# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>INTRODUCTION</td>
<td>..........................................................3</td>
</tr>
<tr>
<td>1.1</td>
<td>MODEL DESIGNATION</td>
<td>....................................................3</td>
</tr>
<tr>
<td>1.2</td>
<td>SPECIFICATIONS</td>
<td>..................................................4</td>
</tr>
<tr>
<td>2.0</td>
<td>INSTALLATION</td>
<td>............................................................5</td>
</tr>
<tr>
<td>2.1</td>
<td>SHIPPING AND STORAGE</td>
<td>............................................5</td>
</tr>
<tr>
<td>2.2</td>
<td>MECHANICAL INSTALLATION</td>
<td>........................................5</td>
</tr>
<tr>
<td>2.2.1</td>
<td>PROCEDURE</td>
<td>.............................................................6</td>
</tr>
<tr>
<td>2.3</td>
<td>PNEUMATIC CONNECTIONS</td>
<td>........................................9</td>
</tr>
<tr>
<td>2.3.1</td>
<td>PIPING</td>
<td>..............................................................10</td>
</tr>
<tr>
<td>2.3.2</td>
<td>INSTRUMENT AIR REQUIREMENTS</td>
<td>.........................10</td>
</tr>
<tr>
<td>2.4</td>
<td>CAM INSTALLATION</td>
<td>..................................................11</td>
</tr>
<tr>
<td>2.4.1</td>
<td>CAM IDENTIFICATION</td>
<td>...........................................11</td>
</tr>
<tr>
<td>2.4.2</td>
<td>EQUIPMENT NEEDED</td>
<td>.............................................11</td>
</tr>
<tr>
<td>2.4.3</td>
<td>PROCEDURE</td>
<td>..........................................................11</td>
</tr>
<tr>
<td>3.0</td>
<td>CALIBRATION</td>
<td>......................................................16</td>
</tr>
<tr>
<td>3.1</td>
<td>EQUIPMENT NEEDED</td>
<td>...........................................16</td>
</tr>
<tr>
<td>3.2</td>
<td>PROCEDURE</td>
<td>..........................................................16</td>
</tr>
<tr>
<td>4.0</td>
<td>PRINCIPLE OF OPERATION</td>
<td>.......................................20</td>
</tr>
<tr>
<td>5.0</td>
<td>MAINTENANCE</td>
<td>....................................................22</td>
</tr>
<tr>
<td>5.1</td>
<td>RESTRICTION</td>
<td>.....................................................22</td>
</tr>
<tr>
<td>5.2</td>
<td>FILTER SCREENS</td>
<td>..................................................22</td>
</tr>
</tbody>
</table>

# LIST OF ILLUSTRATIONS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>Cam and Associated Hardware</td>
<td>.........................................7</td>
</tr>
<tr>
<td>2-2</td>
<td>Typical Positioner Mounting and Feedback Pin Connection</td>
<td>..................................8</td>
</tr>
<tr>
<td>2-3</td>
<td>Standard Cam Characteristics</td>
<td>........................................13</td>
</tr>
<tr>
<td>2-4</td>
<td>Cam Installation, A Side Example</td>
<td>....................................14</td>
</tr>
<tr>
<td>2-5</td>
<td>Cam Installation, B Side Example</td>
<td>....................................15</td>
</tr>
<tr>
<td>3-1</td>
<td>Calibration</td>
<td>.....................................................17</td>
</tr>
<tr>
<td>4-1</td>
<td>Schematic</td>
<td>......................................................21</td>
</tr>
</tbody>
</table>
1.0 INTRODUCTION

The Model 150P Valve Positioner is a cam characterized, double-acting, pneumatic valve positioner that accepts a 3-15 or 3-27 psig input signal and converts it to a pneumatic output to position a control valve actuator. The Positioner can be used with either rectilinear or rotary, single or double acting actuators. A selection of cam profiles is available.

A high-gain, piloted spool valve is used to load the actuator for positioning in response to an input signal. Mechanical feedback is provided by a characterized cam.

No additional parts are necessary to change between single or double acting actuators or direct/reverse action.

1.1 MODEL DESIGNATION

Each Positioner has a nameplate identifying the model number. The following decodes the model number on the nameplate. Before installing or servicing a Positioner, review the nameplate information.

TYPE
150N Pneumatic Valve Positioner

ACTION
L Rectilinear
R Rotary

CAM PROFILE
1 Standard Linear
2 Standard Rotary

INPUT
1 3 to 15 PSIG
2 3 to 27 PSIG

150N L 1 1 SAMPLE MODEL NUMBER
1.2 SPECIFICATIONS

Connections: 1/8” NPT

Input: 3-15 PSIG (.21-1.1 KG/CM²), 3-27 PSIG (.21-1.9 KG/CM²)

Supply: 30 PSIG (2.1 KG/CM²) minimum, 150 PSIG (10.5 KG/CM²) maximum

Supply Pressure Change Effect: output pressure changes less than 0.3% of span for a 5 PSIG (.35 KG/CM²) change

Air Consumption: 0.7 SCFM (.33 L/S) at 60 PSIG (4.22 KG/CM²) supply

Air Pilot Capacity: 7.5 SCFM (3.5 L/S) at 60 PSIG (4.22 KG/CM²) supply

Adjustable Range: ±30% of input span or maximum rated travel

Stroke: Rectilinear, 1/2” to 2”

Temperature Limits: -40°F to 180°F (-40°C to 82°C)

Weight: 2.5 lbs. (1.3 kgs)

Gauges............ Two: 0-160 PSIG (0-11.2 KG/CM²) gauges to monitor output pressure;
One: 0-30 PSIG (0-2.1 KG/CM²) gauge to monitor input pressure.

Position Indictor Indicator and tape scale to indicate valve position (rotary actuators only).

PERFORMANCE

Repeatability: 0.1% of span

Linearity: ±1% of span

Hysteresis: less than 0.75% of span

Dead Band: less than 0.1% of span

Response Level: less than 0.1% of span
2.0 INSTALLATION

This section provides information pertaining to installation of a Series 150N Valve Positioner. This entire section should be reviewed before proceeding with the installation.

Positioner installation is dependent upon the type of valve actuator and its characteristics, and the effect of the valve on the process. Obtain this information before proceeding with the installation.

Operating temperature limits are stated in the Specifications section of this Instruction. The temperature in the selected location must not exceed the specified operating temperatures.

CAUTION

Exceeding the specified operating temperature limits can adversely affect performance and may cause damage to the Positioner.

The Positioner will need to be calibrated before being put into service.

2.1 SHIPPING AND STORAGE

If the Positioner is to be stocked, stored, or shipped to another location prior to piping, make sure that the factory installed plastic plugs are in the pneumatic ports to prevent entry of moisture, dirt, or other contaminant.

2.2 MECHANICAL INSTALLATION

Refer to Page 1 for dimensions and mounting hole locations.

Rigidly mount Positioner to actuator to prevent relative motion. The Positioner may be mounted in any orientation. Feedback torque is 7 inch/lbs. maximum. The location must provide access for:

- Mechanical interconnecting of Positioner and actuator
- Routing of pneumatic piping
- Removing of access cover
- Servicing

Note that the extension spring and related parts mentioned in the following procedures, and shown in Figure 2-1, are present only when a quick opening cam is used.
2.2.1 Procedure

1. Loosen cover screws and rotate cover (and gasket) to provide access. See Page 1.

2. If present, remove extension spring from spring anchor (spring may be disconnected in a new Positioner shipped from the factory). Then remove screw, washer, and anchor. See Figure 2-1.

3. Slightly loosen hex nut or standoff so input shaft is free to turn without turning cam (7/16" socket needed).

4. If removed in step 2, loosely reinstall the spring anchor, washer, screw, and extension spring removed in step 2.

5. For feedback connection between Positioner and actuator, refer to either A or B depending upon type of actuator to be used.

A. RECTILINEAR ACTUATOR

Figure 2-2 shows Positioner and sample actuator. Fabricate and install a slotted bracket and feedback pin based on following statements:

- Feedback level must be perpendicular to actuator stem with actuator at mid-stroke.

- Connection between actuator stem and feedback lever is typically made using a slotted bracket attached to actuator stem and a feedback pin attached to the feedback lever. The slotted bracket must be rigid and motion must be transferred without deflection.

- Figure 2-2, details A and B, show the feedback pin fixed to feedback lever, the preferred method. The distance from the centerline of feedback pin to centerline of input shaft must equal actuator stroke.

- Figure 2-2, detail C shows feedback pin fixed to slotted bracket, an alternate method that causes an increase in linearity error of approximately 2%. The distance from the centerline of free end of feedback pin to centerline of Positioner input shaft must equal actuator stroke x 0.866.

B. ROTARY ACTUATOR

Fabricate and install a coupling based on the following statements:

- Couple the 0.5" square Positioner input shaft to actuator shaft.

- Shaft centerlines must be in-line to minimize friction and binding as shafts rotate.

FIGURE 2-1 Cam and Associated Hardware

NOTE: EXTENSION SPRING, SPRING ANCHOR, AND HEX STANDOFF USED ONLY WITH QUICK OPENING CAM AND SOME SPECIAL CAMS.
A. POSITIONER MOUNTING AND PREFERRED METHOD OF CONNECTING FEEDBACK PIN

B. STROKE SETTING FOR PREFERRED FEEDBACK PIN CONNECTION. FEEDBACK LEVER SHOWN AT MID-STROKE. NOTE 60° ROTATION.

C. ALTERNATE METHOD OF CONNECTING FEEDBACK PIN AND STROKE SETTING.

FIGURE 2-2 Typical Positioner Mounting and Feedback Pin Connection
2.3 PNEUMATIC CONNECTIONS

Pneumatic connections are shown on page 1 and listed below:

IN - Input (or instrument) connection
V1 - No. 1 valve connection
V2 - No. 2 valve connection
S - Supply connection

Valve connections are used either independently or together to load the valve actuator. A user supplied 1/8˝ NPT pipe fitting is 12 foot-pounds. When only one valve connection is used, a user supplied 1/8˝ NPT pipe plug is required for the unused connection.

**CAUTION**

Pressure in excess of 150 psig to any connection may cause damage to the Positioner.

Supply pressure to Positioner must not exceed actuator maximum pressure rating.

Refer to the table to determine the required pneumatic connections between the Positioner and the actuator.

<table>
<thead>
<tr>
<th>ACTUATOR TYPE</th>
<th>POSITIONER ACTION</th>
<th>CONNECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single acting</td>
<td>Direct acting (output increases with increasing input signal)</td>
<td>Connect V2 and plug V1</td>
</tr>
<tr>
<td>Single acting</td>
<td>Reverse acting (output decreases with increasing input signal)</td>
<td>Connect V1 and plug V2</td>
</tr>
</tbody>
</table>
| Double acting | --- | 1. Note actuator position desired for minimum input signal to Positioner.  
               | | 2. Connect V2 to actuator port that causes actuator to move away from position noted in above step.  
               | | 3. Connect V1 to remaining port. |
2.3.1 Piping

All connections are 1/8” NPT.

User supplied materials:

- Scale free piping at least 3/16” OD
- 1/8” NPT pipe fitting is needed for each connection used; the maximum torque to be applied when tightening a fitting is 12 foot-pounds
- 1/8” pipe plug to plug an unused port

Piping recommendations:

- Blow out all piping before connections are made to prevent dirt, chips, or debris from entering the Positioner.
- Use pipe sealant sparingly and only on male threads. A non-hardening sealant is strongly recommended.
- Connect the Positioner to a source of clean, oil-free instrument air. Instrument air requirements are given in the following section. Failure to do so will increase the possibility of a malfunction or deviation from specified performance.

2.3.2 Instrument Air Requirements

Instrument quality air must be supplied to the Positioner.

CAUTION

Synthetic compressor lubricants in the air stream at the Positioner may cause it to fail.

There are many types of synthetic lubricants. Some may not be compatible with the materials used in the construction of the Positioner. Wetting of these materials by such an oil mist of vapor may cause them to deteriorate. This can result in failure of the Positioner. A list of materials used in the Positioner is found in the SPECIFICATIONS section.

Requirements for a quality instrument air supply can be found in the Instrument Society of America’s “Quality Standard for Instrument Air” (ISA-S7.3). Basically this standard calls for the following:

Particle Size - The maximum particle size in the air stream at the instrument should be no larger than 3 microns.
Dew Point - the dew point, at line pressure, should be least 10°C (18°F) below the minimum temperature to which any part of the instrument air system is exposed at any season of the year. Under no circumstances should the dew point, at line pressure, exceed 2°C (35.6°F).

Oil Content - The maximum total oil or hydrocarbon content, exclusive of non-condensibles, should not exceed 1 ppm under normal operating conditions.

2.4 CAM INSTALLATION

This section provides a cam installation procedure which applies to all Model 150N Positioners. It assumes that the Positioner is mounted and Pneumatic connections are made. Use this procedure when changing the cam or cam side.

2.4.1 Cam Identification

A number-letter combination (e.g., 1A and 1B) is used on each side of a cam for identification. The number designates the type of cam (i.e., linear, modified equal percentage, or quick opening) as indicated in the model designation. The letter denotes the side of the cam to be used for Positioner operation.

Each side of a cam also has three marked and graduated input ranges (i.e., 0-100% for whole range and 0-50% and 50-100% for split ranges).

Figure 2-3 shows the standard cam characteristics defined in the model designation.

2.4.2 Equipment Needed

- 7/16˝ open-end wrench
- Torque wrench, set to 75 inch-pounds
- 7/16˝ deep socket
- Medium slotted screwdriver

2.4.3 Procedure

1. Ensure air supply and input signal to Positioner are turned off.

2. Determine desired direction of rotation of the cam for an increasing input signal.

   1) Select side of cam needed. Use A side of cam for clockwise rotation or use B side for counterclockwise rotation.

   2) Select cam lobe corresponding to the desired whole or split range.
3. For access to cam and loosening of cam mechanism, perform the following steps.

   1) Rotate access cover (and gasket). Refer to Page 1.

   2) If present, remove extension spring from spring anchor; then remove screw, washer, and anchor. See Figure 2-1.

   3) Slightly loosen hex nut or standoff so input shaft is free to turn without turning cam (7/16” socket needed).

4. If it is necessary to use other side of cam: remove nut or standoff, turn cam over, and install the washer and standoff; do not tighten Standoff. Cam must be free to rotate.

5. Index cam as follows:

   For the following steps, refer to Figure 2-4 when using the A side of a cam or to Figure 2-5 when using the B side of a cam. Detail A shows cam nomenclature.

   1) Turn on the supply pressure.

   2) Ensure that valve actuator is seated in the position desired with no Positioner input signal. If it is not, loosen fine zero locknut and adjust the fine zero thumbwheel as needed; tighten fine zero locknut.

   3) Carefully align minimum input index line with center of cam follower bearing pin and tighten cam locknut or standoff to 70-75 in./lbs torque.

   4) If removed in step 3 on the preceding page, reinstall, spring anchor and extension spring.

   5) Loosely reinstall the access cover (and gasket) to prevent both inadvertent damage to Positioner components and introduction of dirt and other foreign matter into the Positioner.

   6) Turn off supply pressure.

6. Proceed to section 3 Calibration.
FIGURE 2-3 Standard Cam Characteristics
FIGURE 2-4 Cam Installation, A Side Example
FIGURE 2-5 Cam Installation, B Side Example

NOTE:
EXTENSION SPRING, SPRING ANCHOR, AND SCREW AND WASHER REMOVED FOR CLARITY.
3.0 CALIBRATION

Calibrate a Positioner before placing it in service and after repair. Figure 3-1 locates the calibration adjustments.

This section accommodates two styles of calibration adjustments: concentric and separate. The concentric style is the most common and appears on current Positioners.

To determine the style of calibration adjustment in the Positioner to be calibrated, read the following statements while referring to Figure 3-1.

- Concentric - Span Locknut and Coarse Zero Lockscrew are concentric - a straight-slot screw within a hexagonal nut.
- Separate - Separate Range Spring (Span) and Coarse Zero Lockscrews are provided. Both lockscrews may be hard to see since they are located on almost opposite sides of the Range Spring assembly.

Select the appropriate calibration procedure for the Positioner at hand.

3.1 EQUIPMENT NEEDED

Pressure regulator, adjustable from 0 to 30 psig, qty. 1
Pressure gauge, 0 to 30 psig, qty. 1
Small slotted screwdriver, qty. 1
3/8˝ open-end wrench, qty. 1
1/4˝ nutdriver (CONCENTRIC), qty. 1

3.2 PROCEDURE

1. Refer to Figure 2-1 and open housing cover. Loosen two holding screws (one is identified as the cleaning wire) and pivot cover (and gasket) clockwise to gain access inside housing. Turn upper right holding screw finger-tight to hold cover in position.

2. Calibration Preset

If Positioner has been either serviced and parts have been replaced or the calibration otherwise disrupted, the Fine Zero Thumbwheel and Range Spring can be preset to speed calibration. Otherwise proceed to step 3.

1) Adjust thread projection above Fine Zero Thumbwheel by loosening Fine Zero Locknut and turning Fine Zero Thumbwheel. One thread (1/16) should project above the Fine Zero Thumbwheel.
FIGURE 3-1 Calibration

NOTE. CALIBRATION PRESET – ONE THREAD, 1/16” (1.6mm)
2) **CONCENTRIC** - Adjust Range Spring active coils by loosening Range Spring Locknut and turning Range Spring. Four to four and one-half active coils are desired for a standard input span.

**SEPARATE** - Adjust Range Spring active coils by loosening Range Spring Lockscrew and turning Range Spring. Four to four and one-half active coils are desired for a standard input span.

3) **CONCENTRIC** - Tighten Fine Zero Locknut and Range Spring Locknut after making adjustment.

**SEPARATE** - Tighten Fine Zero Locknut and Range Spring Locknut after making adjustment.

3. Turn on supply pressure.

4. Zero Adjustment

A. Fine Zero Adjustment

1) Set input signal to desired minimum range value.

2) Loosen Fine Zero Locknut.

3) Turn Fine Zero Thumbwheel until desired valve position is reached and tighten Fine Zero Locknut.

If Positioner can not be zeroed, proceed to Coarse Zero Adjustment. Otherwise proceed to step 5 Span Adjustment.

B. Coarse Zero Adjustment

1) Center fine zero adjustment by loosening Fine Zero Locknut and turning Fine Zero Thumbwheel so that approximately one thread (1/16") of the Fine Zero Screw projects above Fine Zero Thumbwheel.

2) Loosen Coarse Zero Lockscrew 1/4 turn. The Span Nut must be tight against the spring.

3) **CONCENTRIC** - Turn Coarse Zero and Span Nut and Fine Zero Thumbwheel simultaneously in the same direction until valve is in desired position. Continue to turn Coarse Zero and Span Nut until Coarse Zero Lockscrew and Range Spring Locknut are accessible.
4) **CONCENTRIC** - Tighten Coarse Zero Lockscrew, then tighten Range Spring Locknut.

**SEPARATE** - Tighten Coarse Zero Lockscrew.

5) Repeat fine zero adjustment in A above.

5. **Span Adjustment**

1) Increase input to produce desired valve full-scale motion and note input span.
   - If span is correct, calibration is complete.
   - If span is incorrect, proceed to step 2.

2) Reduce input to zero value.

3) **CONCENTRIC** - Loosen Range Spring Locknut and Fine Zero Locknut and adjust the number of active range spring coils as follows.

**SEPARATE** - Loosen Range Spring Locknut and Fine Zero Locknut and adjust the number of active range spring coils as follows.

   - If input span is narrow, reduce number of active coils.
   - If span is wide, increase number of active coils.

**NOTE**

For a 12 psi input span, turning the range spring 15° or 1/16” adjusts span about 1%.

4) **CONCENTRIC** - Tighten Range Spring Locknut and Fine Zero Locknut.

**SEPARATE** - Tighten Range Spring Locknut and Fine Zero Locknut.

5) Repeat zero and span adjustments until Positioner is calibrated.

**NOTE**

If a major change in span adjustment (10% or more) has been made, re-adjust coarse zero.

This completes the procedure.
4.0 PRINCIPLE OF OPERATION

The following describes a direct-acting Positioner operating a valve with a double-acting actuator in response to an increased input signal. Refer to Figure 4-1.

The input signal, representing the desired valve position, is applied between the two diaphragms of the input diaphragm assembly. Since the bottom diaphragm has a larger effective area than the top diaphragm, an increase in the input signal will move the diaphragm assembly downward.

The assembly operates the nozzle flapper over the nozzle to control the pilot air pressure acting on the top of the pilot diaphragm assembly. Pilot air to the nozzle and to the top of the diaphragm assembly is taken from the air supply via the restriction.

The restriction and nozzle form a pressure divide circuit. An increase in the input signal causes the input diaphragm assembly to move the nozzle flapper upward and away from the nozzle. This increases pilot air flow through the nozzle to the pilot exhaust and decreases the pilot air pressure acting on the top of the pilot diaphragm assembly.

The pilot diaphragm assembly and the end cap diaphragm operate the spool to control the V1 and V2 outputs to the valve actuator. The spool operates over the V1 and V2 ports and simultaneously supplies one output and exhausts the other on an input signal change, or it blocks both ports so they neither supply nor exhaust when the positioner is in balance.

The spool is moved upward by air supply pressure acting on the bottom of the end cap diaphragm in response to a decrease in pilot air pressure on top of the pilot diaphragm assembly. This connects air supply from the supply port to the V2 port and increases the output of the V2 connection. At the same time, the V1 port is connected to the V1 exhaust to decrease the output of the V1 connection.

The resultant change in valve position is fed back to the positioner via the cam. The increase in the V2 output causes the cam to rotate clockwise moving the span lever upward and increasing range spring tension. The upward force of the range spring causes the input diaphragm assembly to move the nozzle flapper downward and closer to the nozzle. This increases the pilot pressure on top of the pilot diaphragm assembly and forces the spool to move downward.

When the valve reaches the position called for by the input signal, the upward force of the range spring will equal the downward force of the input signal. At this time, the positioner will be in balance with the spool blocking both V1 and V2 ports so that neither is supplying nor exhausting to the valve actuator.
FIGURE 4-1 Schematic
5.0 MAINTENANCE

The Positioner requires no routine maintenance. It is highly recommended that quality instrument air be used as described in section 2.2.2 Instrument Air Requirements.

The restriction and filter screens may require periodic cleaning. The frequency of their cleaning is conditional depending on the quality of instrument air used.

In the unlikely even the 150N Series Positioner should fail, the unit can be returned to the factory for warranty repair if the warranty period has not expired. All units returned for repair are to be shipped freight prepaid to:

Dwyer Instruments, Inc.
Jct. IN 212 and US 12
Michigan City, IN 46360
Attention: Repair Department

5.1 RESTRICTION

The restriction is cleaned with the cleaning wire which is attached to the holding screw for the housing cover. See Figure 2-3 for cleaning wire location.

1. Turn off air supply.

2. Unscrew and remove cleaning wire and restriction sealing screw.

3. Run cleaning wire through restriction in pilot ring several times.

4. Reinstall restriction sealing screw and cleaning wire.

5.2 FILTER SCREENS

Filter screens are located in the V1, V2, and supply ports. A screen must be removed from the spool housing to be cleaned. Screens can be damaged during removal; have spare screens on hand. Refer to the Parts List at the back of this Instruction.

1. Turn air supply off.

2. Remove a screen with a scribe by carefully pulling on and around the edge of a screen.

3. Clean a screen by blowing through in the reverse direction with compressed air. Soak a screen in solvent or clean mechanically if necessary.

4. Insert a screen until it bottoms using an object, such as the eraser end of a pencil, that will not cause damage.