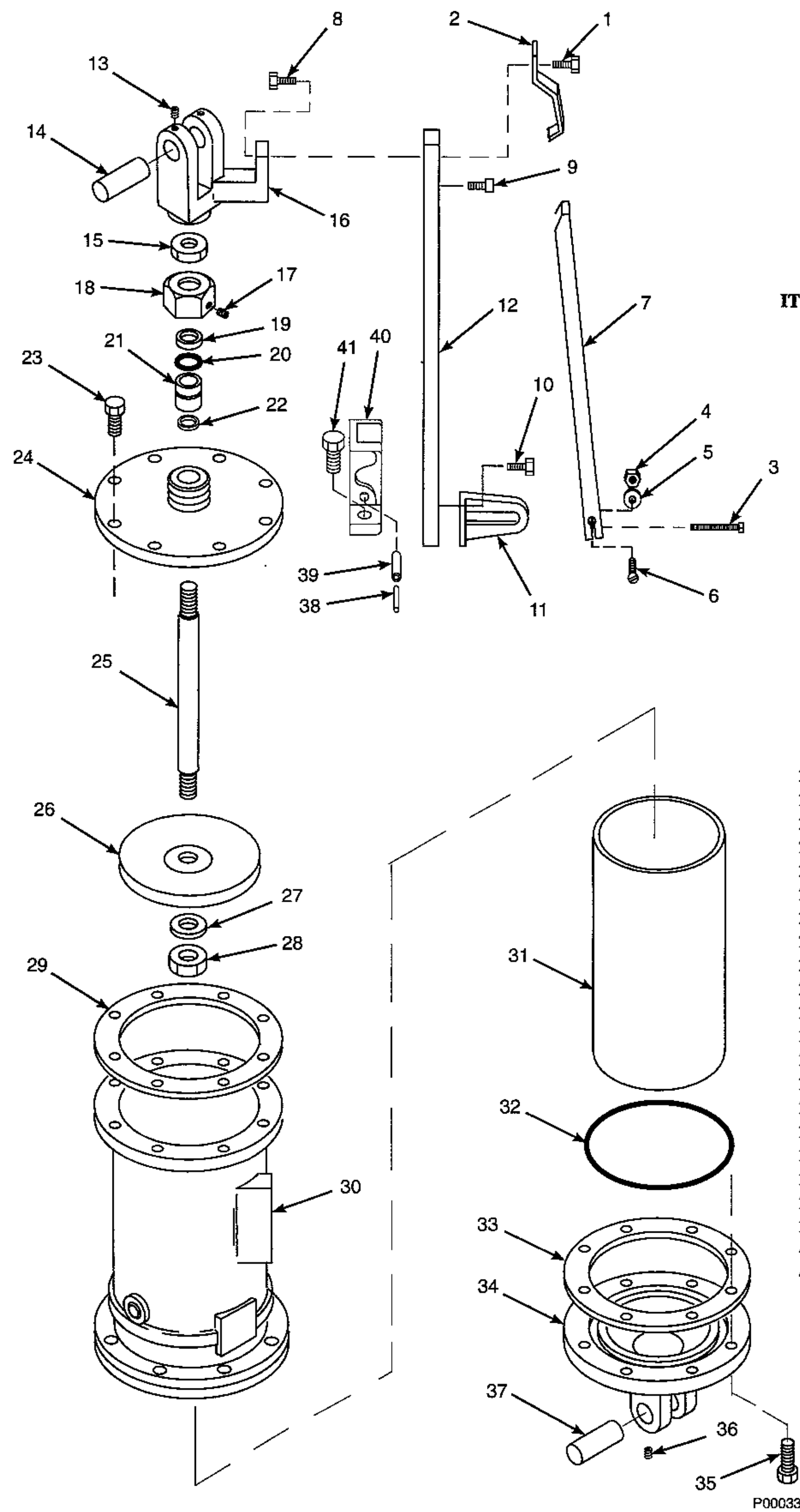
4. Remove hex head cap screw (1, Figure 7-4) securing spring clip (2) to compensating assembly.

5. Remove hex head cap screw (8) and socket head screw (9) and remove compensating assembly from clevis head (16).

6. Remove set screws (13) securing clevis head pin (14) in clevis head.

7. Support cylinder (30) with 2 x 4 inch board long enough to provide leverage. This will prevent it from tipping over when clevis pin is removed. Remove clevis pin and move shaft assembly out of the way.

8. Remove hex head cap screws (23) securing top cylinder head (24) to cylinder (30).



ITEM	DESCRIPTION	PART NUMBER
1	Hex Head Cap Screw	70041AH04R
2	Spring Clip	125783
3	Set Screw	700208A750
4	Hex Nut	70210BC618
5	Washer	70500CL10P
6	Flat Head Screw	70001BU4HE
7	Cam Bar	12015-002
8	Hex Head Cap Screw	70100DX01P
9	Socket Head Screw	70041AH051
10	Hex Head Cap Screw	70100DX11P
11	Angle Bracket	142326-002
12	Side Bar	325916
13	Set Screw	120083-3118063
14	Clevis Head Pin	125775
15	Hex Jam Nut	6292A85H01
16	Clevis Head	325912
17	Set Screw	------
18	Stuffing Box Nut	125907
19	Wiper	152507-002
20	O-Ring	120039-019
21	Gland Bushing	156198
22	Block V-Packing	152508-003
23	Hex Head Cap Screw	120088-5013100
24	Top Cylinder Head	425918
25	Piston Rod	325914
26	Piston	125782
27	Washer	120110-010
28	Stop Nut	120171-003
29	Cylinder Head Gasket	225911
30	Cylinder	425917
31	Cylinder Liner	325913
32	O-Ring	120039-028
33	Cylinder Head Gasket	225911
34	Bottom Cylinder Head	425919
35	Hex Head Cap Screw	120088-5013100
36	Set Screw	120083-3118063
37	Clevis Pin	125775
38	Groove Pin	181829-2250175
39	Back-up Roller	126917
40	Roller Bracket	225908
41	Hex Head Cap Screw	120088-5013150

Figure 7-4. Cylinder Exploded View

9. Pulling on clevis head (16), pull piston assembly and top cylinder head out of cylinder assembly.

CAUTION

Do not pull piston and shaft assembly out of cylinder head. Damage to gland bushing and V-packing may occur.

10. Remove stop nut (28) and washer (27) securing piston (26) to piston rod (25).

11. Wipe piston rod (25) and inside of cylinder liner (31) with clean shop cloth and spray with a light coat of dry film lubricant (molybdenum disulfide spray lubricant).

12. Attach new piston (26) to piston rod with washer and stop nut. Pack concave area of piston seal cup with McLube MoS_2-793.

13. Remove and discard cylinder head gasket (29).

14. Using a putty knife, prepare gasket surfaces of cylinder assembly and cylinder head for new gasket by removing any old gasket material or dirt. Wipe with a clean shop towel.

15. Place new cylinder head gasket (29) on cylinder (30), lining up notch in gasket with notch in cylinder assembly.

16. Align and install top cylinder head (24) and piston assembly onto cylinder assembly.

17. Secure top cylinder head (24) to cylinder assembly with hex head cap screws (23).

18. Align holes in clevis head (16) with hole in shaft lever. Drive in clevis head pin (14), securing clevis head to shaft lever. Lock clevis head pin in position with set screws (13).

19. Install compensating assembly to clevis head with hex head cap screw (8) and socket head screw (9). Make sure side bar (12) is resting against back-up roller (39) in roller bracket (40).

20. Install spring clip (2) to compensating assembly with hex head cap screw (1).

21. Open supply air valve.

22. Test for air leakage around top cylinder head (24). Use a leak detector, such as "Snoop", and send an air signal to power positioner. If leak is detected, repair as necessary.

23. Refer to Section IV to calibrate power positioner.

24. Return power positioner to service.

f. <u>**Lower Cylinder Head Gasket.**</u> Use the following procedures to replace lower cylinder head gasket.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to the power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

1. Remove power positioner from service.

2. Refer to paragraph 7-2.c and remove pilot valve.

3. Remove signal air tubing (2, Figure 7-3) from receiver. Remove hex head cap screws (17) and remove receiver assembly from cylinder.

4. Remove hex head cap screw (1, Figure 7-4) securing spring clip (2) to compensating assembly.

5. Remove hex head cap screw (8), socket head screw (9), and remove compensating assembly from clevis head (16).

6. Remove set screws (13) securing clevis head pin (14) in clevis head.

7. Support cylinder (30) with 2 x 4 inch board long enough to provide leverage. This will prevent it from tipping over when clevis pin is removed. Remove clevis pin and move shaft assembly out of the way.

8. Remove set screws (36) locking clevis pin (37) to bottom cylinder head (34).

WARNING

Before removing lower clevis pin, make sure full weight of cylinder is supported on 2 x 4's. If not supported loose cylinder may fall over and cause personal injury.

9. Support full weight of cylinder assembly on 2 x 4's. Drive out lower clevis pin (37, Figure 7-4) and remove cylinder assembly from stand.

10. Set cylinder assembly on its side and remove hex head cap screws (35) securing bottom cylinder head (34) to cylinder assembly. Remove bottom cylinder head (34) and cylinder head gasket (33).

11. Using a putty knife, prepare gasket surfaces of cylinder and cylinder head for new gasket by removing any old gasket material or dirt. Wipe with a clean shop towel.

12. Install new cylinder head gasket (33) and bottom cylinder head (34) onto cylinder assembly. Secure cylinder head to cylinder with hex head cap screws (35).

13. Insert mounting slot on end of bottom cylinder head (34) onto tab of stand assembly. Make sure full weight of cylinder is supported by 2 x 4's.

14. Align holes of bottom cylinder head (34) with hole in tab of stand assembly. Drive lower clevis pin (37) in with punch and hammer. Lock clevis pin in position with set screws (36).

15. Align holes in clevis head (16) with hole in shaft lever. Drive clevis head pin (14) in, securing clevis head to shaft lever. Lock clevis head pin in position with set screws (13).

16. Install compensating assembly to clevis head with hex head cap screw (8) and socket head screw (9). Make sure slide bar (12) is resting against back-up roller (39) in roller bracket (40).

17. Install spring clip (2) to compensating assembly with hex head cap screw (1).

18. Reinstall receiver assembly to cylinder with hex head cap screws (17, Figure 7-3). Reconnect signal air tubing (2).

19. Reinstall pilot valve, refer to paragraph 7-2.c.

20. Open supply air valve.

21. Test for air leakage around top cylinder head (24, Figure 7-4). Use a leak detector, such as "Snoop", and send an air signal to power positioner. If leak is detected, repair as necessary.

22. Refer to Section IV and calibrate power positioner.

23. Return power positioner to service.

g. Cylinder Replacement. To replace the assembled cylinder with a new cylinder follow the procedures outlined in paragraph 7-2.f, Lower Cylinder Head Gasket. Steps 1 through 9 cover cylinder removal, and steps 13 through 23 provide installation procedures.

h. Cam Bar. Use the following procedure to replace cam bar.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to the power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

1. Remove power positioner from service.

2. Remove flat head screw (6, Figure 7-4), washer (5), and hex nut (4) securing cam bar (7) to angle bracket (11).

3. Remove set screw (3) from cam bar (7).

4. Place replacement cam bar underneath spring clip (2). Secure cam bar in place with flat head screw (6), washer (5), and hex nut (4).

5. Reinstall set screw (3).

6. Refer to Section IV and calibrate power positioner.

7. Return power positioner to service.

i. Shaft Bushings. Use the following procedure to replace shaft bushings.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to the power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

1. Remove power positioner from service.

2. Remove socket head screws (1, Figure 7-5), lock bridge (3), and lock shoe (4) from stand (26).

3. Remove socket head screws (17) securing lock body (7) to stand (26). Remove lock body.

4. Remove set screws (13, Figure 7-4) locking clevis head pin (14) in place.

5. Support cylinder (30) with 2 x 4 inch board long enough to provide leverage. This will prevent it from tipping over when clevis pin is removed. Remove clevis pin and move cylinder lever (9, Figure 7-5) away from clevis.

6. Using manual lever (23), position shaft (10) so taper pin (8) is positioned vertically.

7. Remove retaining ring (24) and manual lever (23) from shaft (10).

8. Loosen socket head screws (18) and remove sector (19) from shaft (10).

9. Loosen socket head screw (12) and remove operating lever (11) from shaft (10).

10. Disconnect shaft (10) from cylinder lever (11) by driving out taper pin (8).

11. While holding cylinder lever (9), slide shaft (10) out of stand assembly's bushings (25).

12. Using a hack saw, cut a pressure relieving slit across the inner face of bushings (25).

13. Using a hammer and large punch, drive old shaft bushings out of stand.

WARNING

Use caution and appropriate safety equipment when applying Loctite. Make sure all specific instructions on Material Safety Data Sheet (MSDS) are followed. Failure to do so may cause severe eye injury.

CAUTION

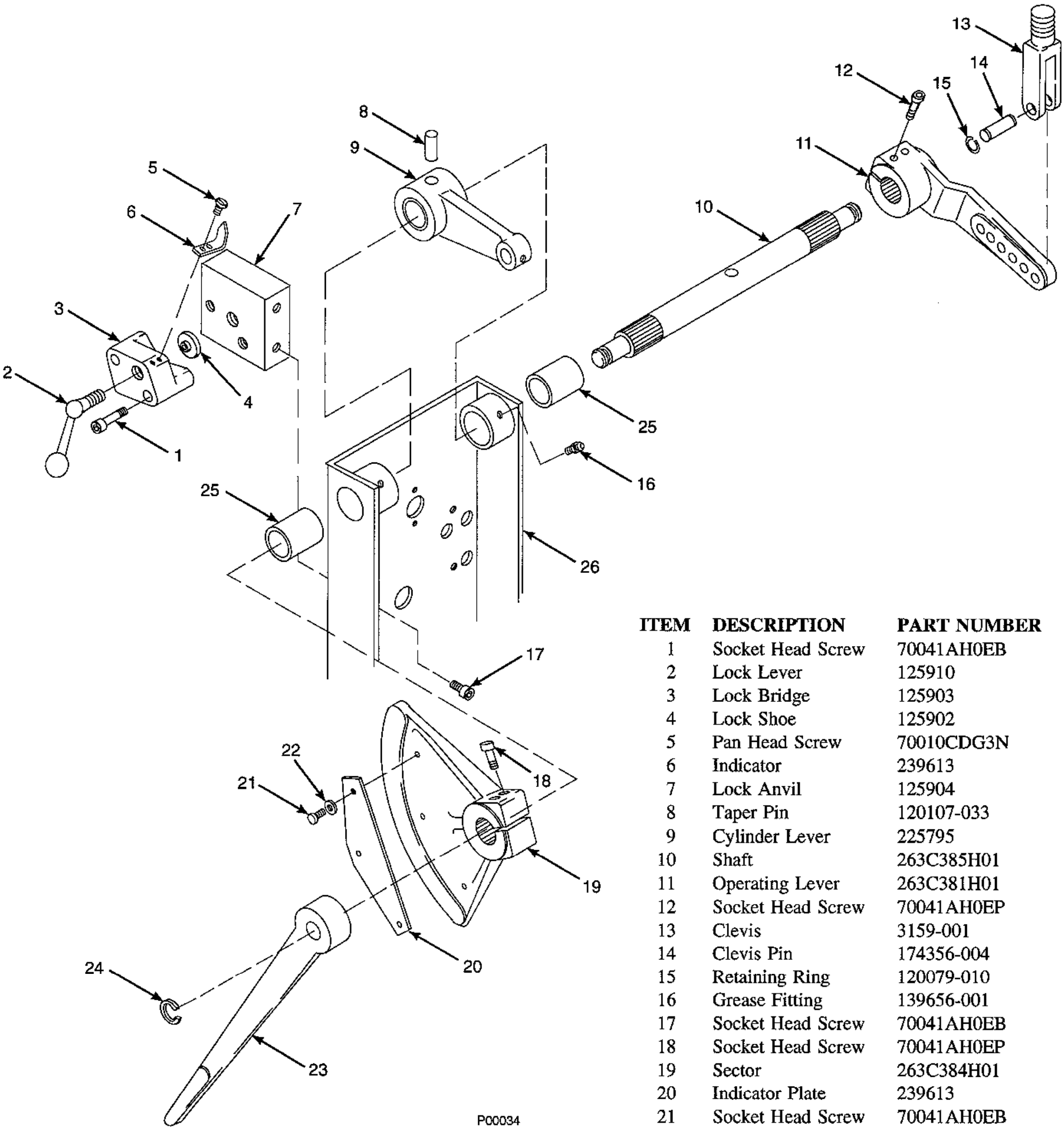
Care must be used when applying Loctite primer or adhesive to bushings to make sure it is only applied to the outer surface. Bushing life may be reduced.

NOTE

Bushings are secured to stand assembly with a coating of Loctite applied on the outside of bushings. Insertion of new bushings and completed installation of shaft assembly must be completed before Loctite sets. This is needed to line up bushings properly. The Loctite will set in approximately 3 minutes. Complete installation of shaft assembly within 15 minutes from when adhesive was applied.

14. Apply Loctite primer (11NA7902A30), to outside surface of shaft bushings (25, Figure 7-5) and allow primer to set for three to five minutes.

15. After primer has set 3 to 5 minutes, apply Loctite adhesive #680 and slide bushings (25) in stand assembly within three minutes.



ITEM	DESCRIPTION	PART NUMBER
1	Socket Head Screw	70041AH0EB
2	Lock Lever	125910
3	Lock Bridge	125903
4	Lock Shoe	125902
5	Pan Head Screw	70010CDG3N
6	Indicator	239613
7	Lock Anvil	125904
8	Taper Pin	120107-033
9	Cylinder Lever	225795
10	Shaft	263C385H01
11	Operating Lever	263C381H01
12	Socket Head Screw	70041AH0EP
13	Clevis	3159-001
14	Clevis Pin	174356-004
15	Retaining Ring	120079-010
16	Grease Fitting	139656-001
17	Socket Head Screw	70041AH0EB
18	Socket Head Screw	70041AH0EP
19	Sector	263C384H01
20	Indicator Plate	239613
21	Socket Head Screw	70041AH0EB
22	Washer	70500CP10G
23	Manual Lever	6293C50G01
24	Retaining Ring	771B949H25
25	Bushing	1111375
26	Stand (Includes 25)	425789-002

Figure 7-5. Shaft Exploded View

16. Slide shaft (10) into bushing (25) on one side of stand assembly.

17. Lift up cylinder lever (9), aligning hole with shaft (10), and insert shaft through cylinder lever and remaining shaft bushing (25). Installation of shaft into new bushings must occur within 15 minutes after application of Loctite adhesive.

18. Connect shaft (10) to cylinder lever (9) by inserting taper pin (8) with small end pointed towards back of power positioner.

19. Secure operating lever (11) to shaft with socket head screws (12).

20. Install sector (19) on shaft (10). Tighten socket head screws (18).

21. Install manual lever (23) on shaft securing with retaining ring (24).

22. Install lock body (7) on stand assembly securing with socket head screws (17).

23. Install lock bridge (3) on stand assembly securing with socket head screws (1). Install lock lever (2) and lock shoe (4).

24. Refer to Section VI and lubricate power positioner shaft bushings.

25. Refer to Section IV and calibrate power positioner.

26. Return power positioner to service.

SECTION VIII. OPTIONS

8-1. **OVERVIEW.** This section of the manual provides service information on the 6 X 10 power positioner options. These options include an air lock, electric position transmitter, and heater/thermostat.

8-2. **AIR LOCK.** The air lock system automatically locks the power positioner piston and shaft assembly when there is a loss of supply air. When supply air pressure falls below a set value, the air lock diaphragm collapses causing a spring to rotate a lock lever. This clamps the friction plate and locks the piston and shaft assembly.

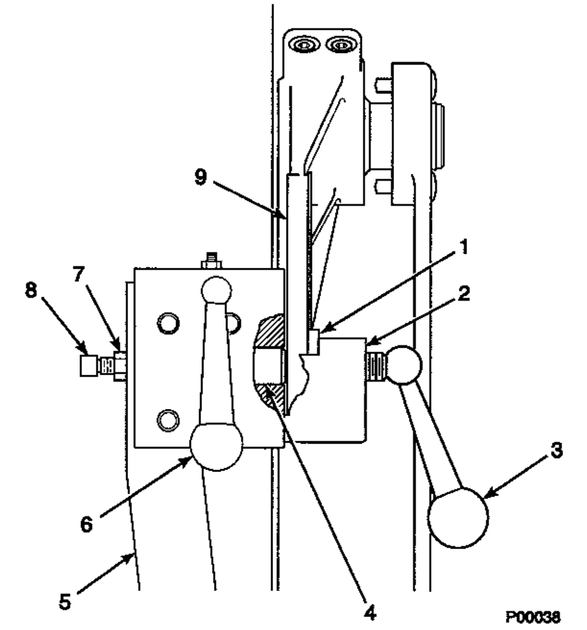
Upon loss of supply air pressure, the automatic lock can be overridden by turning the air lock release handle (6, Figure 8-1) fully clockwise. The operator must then open the bypass valve and manually position the output shaft. After positioning the output shaft it can be locked in place with the manual lock handle (3).

a. Adjustment.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air and signal air, and disconnect any electrical supply or electronic signals to power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

1. Remove power positioner from service, close supply air shut off valve. Disconnect electrical power to power positioner.
2. Back off manual lock handle (3, Figure 8-1) allowing lock shoe (1) to bottom against lock bridge (2).
3. Back off lock nut (7).
4. With air lock lever (5) disengaged (in vertical position), adjust set screw (8) so that lock plunger (4) just clears back face of sector (9).
5. Tighten lock nut (7) and turn manual lock handle (3) so that lock shoe (1) just touches front face of sector.



ITEM	DESCRIPTION	PART NUMBER
1	Lock Shoe	125902
2	Lock Bridge	125903
3	Manual Lock Handle	125910
4	Plunger	131661
5	Air Lock Lever	431666
6	Air Lock Release Handle	231663
7	Lock Nut	70210BC61A
8	Set Screw	6293A95H01
9	Sector	263C384H01

Figure 8-1. Air Lock

6. Restore air and electrical power to positioner.

b. Diaphragm Replacement.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air and signal air, and disconnect any electrical supply or electronic signals to power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

1. Remove power positioner from service, close supply air shut off valve. Disconnect electrical power to power positioner.

8

ITEM	DESCRIPTION	PART NUMBER
1	Spring	131671
2	Air Lock Lever	431666
3	Hex Head Screw (1/2-13 x 1-1/4)	70100DX0CP
4	Jam Nut (5/16-18)	7-210BCA18
5	Washer (Plain 5/16)	70500CL10P
6	Socket Head Screw (5/16-18 x 2)	70041AH077
7	Coupling	132090
8	Diaphragm Washer	131677
9	Socket Head Screw (1/2-13 x 7/8)	70041AH0ED
10	Diaphragm Plate	231678
11	Diaphragm	9351-002
12	Diaphragm Stud	131676
13	Diaphragm Chamber	231673
14	Lock Bracket	231679
15	Lockwasher (1/2 Split)	70510CR105
16	Socket Head Cap Screw (1/2-13 x 1)	70041AHOEF
17	Socket Head Cap Screw (1/2-13 x 3/4)	70041AHOEB
18	Elbow (Stainless Steel)	771B868HOJ
19	Tubing (Stainless Steel)	6293A75HO1
20	Elbow (Stainless Steel)	771B868HO4
	Elbow (Brass)	771B867HO4

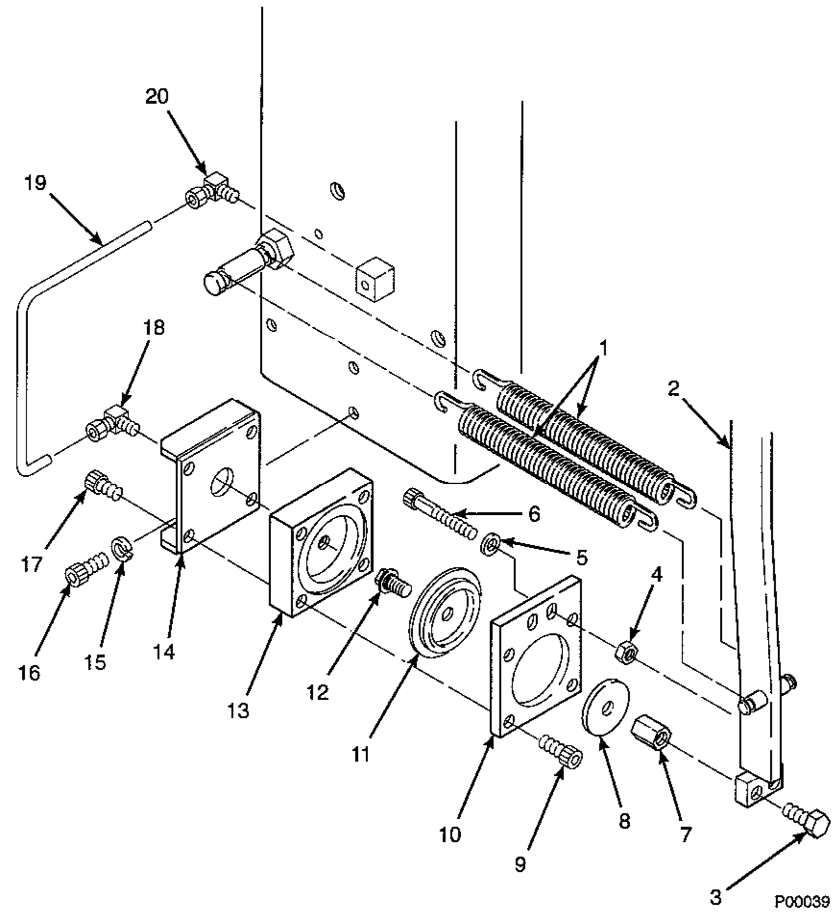


Figure 8-2. Air Lock Diaphragm Exploded View.

2. Remove springs (1, figure 8-2) from air lock lever (2).

3. Disconnect air tubing (19) from elbow (18).

4. Loosen jam nut (4) and unthread socket head screw (6) from air lock lever (2).

5. Remove hex head screw (3) to disconnect lock lever from diaphragm assembly.

6. Remove socket head cap screws (16) and lockwashers (15). Remove diaphragm assembly from power positioner.

7. Remove socket head screw (9) and diaphragm plate (10). Remove assembled diaphragm from diaphragm chamber (13).

8. Holding coupling (7) with a wrench unscrew diaphragm stud (12).

9. Assemble new diaphragm (11) with diaphragm stud (12) and diaphragm washer (8). Holding diaphragm stud securely with a wrench tighten coupling (7) against diaphragm washer (8).

10. Place assembled diaphragm into diaphragm chamber (13) and install diaphragm plate (10).

11. Install diaphragm assembly onto power positioner and reconnect air line tubing (19).

12. Connect air lock lever (2) to coupling (7) with hex head screws (3).

13. Thread socket head screw (6) into air lock lever (2) and secure into place with jam nut (4). Reinstall springs (1).

8-3. ELECTRIC POSITION TRANSMITTER (EPT). For information on the EPT for PP610TR Power Positioner, refer to IB-102-207A, Field Retrofit Kit Electric Position Transmitter.

8-4. HEATER/THERMOSTAT. The heater/thermostat helps prevent freezing of moisture or condensate in power positioner supply and signal air lines. This allows the pilot valve to operate better in temperatures below freezing. With the heater/thermostat installed the power positioner can effectively operate in temperatures down to -10°F (-23.3°C). Operation below this ambient temperature is not recommended.

a. Heater Replacement.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

1. Remove power positioner from service, close supply air shut off valve, and isolate electrical power from power positioner.
2. Remove heater leads (1 and 2, Figure 8-3) from terminals 2 and 4 on terminal block (3).
3. Remove screws (4), washers (5), nuts (6), and heater (7) from bracket (8).
4. Install new heater. Connect black heater lead (1) to terminal 1 and white heater lead (2) to terminal 4 on terminal block (3).

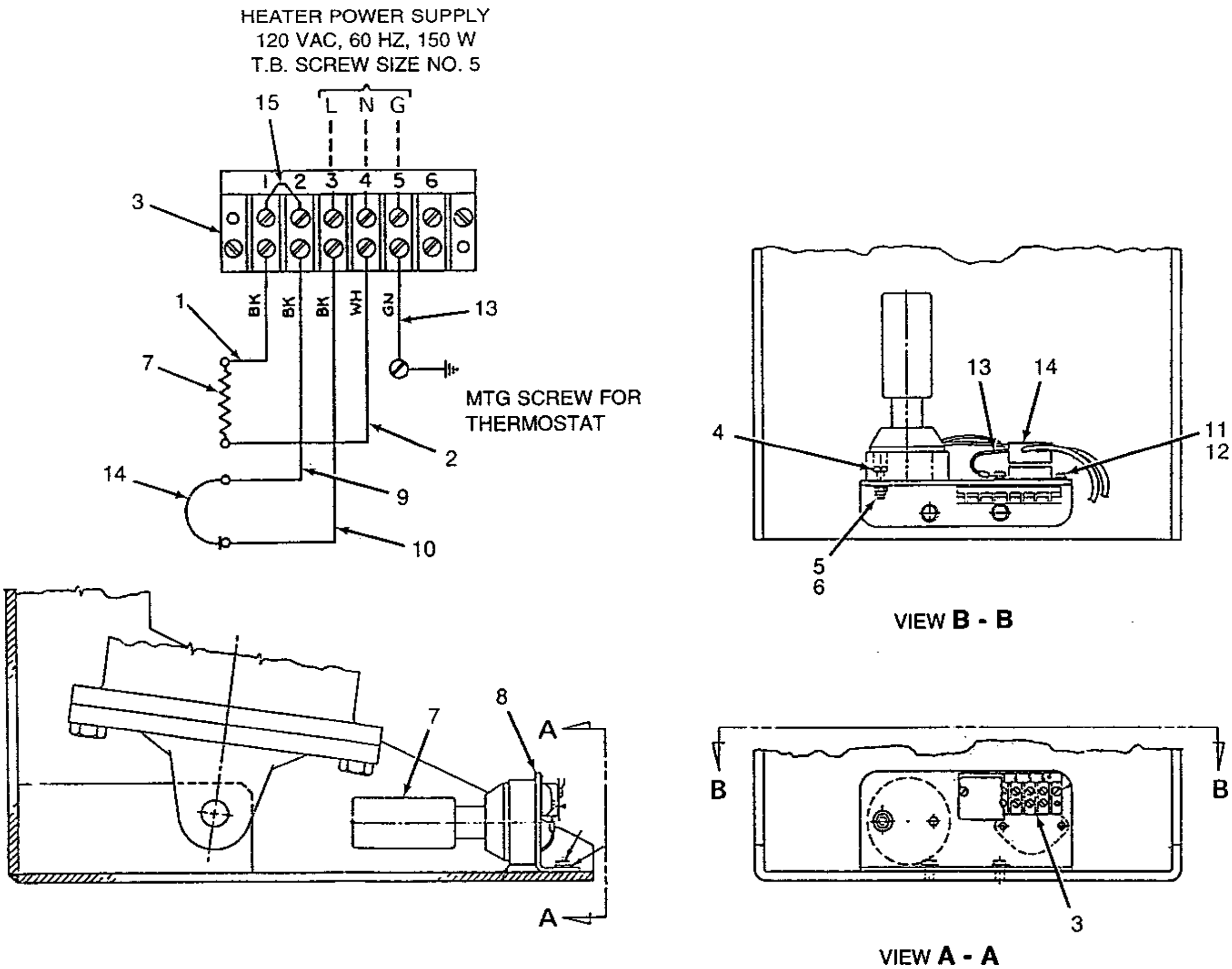
b. Thermostat Replacement.

WARNING

Before performing any maintenance or repair action on power positioner, shut off supply air, signal air, and any electrical supply or electronic signals to power positioner. Isolate power positioner from all systems connected to power positioner. Severe injury or death may result from large torque power positioner is capable of producing, or from electrical shock.

1. Remove power positioner from service, close supply air shut off valve, and isolate electrical power from power positioner.
2. Remove thermostat leads (9 and 10, figure 8-3) from terminals 2 and 3 on terminal block (3). Remove ground lead (13).
3. Remove screws (11), washers (12), and thermostat (14) from bracket (8).
4. Install new thermostat. Reattach ground lead (13).
5. Connect thermostat leads (9 and 10) to terminals 2 and 3 on terminal block (3).

8



ITEM	DESCRIPTION	PART NUMBER
1	Heater Lead (Black)	6292A22G05
2	Heater Lead (White)	6292A22G06
3	Terminal Block	181403-008
4	Screw	70001DAJ8Q
5	Washer	220197-002
6	Nut	120033-007
7	Heater	153407-001
8	Bracket	4511C13H01
9	Thermostat Lead	N/A
10	Thermostat Lead	N/A
11	Screw	70001DAJ8G
12	Washer	70520AL10H
13	Ground Lead	6292A22G07
14	Thermostat	6292A11G01
15	Jumper	145131-001

Figure 8-3. Heater/Thermostat Replacement

SECTION IX. RECOMMENDED SPARE PARTS

Table 9-1. Recommended Spare Parts for PP610TR 6 x 10 Power Positioner.

FIGURE and INDEX No.	PART NUMBER	DESCRIPTION	QTY
	1A97809G01	Spare Parts Kit 6 x 10 Power Positioner	
7-4, 20		O-Ring (120039-019)	1
7-4, 32		O-Ring (120039-028)	1
7-4, 26		Piston Assembly (125782)	1
7-2, 11		Reverse Manifold Gasket (125909)	1
6-4, 17		Chicago Rawhide Wiper (152507-002)	1
7-4, 22		Block V-Packing (152508-003)	1
7-4, 29		Cylinder Head Gasket (225911)	1
6-2, 13		Gasket (5057-002)	1
7-3, 7		Diaphragm (9351-007)	1
	1A97809G03	Spare Parts Kit	
		Piston Assembly (125782)	5
	1A97809G04	Spare Parts Kit	
		Block Vee Packing (152508-003)	15
	1A97810G05	Spare Parts Kit	
		Rawhide Wiper (152507-002)	15
	1A97810G06	Spare Parts Kit	
		Diaphragm (9351-002)	15
	1A97810G06	Spare Parts Kit	
		Cylinder Head Gasket (225911)	15
7-3, 5	175464-226	Calibration Spring 0 - 30 psig	1
7-3, 5	16154	Calibration Spring 3 - 15 psig	1
7-5, 19	263C384H01	Sector	1
7-7	263C386G01	Shaft Assembly	1
6-2, 6	6639-005	Pilot Valve Assembly	1
7-3, 12	7791-021	Spring Connecting Link	1

Table 9-2. Spare Parts for Options (PP610TR 6 x 10 Power Positioner Only).

FIGURE and INDEX No.	PART NUMBER	DESCRIPTION	QTY
	145822	Heater Receptacle	1
8-3, 7	153407-001	Heater	1
	4511C68G01	Electric Position Transmitter Assembly	1
	5505A52H06	O-Ring Gasket	5
8-3, 14	6292A11G01	Thermostat	1
	8741-001	Aluminum Micro-switch	1
8-1, 4	131661	Air Lock Plunger	10
8-1, 1	125902	Air Lock Shoe	5
8-2, 1	131671	Air Lock spring	2
8-2, 8	131677	Air Lock Diaphragm Washer	5
8-2, 11	9351-002	Air Lock Diaphragm	10

NOTE

Table 9-3, Bill of Material for PP610TR 6 X 10 Power Positioner, includes part numbers and descriptions that are keyed to Figure and Index Number references. This listing provides information on all basic PP405TR power positioner parts with the exception of hardware.

Table 9-3. Bill of Material for PP610TR 6 X 10 Power Positioner.

FIGURE and INDEX No.	PART NUMBER	DESCRIPTION	QTY
	425789	Stand Assembly	1
7-5, 25	1111375	Bushing	2
	126198	Serial Number Plate	1
7-5, 16	139656-001	Grease Fitting	2
7-5, 26	425789-002	Stand	1
	6295A68H01	Air Supply Label	1
	6295A68H02	Signal Input Label	1
3-2, 17	263C387	Cylinder Assembly	1
7-4, 30	425917	Cylinder	1
7-4, 34	425919	Bottom Cylinder Head	1
7-4, 24	425918	Top Cylinder Head	1
7-4, 31	325913	Cylinder Liner	1
7-4, 29	225911	Cylinder Head Gasket	2
7-4, 32	120039-028	O-Ring	1
7-4, 21	156198	Gland Bushing	1
7-4, 18	125907	Stuffing Box Nut	1
7-4, 22	152508-003	Block V-Packing	1
7-4, 19	152507-002	Wiper	1
7-4, 20	120039-019	O-Ring	1
7-4, 25	325914	Piston Rod	1
7-4, 26	125782	Piston	1
7-4, 12	325916	Side Bar	1
7-4, 16	325912	Clevis Head	1
7-4, 40	225908	Roller Bracket	1
7-4, 38	181829-2250175	Groove Pin	1
7-4, 39	126917	Back-up Roller	1
	263C386	Shaft Assembly	1
7-5, 10	263C385H01	Shaft	1
7-5, 9	225795	Cylinder Lever	1
7-5, 8	120107-033	Taper Pin	1
7-5, 16	139656-001	Grease Fitting	1
1-2	374610-003	Receiver	1
7-3, 4	5014-4	Diaphragm Cover	1
7-3, 5	175464-348	Zero Balance Spring	1
7-3, 6	5290-7	Diaphragm Stud	1
7-3, 7	9351-7	Diaphragm	1
7-3, 8	5014-019	Stop Ring	1
7-3, 9	5015-027	Shield	1
7-3, 10	70200CAB1A	Nut, 3/8 - 16 Hex	1
7-3, 12	7791-21	Spring Connecting Link	1
7-3, 14	226898	Compensator Assembly	1

Table 9-3. Bill of Material for PP610TR 6 X 10 Power Positioner (Continued)

FIGURE and INDEX No.	PART NUMBER	DESCRIPTION	QTY
7-3, 15	5015-2	Roller	1
7-3, 18	5014-6	Receiver Body	1
7-3, 20	5015-15	Trunnion Screw	1
7-3, 23	5973-7	Spring Washer	1
7-3, 24	5015-14	Spring Nut	1
7-2, 7	6639-005	Pilot Valve	1
7-2, 8	225920	Reverse Manifold	1
7-2, 11	125909	Reverse Manifold Gasket	1
7-3, 22	175464-226	Calibration Spring (0 - 30 psig)	1
7-3, 22	16154	Calibration Spring (3 - 15 psig)	1
7-5, 11	263C381H01	Operating Lever	1
7-5, 13	3159-001	Clevis	1
7-5, 14	174356-004	Clevis Pin	1
7-5, 15	120079-010	Retaining Ring	2
7-4, 14	125775	Clevis Head Pin	2
	426151	Cover Assembly	1
	126154	Strike	2
7-3, 2	6292A08H13	Tubing (Signal Air)	1
7-2, 4	6292A08H12	Tubing (Air Supply)	1
7-4, 7	12015-002	Cam Bar	1
7-4, 11	14236-002	Angle Bracket (Cam Bar)	1
7-4, 2	125783	Spring Clip	1
7-5, 19	263C384H01	Sector	1
7-5, 23	6293C50G01	Manual Lever	1
7-5, 24	771B949H25	Retaining Ring	1
7-5, 7	125904	Lock Anvil	1
8-1, 4	131661	Plunger	1
7-5, 3	125903	Lockbridge	1
7-5, 4	125902	Lock Shoe	1
7-5, 2	125910	Lock Lever	1
	126109	By-pass Indicator	1
	6293A77H01	By-pass Valve	1
	239613	Indicator Plate	1
	139612	Pointer	1
4-3	241-96-6080	I/P Converter	1
7-1	372538-002	Air Filter	1
7-1, 5	372538-023	Filter Element	1

SECTION X. RETURNING EQUIPMENT TO THE FACTORY

10-1. If factory repair of defective equipment is required, proceed as follows:

a. Secure a return authorization from a Rosemount Analytical Sales Office or Representative before returning the equipment. Equipment must be returned with complete identification in accordance with Rosemount instructions or it will not be accepted.

In no event will Rosemount be responsible for equipment without proper authorization and identification.

b. Carefully pack defective unit in a sturdy box with sufficient shock absorbing material to insure that no additional damage will occur during shipping.

c. In a cover letter, describe completely:

1. The symptoms from which it was determined that the equipment is faulty.
2. The environment in which the equipment has been operating (housing, weather, vibration, dust, etc.).
3. Site from which equipment was removed.
4. Whether warranty service or nonwarranty service is requested.
5. Complete shipping instructions for return of equipment.

d. Enclose a cover letter and purchase order and ship the defective equipment according to instructions provided in Rosemount Return Authorization, prepaid, to:

American

Rosemount Analytical Inc.
RMR Department
1201 N. Main Street
Orrville, Ohio 44667

European

Rosemount Ireland
Equipment Return Repair Dept.
Site 7 Shannon Industrial Estate
Co. Clare
Ireland

If warranty service is requested, the defective unit will be carefully inspected and tested at the factory. If failure was due to conditions listed in the standard Rosemount warranty, the defective unit will be repaired or replaced at Rosemount's option, and an operating unit will be returned to the customer in accordance with shipping instructions furnished in the cover letter.

For equipment no longer under warranty, the equipment will be repaired at the factory and returned as directed by the purchase order and shipping instructions.

INDEX

This index is an alphabetized listing of parts, terms, and procedures having to do with the Hagan Model PP610TR Torque Type Power Positioner. Every item listed in this index refers to a location in the manual by one or more page numbers.