Bailey

PRODUCT INSTRUCTIONS

MINI-LINE* 500 CONTROLLER
TYPE AD

BAILEY METER COMPANY • WICKLIFFE, OHIO 44092
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FIGURE 1  Type AD Pneumatic Controller Mounting Dimensions
INSTALLING THE CONTROLLER

1. Carefully remove Controller from shipping carton. Inspect for any obvious damage. (Refer to inside back cover of this Instruction.)

2. Attach mounting base to wall or panel in accordance with dimensions given in Figure 1. Do not locate Controller more than 400 feet from transmitters or final control elements.

3. Make necessary adjustments for particular service desired as outlined under "Adjusting for Service" on page 7.

4. Make external connections to mounting base in accordance with Table A and Figure 2. Connections are female 1/4 inch NPT.

NOTE Connecting tubing of copper or aluminum (.028 to .032 inch wall thickness) or plastic tubing is recommended. Connections are spaced to permit use of 1/4 inch NPT Parker elbows.

5. Plug Controller into mounting base by means of six plugs matching holes in rear of Controller assembly. Tighten mounting screws.

6. Adjust air supply to mounting base. 30 psig for 3 to 27 psig range; 18 psig for 3 to 15 psig range.

FIGURE 2 Input Output Connections

<table>
<thead>
<tr>
<th>CONTROLLER FUNCTION OR ACTION*</th>
<th>MOUNTING BASE CONNECTIONS**</th>
<th>DISC SWITCHES (SEE FIGURE 5)</th>
<th>DISC SWITCHES (SEE FIGURE 4)</th>
<th>PLUG IN UNITS (SEE FIGURE 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Prop</td>
<td>E1: Input, E2: Vent, E3R: Vent</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Reverse Prop</td>
<td>E1: Input, E2: Vent, E3R: Vent</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Differential</td>
<td>E1: Input, E2: Vent, E3R: Vent</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>2 Element Controller</td>
<td>E1: Input, E2: Input, E3R: Vent</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Totalizing</td>
<td>E1: Input, E2: Input, E3R: Vent</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Signal (Range) Conversion</td>
<td>E1: Input, E2: Input, E3R: Vent</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Subtracting</td>
<td>E1: Input, E2: Input, E3R: Vent</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Floating (Pure Integral)</td>
<td>E1: Input, E2: Vent, E3R: Output 1</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Differential Floating</td>
<td>E1: Input, E2: Output (1), E3R: Plug</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Prop Plus Integral</td>
<td>E1: Input, E2: Plug (3), E3R: Plug</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Averaging Damped Input</td>
<td>E1: Input, E2: Plug, E3R: Plug</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Prop Plus Derivative</td>
<td>E1: Input, E2: Vent, E3R: Vent</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Diff Plus Derivative</td>
<td>E1: Input, E2: Vent, E3R: Vent</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Prop Plus 1st Plus Der</td>
<td>E1: Input, E2: Vent, E3R: Vent</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
<tr>
<td>Diff Plus 1st Plus Der</td>
<td>E1: Input, E2: Vent, E3R: Vent</td>
<td>D: Open, P: Closed, P+1: Open</td>
<td>Int: None, Der: None</td>
<td></td>
</tr>
</tbody>
</table>

(1) Input for adjustment output 1 service
(2) Output for adjustment plugged in service
(3) Input for calibration plugged in service
(4) P for adjustment P 1 n service

**Factory calibration
*Additional applications requiring special tubing or accessories are shown schematically in Figure 11
**Air supply is connected to S in all cases.

TABLE A Tubing Connections and Switch Settings for Type AD Controller
**PLACING IN SERVICE**

IMPORTANT: If Controller has had factory calibration disturbed, it must be recalibrated as outlined under "Aligning the Controller" on page 12.

The Controller is calibrated at the factory as a differential Controller with integral control action. It is null with midrange pressure in all bellows. If this is the desired application, the Controller may be placed directly in service after making the necessary connections in accordance with Table A and Figure 2. To adjust a unit for any other service, follow the procedure outlined below (A faster method, limited to certain applications is given following the standard procedure.)

**Adjusting for Service**

1. Set gain at 1.0. (Lock gain arm in place each time it is repositioned.) Set integral or derivative switches or plug in valves (Figure 4), "D R" switch and "P P-I" switch (Figure 5) to positions indicated in Table A and Figure 2.

NOTE: If integral or derivative plug in units are used, valve will be "open" or "closed" when adjusting screw is turned to full clockwise or counterclockwise position respectively.

2. Attach Controller to mounting base. Connect separate variable input pressures to input connections given in Table A.

3. Apply midrange pressure to input connections. If full range is not used in system application, apply midrange pressure of actual input range employed. (i.e., for a range span of 10 to 15 psig, applied pressure is 12.5 psig)

4. Connect pressure gage or manometer to output connection "O." Apply air to supply connection "S," 30 psig for 3 to 27 psig range, 18 psig for 3 to 15 psig range.

5. Turn A-B bias adjustment screw until tie plate hinges are in line with hinges on C-D beam (see upper beam alignment line, Figure 3)

NOTE: Do not turn bias screw if service involves inputs to both A and B bellows. Correct bellows match is set at factory. (If bellows match has been destroyed, see "Aligning the Controller" on page 12.)

6. Remove indicating panel (Item 20, Figure 18) and turn C-D sector screw until tie plate hinges are in line with hinges on A-B beam (see lower beam alignment line, Figure 3)

7. Adjust output pressure to midrange with C-D bias screw. NOTE after step 5 also applies with inputs to both C and D bellows.

8. Apply required null pressure to input connections as dictated by system application

9. Set gain at 2 and adjust output to required output null pressure by turning C-D sector screw.

10. Set gain at 20 and adjust output to required output null pressure by turning A-B sector screw.

11. Repeat steps 9 and 10 until output is correct at gains of 2 and 20.

12. Set gain at 1.0 and note output. If output is not equal to required null, unlock and rotate nozzle until deviation is approximately doubled. Lock nozzle.

**Figure 4** Integral and Derivative Switches and Plug in Units

**Figure 5** Controller Rear View Showing D R and P P-I Switches
NOTE Large nozzle adjustments may disturb parallel relationship of vane and sector plate. To readjust vane, loosen vane adjustment screw (Figure 3) and slide vane support until vane is approximately parallel to sector plate.

13. Repeat steps 9 thru 12 until gain may be shifted from .2 to 20 without changing output more than 0.5 psig.

14. Set gain to desired value and lock gain arm in place. Disconnect variable input pressure and gage lines.

15. Set integral and derivative control action units, if employed, to desired speed of response by rotating adjustment screw below calibrated dial. See Figure 4. (To change integral unit dial range, refer to "Aligning the Controller".)

NOTE If Controller cannot be adjusted with above procedure or if Controller has been disassembled or factory calibration otherwise disturbed, a complete recalibration as outlined under "Aligning the Controller" on page 12 will be required.

Alternate Adjustment Procedure

It is possible to null the Controller using the bias screws rather than the sector screws. This is an advantage since the bias screws are more easily accessible from the front of the Controller and the required adjustments can be made rapidly.

Changing the bias screw positions will shift the A, B, and C, D beams slightly out of alignment. This will not cause any difficulty in many applications. However, the bias screws should not be used for nulling where a differential pressure is employed (any application involving inputs to both A and B bellows).

NOTE If any doubt exists regarding the suitability of the rapid method for a particular application, perform the nulling procedure outlined under "Aligning for Service".

To adjust by the alternate method:

1. Set gain at 1.0. (Lock gain arm in place each time it is repositioned.) Set integral or derivative switches or plug in valves (Figure 4), "D R" switch and "P P-I" switch (Figure 5) to positions indicated in Table A and Figure 2.

NOTE If integral or derivative plug in units are used, valve will be "open" or "closed" when adjusting screw is turned to full clockwise or counterclockwise position respectively.

2. Attach Controller to mounting base. Connect separate variable input pressures to input connections given in Table A.

3. Connect pressure gage or manometer to output connection "O". Apply air to supply connections "S", 30 psig for 3 to 27 psig range, 18 psig for 3 to 15 psig range.

4. Apply required null pressure to input connections as dictated by particular system application (see "Null Balance" on page 19).

5. Set gain at 0.2 and adjust output to required null pressure by turning C D bias screw.

6. Set gain at 20 and adjust output to required null pressure by turning A B bias screw.

7. Repeat steps 5 and 6 until output is correct at both gain settings.

8. Set gain at 1.0, lock gain arm and note output. If output pressure is required null pressure proceed with step 9. If output pressure is not equal to required null pressure, A B and C D sector screws are not properly adjusted. Follow standard procedure outlined under "Adjusting for Service" on page 7. If Controller cannot be correctly adjusted by standard procedure, a complete recalibration as outlined under "Aligning the Controller" will be required.

9. Set gain to desired value and lock gain arm in place.

10. Vary input pressure thru operating range making certain that beams do not touch slide castings and that calibration is accurate within desired tolerance. If beam interference is encountered or greater accuracy desired, Controller must be recalibrated following procedure outlined under "Aligning the Controller" and then performing "Adjusting for Service" on page 7.

11. Disconnect variable input pressure and gage lines. Set integral and derivative control action units, if employed, to desired speed of response by rotating adjustment screw below calibrated dial. See Figure 4.
ROUTINE SERVICING

1. The air supply to the Controller must be kept free of dirt, oil, and moisture for satisfactory operation. Inspect the felt filters in the Controller mounting base and replace them if they are dirty (These filters are included as added protection only and are not intended to supplant the required clean air supply.)

2. Periodically replace felt pad air filters as follows

a. Turn OFF supply air and disconnect supply air and output lines (Figure 6)

b. Remove wire mesh disc (Figure 6) and felt pads with pick or similar instrument.

c. Replace felt pads and wire mesh discs.

NOTE When replacing mesh discs, make certain there is a disc under felt pad in supply connection.

d. Reconnect supply air and output lines to mounting base.

FIGURE 6 Replacing the Filter Pads

3. All pressure connections must be kept air tight. Periodically check all air pressure connections for leakage with a soapsuds solution.

4. Periodically inspect Controller nozzle tip (Figure 3) and vane for deposits of oil, dirt, etc. Clean with a suitable solvent.

TROUBLESHOOTING

If the Controller is inoperative or if operation is faulty, first check the calibration as outlined under "Placing in Service" on page 7. If still incorrect, perform a visual check for loose screws, damaged or broken parts, etc. The Fault Correction Chart below lists most common problems and corrective actions. Refer to the specific subheading for replacement of parts.

Replacing the Bellows, Sector Plate, or Tie Plate (Refer to Figure 18)

1. Remove screws (10) attaching balance beam to castings (30 and 31).

2. Unlock bellows set screws (26).

3. Remove range spring nuts (45). Remove spring support (7) with springs attached.

4. Remove gain assembly vane (41) and vane adjustment (24) by removing vane adjustment screw (48).

5. Remove bolts (23 and 36) attaching side castings (30 and 31) to rear manifold (22). Remove screws (18) holding side casting together. Pull castings slightly forward and remove castings with bellows attached.

6. Remove retaining ring (12) and push bellows (13) out of castings.

7. Disassemble center structure only if sector plate (29) or tie plate (15) replacement is necessary.

8. Reassemble unit following steps 1 thru 7 in reverse order. Coat all O-rings lightly with silicone grease.

Bearing Adjustment (Refer to Figure 18)

Normally, the bearing adjustment should not have to be disturbed. If, however, the gain adjustment arm is loose and the Transmitter can not be nulled, the gain adjustment arm can be removed and the bearing adjusted as follows.

1. Remove vane (41), nozzle (52) and gain locking knob (44).

2. Remove Booster Relay (2) from rear of manifold (22).
# FAULT CORRECTION CHART

<table>
<thead>
<tr>
<th>FAULT</th>
<th>CAUSE</th>
<th>CORRECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROLLER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controller unstable</td>
<td>a Interference of parts</td>
<td>a Adjust clearance or replace parts as necessary</td>
</tr>
<tr>
<td>Unit has insufficient sector</td>
<td>a Hinges out of alignment</td>
<td>a Reset hinge alignment (page 12 steps 1-6)</td>
</tr>
<tr>
<td>plate adjustment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain adjustment rough and</td>
<td>a Bearing adjustment</td>
<td>a Disassemble and adjust bearings (page 9)</td>
</tr>
<tr>
<td>unrepeatable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bellows cannot be matched</td>
<td>a Hinges out of alignment</td>
<td>a Reset hinge alignment (page 12 steps 1-6)</td>
</tr>
<tr>
<td>Controller Inoperable</td>
<td>a No air supply</td>
<td>a Check supply connection</td>
</tr>
<tr>
<td></td>
<td>b Vane not touching nozzle</td>
<td>b Position vane for light pre load</td>
</tr>
<tr>
<td></td>
<td>c Dirty air supply</td>
<td>c Replace booster and blow out lines</td>
</tr>
<tr>
<td></td>
<td>d Derivative switch is closed</td>
<td>d Check position of derivative switch</td>
</tr>
<tr>
<td>Nonlinearity</td>
<td>a Hinges out of alignment</td>
<td>a Reset hinge alignment (page 12 steps 1-6)</td>
</tr>
<tr>
<td></td>
<td>b A B bellows not matched</td>
<td>b Match bellows (page 12, see &quot;Aligning the Controller&quot;)</td>
</tr>
<tr>
<td>Poor Sensitivity</td>
<td>a C D bellows not matched</td>
<td>a Match bellows (page 12, see 'Aligning the Controller&quot;)</td>
</tr>
<tr>
<td></td>
<td>b Leak in output line</td>
<td>b Check and repair line</td>
</tr>
<tr>
<td>Set Point changes with integral adjustment</td>
<td>a Leak beyond integral valve (C bellows)</td>
<td>a Check and repair line or bellows</td>
</tr>
<tr>
<td>Integral Time not equal in both directions</td>
<td>a Leak beyond integral valve (C bellows)</td>
<td>a Check and repair line or bellows</td>
</tr>
<tr>
<td>Derivative Time not equal in both directions</td>
<td>a Leak beyond derivative valve (D bellows)</td>
<td>a Check and repair line or bellows</td>
</tr>
<tr>
<td>BOOSTER RELAY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Booster unit output pressure</td>
<td>a Clogged nozzle orifice</td>
<td>a Clean nozzle orifice</td>
</tr>
<tr>
<td>does not immediately increase</td>
<td>b Leakage around sections of</td>
<td>b Torque four screws (Figure 19) clamping sections together to 30 in lb. If leakage continues, replace all diaphragms and O rings (see Troubleshooting)</td>
</tr>
<tr>
<td>when flow of air is blocked</td>
<td>Booster casing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c Dirty filters</td>
<td>c Remove and replace filters</td>
</tr>
<tr>
<td></td>
<td>d Booster calibration incorrect</td>
<td>d Check Booster calibration (see Aligning the Controller&quot;) on page 12</td>
</tr>
<tr>
<td>Booster output sluggish or</td>
<td>a Leakage present between</td>
<td>a Replace all diaphragms and O rings as outlined under &quot;Troubleshooting&quot;</td>
</tr>
<tr>
<td>output increases then drops</td>
<td>chambers 2 and 3 (Figure 17)</td>
<td></td>
</tr>
<tr>
<td>to zero when flow of air is</td>
<td>b Dirty filters</td>
<td></td>
</tr>
<tr>
<td>blocked</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Booster unit output pressure</td>
<td>a Blocked air line from</td>
<td>a Remove line and clean</td>
</tr>
<tr>
<td>does not immediately decrease</td>
<td>Booster unit to nozzle</td>
<td></td>
</tr>
<tr>
<td>when vane is pulled away from</td>
<td>b Booster calibration</td>
<td>b Check Booster calibration (see &quot;Aligning the Controller&quot;) on page 12</td>
</tr>
<tr>
<td>nozzle</td>
<td>incorrect</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c Internal leakage between</td>
<td>c Replace all diaphragms and O rings as outlined under &quot;Troubleshooting&quot; on page 9</td>
</tr>
<tr>
<td></td>
<td>chambers 3 and 4 (Figure 17)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output pressure remains at</td>
<td></td>
</tr>
<tr>
<td></td>
<td>value of supply pressure</td>
<td></td>
</tr>
</tbody>
</table>
3. Remove rear manifold (22).

NOTE. Be sure to remove bolts attaching gain adjustment arm assembly to manifold.

4. Rotate gain adjustment arm (38) and draw arm from assembly.

5. Remove nozzle arm (38) from pivot support

6. Clean bearings in upper (35) and lower (37) bearing plates with solvent. Both bearings must turn freely and without excessive free play. Add a light grease to bearings. Lubricate O rings lightly with silicone grease.

7. Install nozzle arm assembly (38) in upper bearing plate (35). Add lower bearing plate (37) with two screws. Screws should not be fully tightened.

8. Place entire pivot support in a vise. Rotate nozzle arm 90 degrees. If nozzle arm turns smoothly, tighten screws (18). If nozzle arm rotation encounters a tight spot, tap lower bearing plate (37) lightly with a hammer. Direction of tapping should be perpendicular to nozzle pivot shaft and such that axis of this shaft is shifted. Repeat bearing plate adjustment until nozzle arm turns freely. Tighten screws (18) and recheck for binding.

BOOSTER RELAY

It is recommended that the Booster Relay portion of the Transmitter be returned to the factory for repair, since realignment of the diaphragm clamping assembly and the required recalibration is extremely critical. However, if field repair is necessary, follow the procedure outlined below.

Replacing Booster Unit Diaphragm and O Ring (Figure 19)

1. Remove Booster from Transmitter.

2. Remove four screws (19) in cover (20) and remove cover.

3. Remove base (28) and spring (10).

4. To disassemble base (28):
   a. Remove valve cap (14) and O ring (22).
   b. Turn base over and let upper valve seat (13) and upper seat spring (11) fall out of base.
   c. Remove valve adjustment screw (12) from valve cap (14) by turning screw clockwise until threads disengage.

5. Hold clamp plate (5) with fingers. With other hand, pull exhaust section (3) away from clamp plate, permitting diaphragm to slip thru center of exhaust section. Remove nozzle section (2) in the same manner by pulling section away from lower seat (8).

6. To disassemble diaphragm assembly (5, 6, 7, 8), remove four screws (18) from clamp plate (5) and carefully pull sections apart.

7. Reassemble the unit in reverse order to disassemble, observing the precautions outlined below. Note that the four sections of the Relay (items 5, 6, 7, 8) are a projecting line on one face to serve as an alignment and reassembly guide.

8. Reassemble diaphragm assembly carefully to insure concentric alignment between diaphragms (17) and metal parts (5, 6, 7, 8). Apply Locitite Grade D (Locitite Corporation, Newington, Connecticut) cement to threads of four screws (18) before inserting in threaded holes. (Do not use sealing cement between diaphragms and metal parts.) Tighten screws evenly and gradually to a final torque of eight in lb.

9. To reassemble nozzle section (2) and exhaust section (3), slip diaphragm (17) thru center hole of applicable section. Assemble so that indented sides of nozzle and exhaust sections face each other. Make sure that projecting lines on outside faces are aligned.

10. Assemble base (28), spring (10), and cover (20) in subassembly completed in steps 8 and 9. Press sections of Relay together firmly with hands. Make sure that projecting lines on all four sections are aligned.

11. With parts 9 and 11 thru 14 removed from base (28), observe alignment between seat (8) and hole in bottom of base (28). Exhaust valve seat in Item 8 should be centered under hole in base (28). If not, align parts as follows:

12. Remove base (28) and reposition diaphragm assembly (5, 6, 7, 8) slightly to obtain concentricity (Separate Relay sections 20, 2, 3 slightly so that diaphragms are free to move when position of diaphragm assembly is changed.)

13. Reassemble base (28) and spring (10) to subassembly. Recheck alignment and reposition diaphragm assembly if necessary.
14. Press Relay sections (20, 2, 3, 28) together firmly. Make sure that projecting lines on all four sections are aligned. Insert four screws (19) thru sections, and tighten screws evenly and gradually to a full torque of 30 in lb.

15. Reassemble spring (11), upper valve seat (13), and valve stem (9) in base (28). Replace valve adjustment screw (12) in valve cap (14), and reassemble valve cap (14) in base (28).

16. Booster Relay must now be recalibrated as outlined under "Aligning the Controller". page 12.

ALIGNING THE CONTROLLER

If the Type AD Pneumatic Controller has been disassembled for any reason, or the factory calibration has been disturbed, or the Controller cannot be correctly adjusted as outlined under "Placing in Service", the Controller must be completely recalibrated as outlined below.

NOTE: The Controller should be calibrated in the same position as that of final installation. Recommended mounting is shown in Figure 1.

Complete Calibration Procedure

1. Attach Controller to mounting base. Connect output "O" to a gage. Connect supply pressure, 30 psig for 3 to 27 psig range. 18 psig for 3 to 15 psig range.

2. Open derivative switch or valve of derivative plug in unit. Close integral switch or valve of integral plug in unit. (See Figure 4.)

NOTE: If integral or derivative plug-in units are employed, valve will be "open" or "closed" when adjusting screw is turned to full clockwise or counterclockwise position respectively.

3. Place direct reverse switch in "D" position, place proportional proportional plus in integral switch in P+1 position (See Figure 5.) Plug E3R connection.

4. Apply midrange pressures to E1, E2, and E3 connections. 15 psig for 3 to 27 psig range. 9 psig for 3 to 15 psig range. Turn on supply air.

5. Set gain at 1.0. Adjust A B and or C D sector screws (Figure 7) to obtain an output equal to midrange pressure.

6. Beam hinges should be aligned with hinges on tie plate (see Figure 7). If not, adjust beam position with A B and or C D bias screws until proper alignment is obtained. (This will necessitate readjusting A B and or C D sector screws to regain midrange output pressure.)

7. Connect output connection "O" to E2 and to an indicating gage. Connect separate variable inputs to E1 and E3. Turn E3R input to E3 if calibration is being performed with integral plug-in unit in place.

8. Open integral switch or valve of integral plug in unit. Close derivative switch or valve of derivative plug in unit.

9. Remove pressure from E3. Unlock set screws retaining C and D bellows (Figure 7) and rotate bellows with bellows matching screws until eccentricity marks are located toward front of Controller.

10. Set gain adjustment pointer at line across scale below gain of 1. Adjust pressure to 1 E1 connection to midrange value. Adjust C D sector screw to provide midrange output pressure.

11. Apply pressure from minimum to maximum range to connection E3 while noting output pressure. Remove pressure from E3 connection.

12. If output increased, rotate C and D bellows clockwise by equal amounts. If output decreased, rotate counterclockwise by equal amounts. Do not exceed 90 degrees rotation of either bellows.

13. Repeat steps 11 and 12 until output change is less than 1.0 psig Apply pressure to E3 connection and lock bellows with set screws.

14. Repeat step 11. If output increases rotate C D bias screw clockwise. If output decreases, rotate screw counterclockwise.

15. Repeat steps 11 and 14 until output change is less than .5 psig. If more than 1.2 turn of C D bias screw is required, return screw to original position, unlock C and D bellows and repeat steps 11 thru 15.)
FIGURE 7  Type AD Pneumatic Controller Adjustments
16. Tee connection E1 to E2 and connect to a variable input pressure and gage. Connect a variable input pressure and gage to E3. Plug E3R.

17. Open derivative switch or valve of derivative plug-in unit. Close integral switch or valve of integral plug-in unit.

18. Unlock set screws retaining A and B bellows (Figure 17) and rotate bellows until eccentricity marks are toward front of Controller.

19. Set gain mechanism at line across gain scale above 20. Adjust pressure to E3 Connection to midrange value. Adjust A-B sector screw to provide a midrange output pressure.

20. Apply pressure from minimum to maximum range to connection E1 while noting output pressure. Remove pressure from E1 and E2.

21. If output increased, rotate A and B bellows counterclockwise by equal amounts. If output decreased, rotate clockwise by equal amounts. Do not exceed 90 degrees rotation of either bellows.

22. Repeat steps 20 and 21 until output pressure change is less than 1.0 psig. Apply pressure to E1 and E2 and lock bellows.

23. Repeat step 20. If output pressure increases, rotate A-B bias screw clockwise. If pressure decreases, rotate counterclockwise.

24. Repeat steps 20 and 23 until output change is less than 5 psig. (If more than 1/2 turn of A-B bias screw is required, return screw to original position, unlock A and B bellows and repeat steps 20 thru 24.)

25. Controller is now ready to be adjusted in accordance with procedure outlined under "Placing in Service" on page 7.

**Integral Valve Dial Range**

The integral valve setting is adjusted by turning the adjustment screw beneath the dial indicator. The dial is graduated on one side for a range of .05 to 25 repeats per minute. The opposite side is calibrated from 15 to 100 repeats per minute. To change the indicating scale range:

1. Set indicating dial to 15 repeats per minute by turning integral adjusting screw

2. Remove "E" retaining ring which holds indicating dial in place.

3. Remove indicating dial, turn and replace dial to read 15 repeats per minute on reverse side.

4. Replace "E" retaining ring to hold in place.

**Booster Relay Calibration**

The Booster Relay has only one adjustment. The valve adjustment, shown in Figures 8 and 9, adjusts the inlet valve seat to balance the effective areas of the chamber 1 and chamber 4 diaphragms to obtain an even rate of output pressure change. This adjustment is sealed with a drop of Loctite cement (Grade C) after factory calibration. Do not change the setting of this adjustment unless absolutely necessary if the Relay has been disassembled, or if the setting of the valve adjustment has been changed for any reason. Check the calibration of the unit as outlined below.

1. Remove Booster Relay from instrument.

2. Attach calibration block, Part Number 5320549 2, to Relay using screws removed in step 1, and connect in calibration setup as shown in Figure 8. Connect mercury manometer to Booster Relay output pressure connection on calibration block. Connect another mercury manometer to tee fitting in piping to input connection of calibration block.

3. Apply supply pressure of 30 psig for 3 to 27 psig range (18 psig for 3 15 psig range) to Booster Relay supply pressure connection on calibration block.

4. Slowly apply about 2 psig to calibration block input connection to simulate nozzle back

---

**FIGURE 8 - Booster Relay Calibration Setup**
pressure. Note value of pressure (on nozzle back pressure manometer) at which output pressure increases at a constant rate. Slowly reduce nozzle back pressure and note nozzle pressure at which output pressure decreases at a constant rate.

a. If rate of output pressure rise slows down (decelerates), turn valve adjustment screw clockwise a small amount.

b. If rate of output pressure rise speeds up (accelerates), turn adjustment screw counter clockwise a small amount.

5. Repeat step 4 above until output pressure changes at a constant rate. The difference between the nozzle back pressure which causes a constant rise and that which causes a constant drop should be less than 0.1 psi and should occur between 1.6 psi and 2.5 psi.

6. If Booster Relay cannot be calibrated as described above, fault may be caused by leakage. Refer to "Troubleshooting" to check Booster Relay for leakage.
FIGURE 11 Tubing Connections and Switch Settings for Special Applications of the Type AD Controller

DEAD BAND SWTCH (WHEN G>1)
DIFFERENTIAL GAP CONTROLLER (WHEN G<1)
HOW THE CONTROLLER OPERATES

The amplification of the output pressure is dependent upon the gain setting of the unit.

With the input pressure applied only to the B bellows (either directly thru connection E2 or thru E1 with the direct reverse switch in the "R" position), the Controller transmits an output pressure proportional to the input pressure, but acting in the opposite direction. The amplification of the output pressure is dependent upon the gain setting.

Inputs to the C bellows are used only for totalizing, subtracting, or averaging functions (see Table A). Whenever integral control action is employed, the C bellows will not have a separate input but will receive the D bellows pressure thru a throttling valve. Inputs to the C bellows are unaffected by the gain setting.

The D bellows, rather than having an individual input signal, is connected directly to the Booster Relay output pressure (feedback).

With input pressures applied to more than one bellows of the Controller, the output pressure is the algebraic sum of the resultant forces on the A, B, and C, D balance beams. Pressures applied to the A and C bellows act in the same direction and a totalizing function is obtained. Pressures applied to the A and B bellows (or the C and D bellows) act in opposition (different function) and the output pressure is proportional to their difference. The change in output pressure from the Controller for given input pressure changes is determined as follows:

\[ \Delta D = \text{Gain Setting} \times (\Delta A + \Delta B + \Delta C) \]

Where

- \( \Delta D \): output pressure change
- \( \Delta A \): input pressure change to A bellows
- \( \Delta B \): input pressure change to B bellows
- \( \Delta C \): input pressure change to C bellows

Integral Control Action

Integral action is accomplished by means of a volume chamber and adjustable throttle valve unit plugged into the air line between the C and D bellows (see Figure 13).
FIGURE 13 Arrangement for Integral Control Action

The speed at which the integral action takes place is determined by the throttle valve setting and is expressed as the integral rate in repeats per minute. The plug in integral unit provides an integral rate from 0.5 to 100 repeats per minute.

Derivative Control Action

Derivative action is accomplished by a unit containing a spring-loaded bellows enclosed in a volume chamber (Figure 14) which is plugged into the line between the Booster Relay and the D bellows.

The restriction (throttle valve) between the Booster Relay and the D bellows causes an initially amplified output pressure change. The amplified output pressure returns to normal as the volume chamber pressure bleeds to the D bellows. The throttle valve setting determines the time interval required for the accelerated output signal to return to normal. The plug in derivative unit provides a derivative time of .1 to 10 minutes.

FIGURE 14 Arrangement for Derivative Control Action

FIGURE 15 Arrangement for Floating Control Action

Floating Control Action

Floating control action (pure integral) is accomplished by taking the output pressure from the C instead of D bellows in any controller with proportional plus integral action (see Figure 15). This provides a slowly increasing output pressure which will continue to increase until the controller has stabilized with equal pressures in the A and B bellows.

Gain Setting

Gain is the ratio of the resulting output pressure change for a given change in input pressure.

\[
\text{Gain} = \frac{\text{change in output pressure}}{\text{change in input pressure}}
\]

The gain mechanism of the Controller is shown schematically in Figure 16. The actual components of the gain mechanism are shown in Figure 7. The amount of gain for any given position of the gain adjustment arm is the ratio of distance L1 to L2. If the nozzle and vane assembly is positioned near the A B bellows end of the sector plate, a small change in A B bellows pressure will require a large change in output pressure to rebalance the Controller. With the nozzle and vane positioned near the C D bellows end of the sector plate, the same input pressure change to the A B bellows will produce a smaller output pressure change.

The gain of the Controller can be varied from .2 to 20 by sliding the gain arm along the gain indicating scale (Figure 7). A 10 psi change in input pressure will produce a 1 psi change in output pressure.
output pressure at the lowest gain setting. At
the highest gain setting, a 1 psi change in in-
put pressure will produce a 20 psi change in
output pressure.

Null Balance

The controller is "nulled" when the sector
plate is made parallel to the balance beams
with the required "null pressures" applied to the
controller. This is accomplished by proper ad-
justment of the controller as described under
"Placing in Service" on page 7. At null balance
the gain mechanism can be shifted through
range without causing a change in output pressure
since as a result of the parallel alignment with
null pressures applied, no change in vane
angle data occurs over full travel of the
gain mechanism.

The required "null pressures" depend upon
the individual control system and must be
selected before attempting to calibrate the
controller.

Booster Relay Operation

A schematic operating diagram of the
Booster Relay is shown in Figure 17.

Three diaphragms divide the inside of the
unit into four air pressure chambers. The di-
aphragms move together since they are clamped
at their centers by the diaphragm assembly.
Since chambers 1 and 4 are connected and are
equal in effective diaphragm area, their oppo-
sing forces on the diaphragm assembly balance
out. Chamber 2 is open to atmosphere. The
operator spring exerts a force downward on the
diaphragm assembly. Thus, since chamber 3 pressure exerts a force upward, the position of the diaphragm assembly is a direct function of chamber 3 pressure.

Supply air enters chamber 3 and the nozzle thru a pressure reducing orifice. The rate of air flow from the nozzle determines the magnitude of the pressure in chamber 3. At balance, this pressure is about 2 psig, which is the pressure required to balance the downward force of the operator spring.

When the measured variable increases, linkage from the measuring element moves the vane closer to the nozzle tip, retarding the flow of air from the nozzle and increasing the pressure in chamber 3. The pressure increase moves the diaphragm assembly up, opening the inlet valve and closing the exhaust valve. Supply air enters chamber 1 thru the inlet valve, causing the output pressure of the Booster Relay to begin to increase.

Chamber 1 pressure is also applied to the restoring bellows. As the pressure increases the restoring bellows extends, moving the vane away from the nozzle. The resultant increased rate of air flow from the nozzle causes the pressure in chamber 3 to begin to decrease.

Chamber 1 pressure will continue to increase until the vane is restored to that position with respect to the nozzle which produces a pressure of 2 psig in chamber 3. The operator spring by ther has moved the diaphragm assembly down to its original position, closing the inlet valve and causing the Booster Relay output pressure to stabilize at the new increased value.

When the measured variable decreases, the operation of the Booster Relay as described above is reversed.

### EXPLANATION OF NOMENCLATURE

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<th>Type (A, D)</th>
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<td>1 3 to 15 psig</td>
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<td>2 3 to 27 psig</td>
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<th>Mode</th>
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<td>2 Proportional plus Integral</td>
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<td>3 Proportional plus Integral plus Derivative</td>
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<td>4 Proportional plus Derivative</td>
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Nomenclature appears on the Controller Specification Sheet included in the Instruction Books furnished on system or contract jobs only. An "X" in any Nomenclature position indicates that the feature is special.
SPECIFICATIONS

OPERATING CONDITIONS

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<th>Influence</th>
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<th>Normal</th>
<th>Operative Limits</th>
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<td>Type AD200</td>
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*Air must be dry below 32°F

Ambient Temperature Effect

Supply Pressure Effect

0.02% per psi deviation from reference supply pressure

REFERENCE PERFORMANCE CHARACTERISTICS (% RANGE SPAN)

Accuracy (gain 1) . 0 %

Dead Band (gain 1) . 0 %

Drift (gain 20) (within first 3 hours) 1% (no change after 3 hours)

Hysteresis (gain 1) . 0 %

Linearity (gain 1) . 0 %

Reset Sensitivity (gain 1) . 0 %

Repeatability (gain 1) . 0 %

DESIGN DATA

Air Capacity (for 1 psi drop)

Output

Air Consumption (at balance on dead end service)

Case Classification

Gain Adjustment Range

Rate Adjustment Range

Reset Adjustment Range

Ambient Temperature Range of Operation

3 15 psig 3 27 psig

0 78 scfm 0 55 scfm

0 68 0 64 scfm

0 11 scfm NEMA Type 2 (Weatherproof)

0 2 to 20

0 1 to 10 minutes

0 05 to 100 repeats, min

40°F to 140°F

REPLACEMENT PARTS

Spare Parts Kit

The Spare Parts Kits shown in Figures 18 and 19 should be carried in stock. Specify the Spare Parts Kit part number to order a complete kit.

Ordering Individual Parts

A Parts Drawing for the Type AD Controller is shown in Figure 18. Normally this drawing will apply to the units furnished. However, there may be individual differences in specific units because of:

a. Design changes made since the printing of this Instruction Section.

b. Special design of the AD Controller furnished to make it suitable for special applications.

Therefore, when ordering parts, assure the receipt of correct replacements for the Controller by specifying on the order:

1. The complete nomenclature (stamped on instrument nameplate) of the Controller for which parts are desired.

2. The Parts Drawing on which each part is illustrated. (The Parts Drawing Number is given in the title for the Figure.)
### Table: Type AD Pneumatic Controller

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**NOTE** SPECIFY CODE LABEL NUMBER WHEN ORDERING PARTS

Reset Booster Relay Assembly, Pt No 5319700 5
Product Warranty

Bailey Meter Company warrants the products manufactured by it to be free from defects in material and workmanship and will repair or replace, at its option, free of charge, f.o.b. its factory, such part or parts which prove defective within one year from date of shipment. In respect to any products which are not an integral part of a product manufactured by the Company, the warranty given by the manufacturer thereof shall apply.

Shipping Damage

We strongly recommend that you inspect and test your instrument as soon as you receive it. If the instrument is damaged or operates improperly, notify the carrier for inspection of the shipment. The carrier's claim agent will prepare a report of damage, a copy of which should be forwarded to your nearest Bailey District Office (see back cover for location). The District Office will then tell you how to have the instrument repaired or replaced.

Service

The Bailey Meter Company is vitally concerned that your Bailey instrument provides continued, fine performance. This instruction manual is designed to fully describe the correct installation, operation, and maintenance of your instrument under recommended conditions. If the need arises, factory-trained Service Engineers are on call for prompt, in-plant maintenance. Telephone or wire your nearby Bailey District Office to make arrangements for this service (see back cover for location and telephone number).

Replacement Parts and Supplies

Complete parts drawings and recommended spare parts kit information are included in this instruction manual. When replacement parts or supplies are required for maintenance of your Bailey instrument, contact your nearest Bailey District Office (see back cover for location). Always specify complete data on the instrument nameplate on your inquiry or order for parts. Common parts are available for shipment within 48 hours on a speed order basis.
BAILEY METER COMPANY DISTRICT OFFICES, U.S.A.

CALIFORNIA
San Francisco
Code 415
Phone 989 6140
Los Angeles
Code 913
Phone 283 1187

COLORADO
Denver
Code 303
Phone 757 5408

GEORGIA
Atlanta
Code 404
Phone 378 4348

ILLINOIS
Chicago
Code 312
Phone 427 7324

LOUISIANA
New Orleans
Code 504
Phone 488 0841

MASSACHUSETTS
Boston
Code 617
Phone 426 0465

MICHIGAN
Detroit
Code 313
Phone 357 0440

MINNESOTA
St. Paul
Code 612
Phone 645 7755

MISSOUR
Kansas City
Code 816
Phone 361 4902
St. Louis
Code 314
Phone 967 5532

NEW YORK
Buffalo
Code 716
Phone 839 8666
New York
Code 212
Phone 986 8770
Schenectady
Code 518
Phone 374 7991

NEW JERSEY
East Orange
Code 201
Phone 674 6830

NORTH CAROLINA
Charlotte
Code 704
Phone 334 9161

OHIO
Cincinnati
Code 513
Phone 281 0132
Cleveland
Code 216
Phone 851 8600

PENNSYLVANIA
Philadelphia
Code 215
Phone 664 3284
Pittsburgh
Code 412
Phone 921 6356

TEXAS
Dallas
Code 214
Phone 363 6295
Houston
Code 713
Phone 774 9605

WASHINGTON
Seattle
Code 206
Phone 324 9300

WISCONSIN
Milwaukee
Code 414
Phone 461 1310

BAILEY METER COMPANY LTD., CANADA

ALBERTA
Edmonton
Code 403
Phone 488 3436

BRITISH COLUMBIA
Vancouver
Code 604
Phone 731 3709

MANITOBA
Winnipeg
Code 204
Phone 943 1481

NOVA SCOTIA
Halifax
Code 902
Phone 455 0574

ONTARIO
Ottawa
Code 613
Phone 722 1373
Toronto
Code 416
Phone 444 8488

QUEBEC
Montreal
Code 514
Phone 489 3881

Bailey Meter Company
Wickliffe, Ohio 44092
In Canada: Bailey Meter Company Limited, Montreal, Canada