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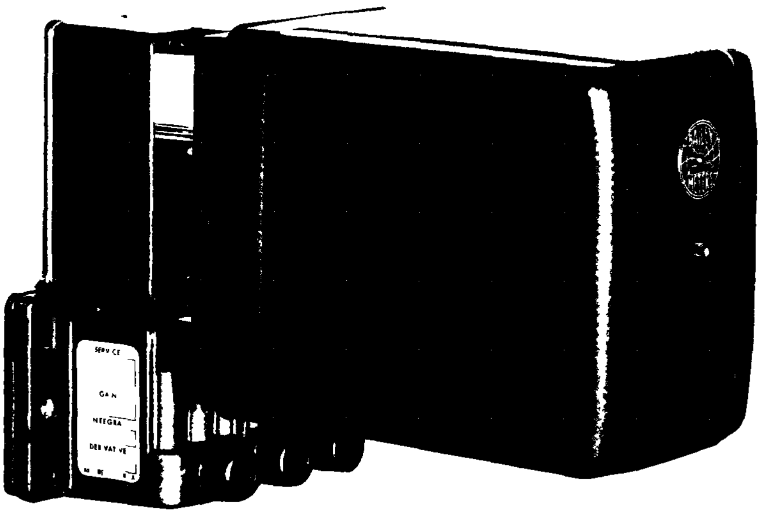
SECTION
P92-1-1

PRODUCT INSTRUCTIONS

MINI-LINE* 500 CONTROLLER
TYPE AD



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LIST OF ILLUSTRATIONS

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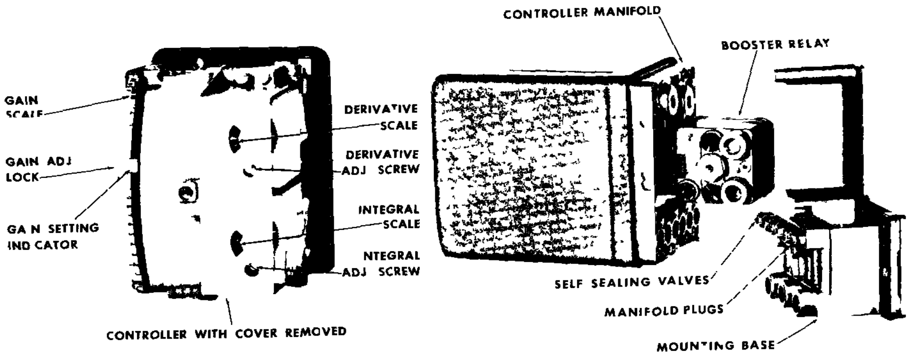


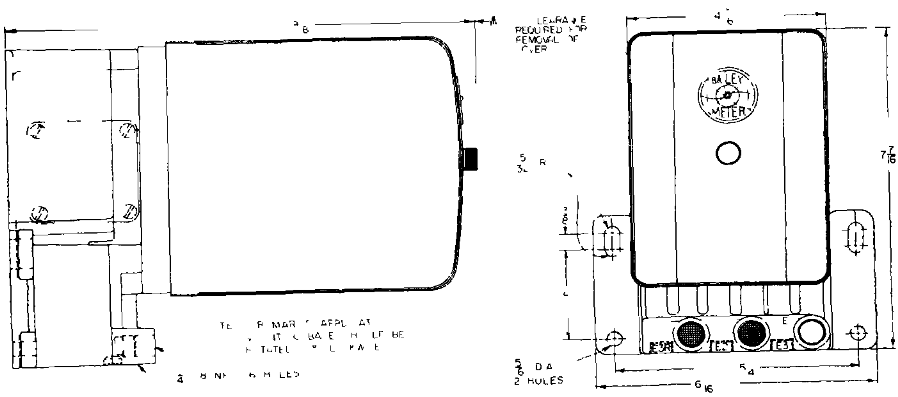


FIGURE 1 Type AD Pneumatic Controller Mounting Dimensions

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.

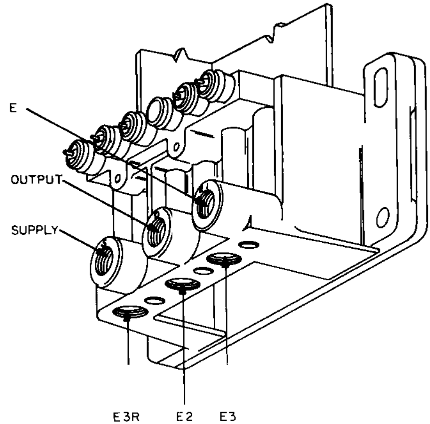


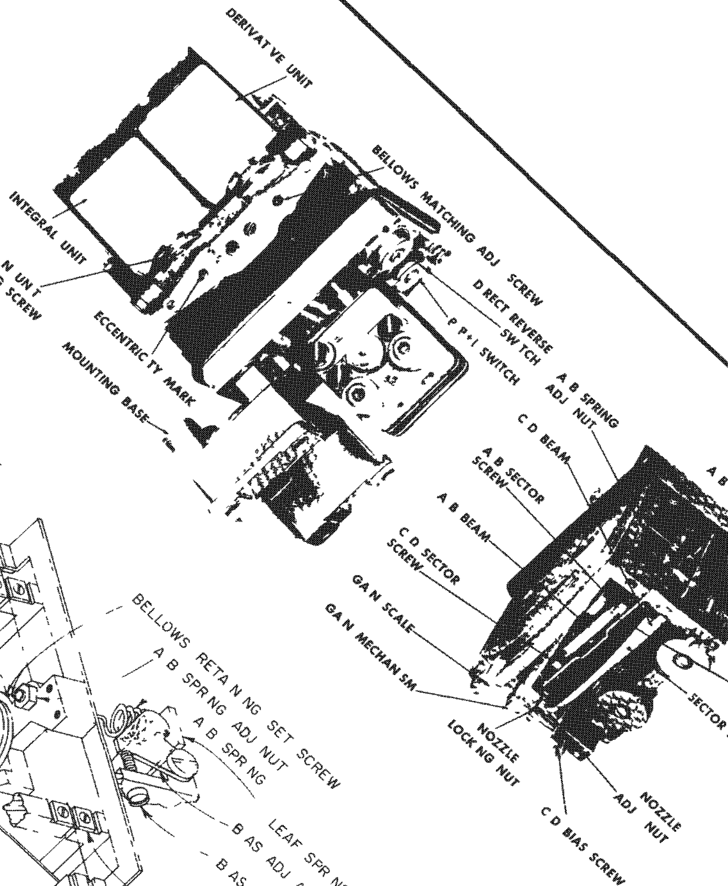
FIGURE 2 Input Output Connections

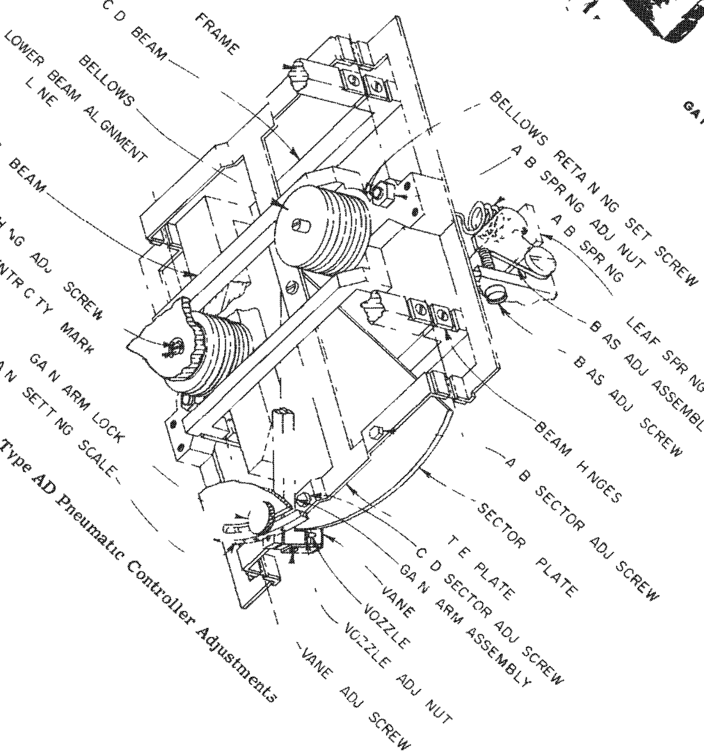
CONTROLLER FUNCTION OR ACTION*	MOUNTING BASE CONNECTIONS**					DISC SWITCHES (SEE FIGURE 5)		DISC SWITCHES (SEE FIGURE 4)		PLUG IN UNITS (SEE FIGURE 4)	
	E1	E2	E3	E3R	O	D R	P P+I	Int	Der	Int	Der
Direct Prop	Input	Vent	Vent	Vent	Output	D	P	Closed	Open	None	None
Reverse Prop	Input	Vent	Vent	Vent	Output	R	P	Closed	Open	None	None
Differential	Input	Input	Vent	Vent	Output	D	P	Closed	Open	None	None
2 Element Controller	Input	Input	Input	Vent	Output	D	P	Closed	Open	None	None
Totalizing	Input	Vent	Input	Vent	Output	D	P	Closed	Open	None	None
Signal (Range) Conversion	Input	Vent	Vent	Vent	Output	D	P	Closed	Open	None	None
Subtracting	Input	Vent	Input	Vent	Output	R	P	Closed	Open	None	None
Floating (Pure Integral)	Input	Vent	Output (1)	Plug	Plug (2)	D	P + I	None	Open	Closed	None
Differential Floating	Input	Input	Output (1)	Plug	Plug (2)	D	P + I	None	Open	Closed	None
Prop Plus Integral	Input	Vent	Plug (3)	Plug	Output	D	P + I	None	Open	Closed	None
◆ Diff Plus Integral	Input	Input	Plug (3)	Plug	Output	D	P + I	None	Open	Closed	None
Averaging Damped Input	Input	Vent	Plug	Input	Output	D	P	None	Open	Open	None
Prop Plus Derivative	Input	Vent	Vent	Vent	Output	D	P	Closed	None	None	Open
Diff Plus Derivative	Input	Input	Vent	Vent	Output	D	P	Closed	None	None	Open
Prop Plus Int Plus Der	Input	Vent	Plug (3)	Plug	Output	D	P + I (4)	None	None	Closed	Open
Diff Plus Int Plus Der	Input	Input	Plug (3)	Plug	Output	D	P + I (4	None	None	Closed	Open

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





Type AD Pneumatic Controller Adjustments

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 nulled 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 derevative 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 gain 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

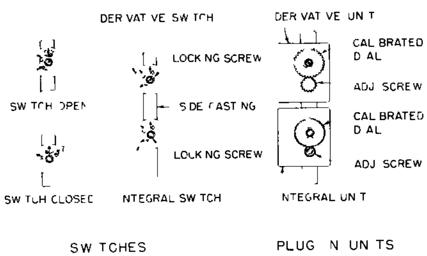


FIGURE 4 Integral and Derivative Switches and Plug in Units

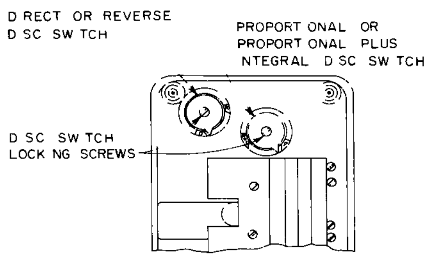


FIGURE 5 Controller Rear View Showing D R and P P+1 Switches

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 "Adjusting 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 derevative 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.

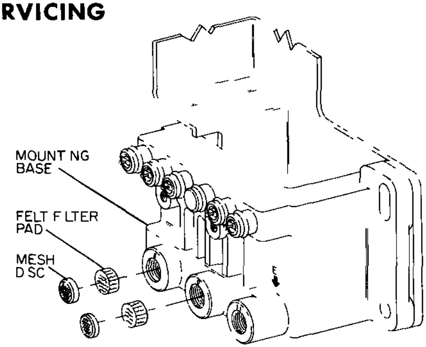


FIGURE 6 Replacing the Filter Pads

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).

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FAULT CORRECTION CHART

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

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 withdraw 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 20, 2, 3, and 28 in Figure 5) have 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 Loctite Grade D (Loctite 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) to 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 integral switch in P+I 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 Tee 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 E1 connection to midrange value Adjust C D sec*tor 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)

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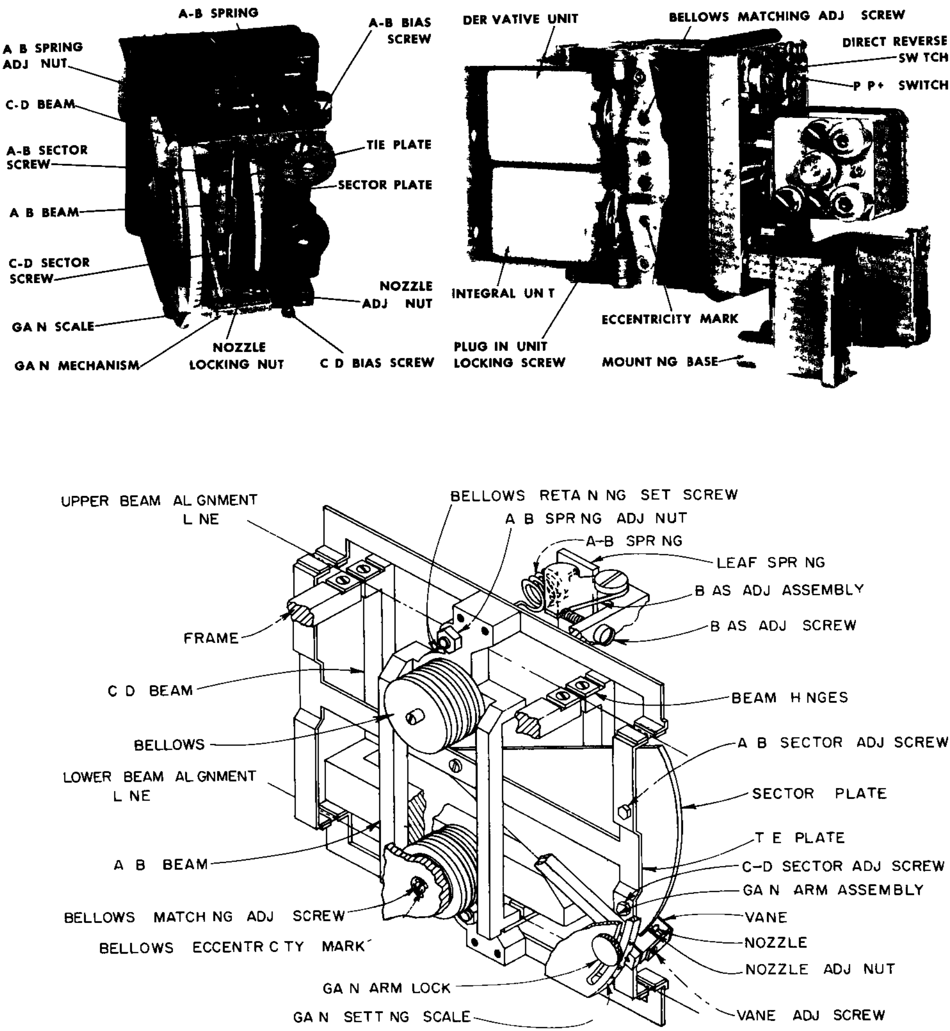


FIGURE 7 Type AD Pneumatic Controller Adjustments

16 Tee connection E1 to E2 and connect to a variable input pressure and gage. Connect a vari able input pressure and gage to E3. Plug E3R.

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

18. Unlock set screws retaining A and B bel lows (Figure 7) and rotate bellows until eccen tricity 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 bel lows 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 turn ing the adjustment screw beneath the dial indi cator. The dial is graduated on one side for a range of .05 to 25 repeats per minute. The op posite side is calibrated from 15 to 100 repeats per minute. To change the indicating scale range·

1. Set indicating dial to 15 repeats per min ute 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 mano meter to Booster Relay output pressure connec tion on calibration block. Connect another mer cury manometer to tee fitting in piping to input connection of calibration block.

3. Apply supply pressure of 30 psi 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 psi to calibration block input connection to simulate nozzle back

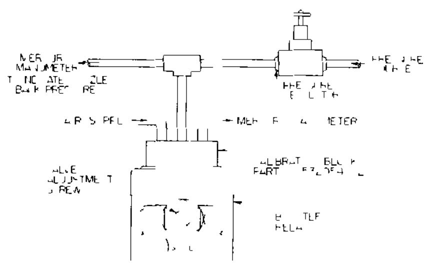


FIGURE 8 - Booster Relay Calibration Setup

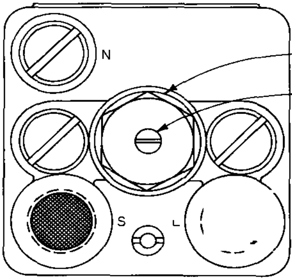


FIGURE 9 Booster Relay Adjustment

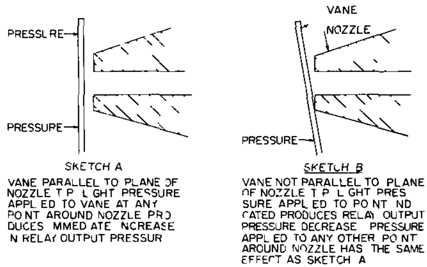


FIGURE 10 Vane-Nozzle Alignment

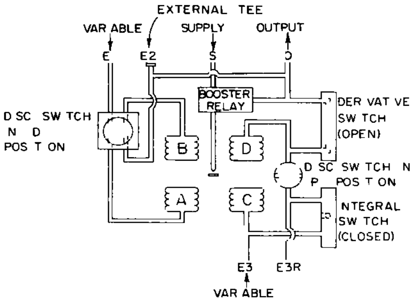
pressure. Note value of pressure (on nozzle back pressure manometer) at which output pressure increases at a constant rate. Slowly reduce nozzle back pressure and note nozzle pressure at which output pressure decreases at a constant rate

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 be tween 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 leak age. Refer to "Troubleshooting" to check Boost er Relay for leakage



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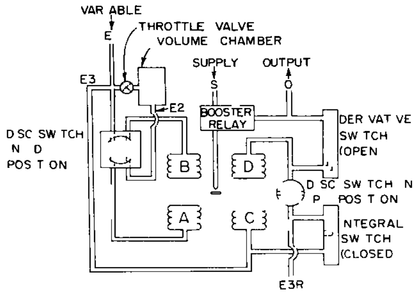
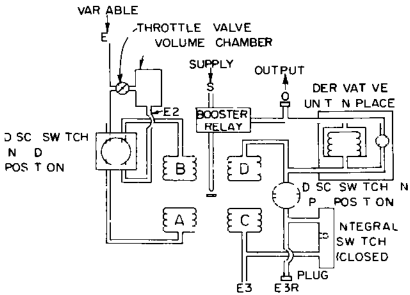
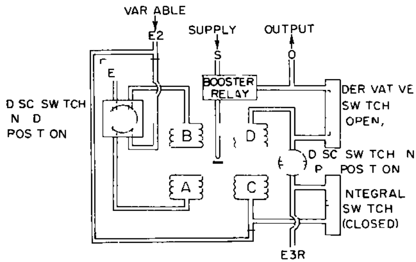


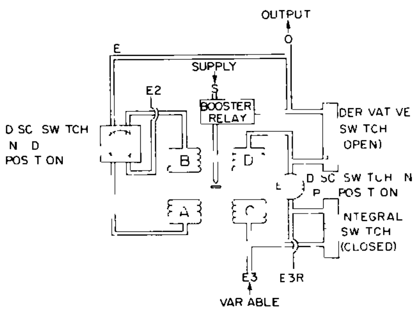
DER VAT VE, L M TED



D FFERENT AT ON, SECOND DER VAT VE



S GNAL RANGE CONVERS ON



DEAD BAND SW TCH (WHEN G > 1)
D FFERENT AL GAP CONTROLLER (WHEN G < 1)

FIGURE 11 Tubing Connections and Switch Settings for Special Applications of the Type AD Controller

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HOW THE CONTROLLER OPERATES

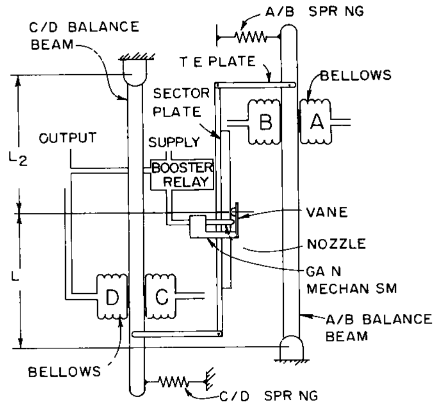


FIGURE 12 - Schematic of Type AD Controller

Refer to Figure 12. The sequence of operation begins with a change in input pressure to the bellows units which position the two balance beams. The resultant shift in balance beam alignment causes a change in the angle of the tie plate connecting the free ends of the balance beams. The tie plate supports a sector plate which positions the vane of the gain mechanism. The shift in vane to nozzle distance produces a nozzle back pressure change that is amplified and transmitted by the Booster Relay as an output pressure.

The Booster Relay also supplies the amplified pressure to the D bellows to eliminate the unbalance caused by the input pressure change and restore the vane and nozzle to their "at balance" distance.

The effect a given input pressure change has upon the output pressure depends upon the function for which the Controller is set, the gain setting of the unit, and the control actions employed. The following paragraphs explain the functions and control actions which can be provided by the Pneumatic Controller.

Controller Functions

With input pressure applied only to the A bellows, the Controller transmits an output pressure proportional to the input pressure. 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 (differential 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

$$\Delta D = \text{Gain Setting}\,(\Delta A - \Delta B) + \Delta C$$

Where

ΔD output pressure change
ΔA input pressure change to A bellows
ΔB input pressure change to B bellows
ΔC 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)

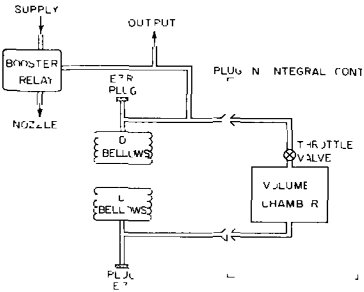


FIGURE 13 Arrangement for Integral Control Action

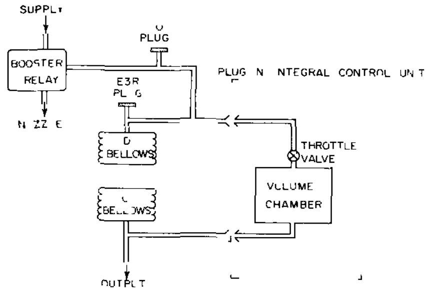


FIGURE 15 Arrangement for Floating Control Action

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 05 to 100 repeats per minute

Derivative Control Action

Derivative action is accomplished by a unit containing a spring loaded bellows inclosed in a volume chamber (Figure 14) which is plugged into the air 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.

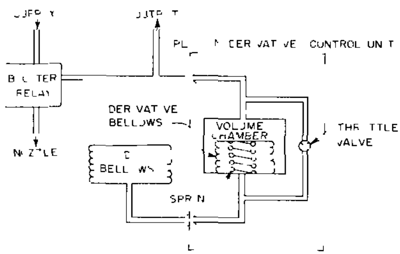


FIGURE 14 Arrangement for Derivative Control Action

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

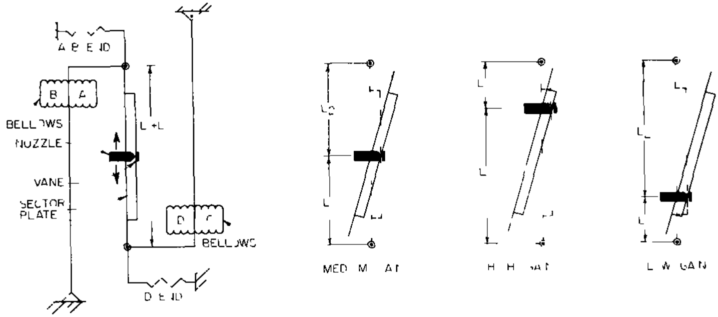


FIGURE 16 Schematic of Gain Adjustment

output pressure at the lowest gain setting At the highest gain setting, a 1 psi change in input 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 adjustment of the Controller as described under "Placing in Service' on page 7 At null balance the gain mechanism can be shifted thru full range without causing a change in output pressure since as a result of the parallel alignment with null pressures applied, no change in vane nozzle distance 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 diaphragms 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 opposing forces on the diaphragm assembly balance out. Chamber 2 is open to atmosphere The operator spring exerts a force downward on the

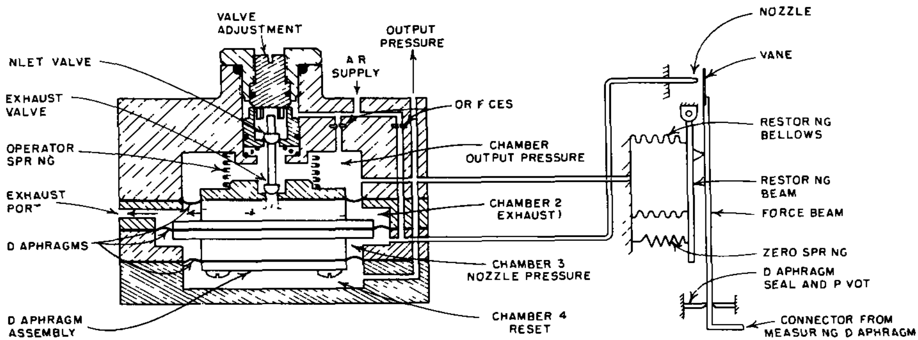


FIGURE 17 Schematic Operating Diagram of Booster Relay

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.

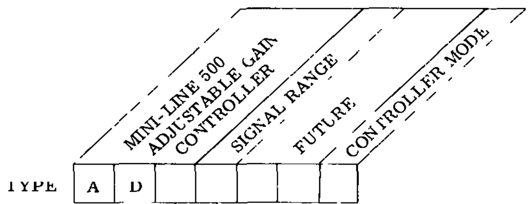
When the measured variable increases, linkage from the measuring element moves the vane closer to the nozzle tip, retarding the flow of air from the nozzle and increasing the pressure in chamber 3. The pressure increase moves the diaphragm assembly up, opening the inlet valve and closing the exhaust 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 then 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



0	Without Manifold
5	With Manifold

1	3 to 15 psig
2	3 to 27 psig

1	Proportional Only
2	Proportional plus Integral
3	Proportional plus Integral plus Derivative
4	Proportional plus Derivative

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

Influence		Reference	Normal	Operative Limits
Ambient Temperature		75F	40F to 140F	20F* to 180F
Supply	Type AD□100□	18 psig ±2%	16 to 20 psig	25 psig max
Pressure	Type AD□200□	30 psig ±2%	28 to 35 psig	40 psig max

*Air must be dry below 32F

Ambient Temperature Effect . . 0% error at 75F (Will not exceed 2% range span at any temperature between 40F and 140F)

Supply Pressure Effect . 0 02% per psi deviation from reference supply pressure

REFERENCE PERFORMANCE CHARACTERISTICS (% RANGE SPAN)

Accuracy (gain 1)	0 5%
Dead Band (gain 1)	0 01%
Drift (gain 20) (within first 3 hours)	1% (no change after 3 hours)
Hysteresis (gain 1)	0 5%
Linearity (gain 1)	0 5%
Reset Sensitivity (gain 1)	0 15% input range span to change output from min to max to min
Repeatability (gain 1)	0 25%

DESIGN DATA

	3 15 psig	3 27 psig
Air Capacity (for 1 psi drop)		
Exhaust	0 78 scfm	0 55 scfm
Output	0 68	0 64 scfm
Air Consumption (at balance on dead end service)	0 11 scfm	0 17 scfm
Case Classification	NEMA Type 3 (Weatherproof)	
Gain Adjustment Range	0 2 to 20	
Rate Adjustment Range	0 1 to 10 minutes	
Reset Adjustment Range	0 05 to 100 repeats/min	
Ambient Temperature Range of Operation	40F to 140F	

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)

Bailey

FIGURE 18 Parts Drawing P92 5

ITEM	PART NO	NAME
1		CODE LABEL SPECIFY NO ON LABEL
		WHEN ORDERING PARTS
2	5319700 5	BOOSTER ASSY
3	8 32x2 1 2	FIL HD SCR SST, 2 REQD
4	5320444 1	MOUNTING SCR, 3 REQD
5	10 32x1 2	FIL HD SCREW SST
		(SEE TABLE)
6	5320626 1	SHOULDER SCR, 2 REQD
7	5320646 1	SPRING
8	5320675 1	SPG ASSY FOR 3 27 PSIG
		RANGE, 2 REQD
9	5320676 1	SPG ASSY FOR 3 15 PSIG
		RANGE 2 REQD
10	5320627 1	SHOULDER SCR, 8 REQD
11	5322987 1	HINGE ASSY, 4 REQD
12	5323005 1	RET RING, 4 REQD
13	5320674 1	BELLOWS ASSY 4 REQD
14	5311428 3	O RING 4 REQD
15	5320640 1	TIE PLATE
16	5320652 1	VANE ADJ STUD 2 REQD
17	5320672 1	CONICAL SPG 2 REQD
18	10 32x5 8	FIL HD SCR SST, 4 REQD
19	5323030 1	NOZZLE LOCKNUT
20	5321579 1	INDICATING PANEL
21	5323004 1	O RING & GASKET SHEET
22	5321596 1	MANIFOLD ASSY
23	10 32x1	SOC HD SCR SST, 4 REQD
24	5322332 1	VANE ADJUSTMENT
25	5321468 1	BELLOWS BEAM, 2 REQD
26	197504 1	CONE PT SET SCR, 4 REQD
27	2 56x3 16	PAN HD SCR SST 4 REQD
28	5323720 1	ADJ INSERT
29	5320650 1	SECTOR PLATE
30	5321465 1	B D BELLOWS BASE
31	5321463 1	A C BELLOWS BASE
32	5320659 1	SPRING ADJ, 2 REQD
33	5320634 1	SPG ADJ PIVOT, 2 REQD
34	5320632 1	ADJ SCREW 2 REQD
35	5320647 1	UPPER BEARING PLATE
36	10 32x7 8	FIL HD SCR SST, 6 REQD
37	5322647 1	LOWER BEARING
38	5320712 1	NOZZLE ARM ASSY
39	4 40x1/4	FIL HD INT SEMS SST
		2 REQD
40	5322713 1	NOZZLE ARM SPG ASSY
41	5322333 1	VANE ASSY
42	5311428 10	O RING
43	5311428 2	O RING 7 REQD
44	5322650 1	LOCK KNOB
45	5320661 1	SPG ADJ NUT 4 REQD
46	5323006 1	GAIN SCALE
47	3 48x1 8	PAN HD SCR SST 2 REQD
48	4 40x5 16	PAN HD SST SCR 5 REQD
49	3 48x1/8	FLAT HD SCR SST 2 REQD
50	6 32x3 8	HEX IND CAP SCREW SST
		SEE NOTE
51	NO 10	REG SPR LKWASH SST
		18 REQD
52	5322337 1	NOZZLE
53	NO 6	REG SPR LKWASH SST
		SEE NOTE
55	4 40	HEX NUT SST
56	532172 7	SPRING WASHER 3 REQD
57	10 32	HEX NUT SST 2 REQD
58	5323017 1	RET RING 3 REQD
59	NO 8	REG SPR LKWASH SST
		2 REQD
60	5320639 2	CLAMP PLATE
61	532172 12	SPRING WASHER
62	5323028 1	DESIGNATION DECAL
63	5323028 2	DESIGNATION DECAL
64	5320657 1	PROP PROP + INTEGRAL
		VALVE ASSY
65	5320658 1	DIRECT REVERSE SWITCH
		ASSEMBLY
66	5320702 1	DERIVATIVE ASSY
		SEE TABLE
67	5322996 1	INT ASSY SEE TABLE
68	1961561 ☐	NAMEPLATE SPECIFY
		TYPE AND RANGE OF CONT
		FOR CORRECT ENGRAVING
69	5322979 1	INT & DERIVATIVE VALVE
		ASSY SEE TABLE
70	5320626 2	SHOULDER SCR 2 REQD
71	197507 1	RUBBER WASH 2 REQD
72	5323562 1	COVER INCL ITEMS 73
		THRU 78)
73	1064 4	RED FIBRE WASHER
74	5322994 1	COVER SCREW
75	197174 1	FLAT SPEED NUT
76	2 56x3 16	RD HD SST SCREW
77	196777 2	TRADE MARK
78	198173 16	RETAINING RING
		FOR WALL MOUNTED CONTROLLERS ONLY
80	5323021 1	MTG BASE ASSY (INCL
		ITEMS 81 THRU 85)
81	5324066 1	VALVE CORE 5 REQD
82	5320414 1	FELT PAD 4 REQD
83	5320413 1	WIRE MESH DISC 4 REQD
84	5322981 1	D CONNECTION PLUG
85	5311428 11	O RING GASKET 6 REQD

TABLE

TYPE	CONTROLLER ACTION	SPARE PARTS KIT PT NO	RANGE PSIG	ITEM 5	ITEM 66	ITEM 67	ITEM 64
AD02001	PROPORTIONAL	256131 1	3 27	4 REQD			2 REQD
AD01001	ONLY	256131 2	3 15				
AD02002	PROP PLUS	256131 1	3 27	3 REQD		1 REQD	1 REQD
AD01002	INTEGRAL	256131 2	3 15				
AD02004	PROP PLUS	256131 1	3 27	3 REQD	1 REQD		1 REQD
AD01004	DERIVATIVE	256131 2	3 15				
AD02003	PROP PLUS	256131 1	3 27	2 REQD	1 REQD	1 REQD	
AD01003	INT AND DER	256131 2	3 15				

SPARE PARTS KITS PART NUMBERS

QTY	256131 1 3 27 PSIG RANGE ITEM NOS	256131 2 3 15 PSIG RANGE ITEM NOS
1 EA	7 21 40 42	7 21 40 42
2 EA	8 17	9, 17
4 EA	12, 13 82 83	12 13 82 83
6 EA	14 85	14 85
11	43	43

NOTE 1 EACH OF ITEMS 50 AND 53 ARE REQUIRED IF INTEGRAL OR DERIVATIVE ASSEMBLY (ITEM 66 OR 67) IS ADDED IN FIELD

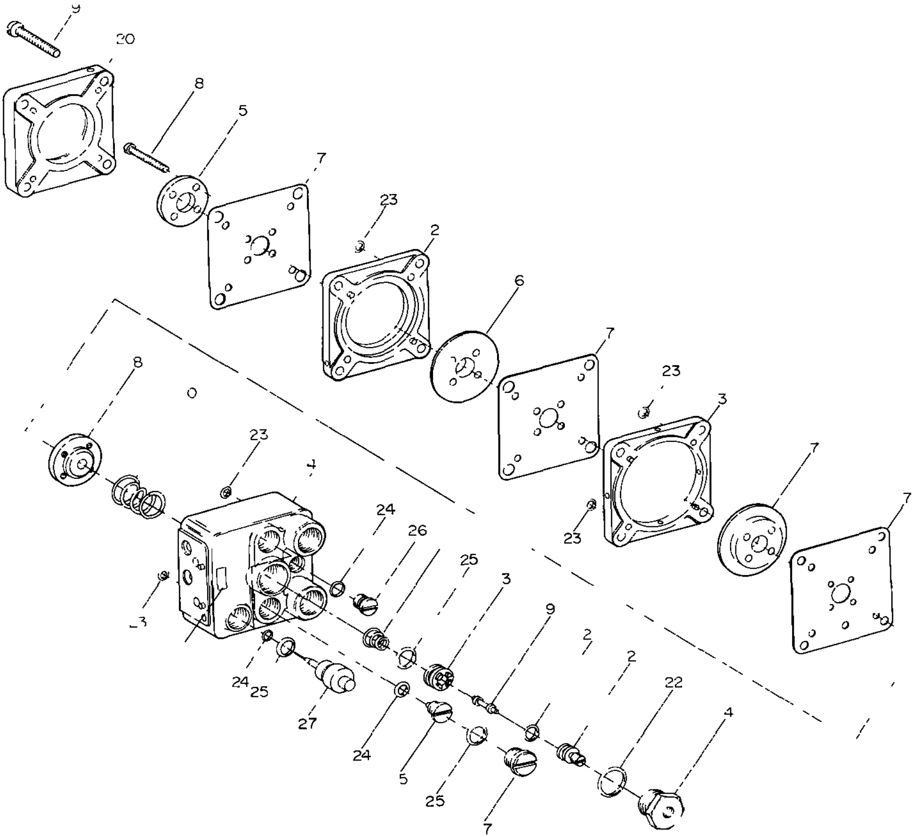


FIGURE 19 Parts Drawing P99 119

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ITEM	PART NO	NAME	ITEM	PART NO	NAME	ITEM	PART NO	NAME
1	SEE NOTE	CODE LABEL	12	5316808 1	VALVE ADJ SCREW	21	5311428 20	O RING
2	5319691 1	NOZZLE SECTION	13	5319698 1	UPPER VALVE SEAT	22	5311428 7	O RING
3	5324275 1	EXHAUST SECTION	14	5316809 1	VALVE CAP	23	5311428 10	O RING 7 REQD
4	5323282 3	BASE	15	5316464 1	ORIFICE ASSY 2 REQD	24	5311428 2	O RING 4 REQD
5	5319703 1	CLAMP PLATE	16	5318872 1	SEALING CAP	25	5311428 11	O RING 4 REQD
6	5319701 1	DIAPHRAGM CLAMP	17	5319704 1	DIAPHRAGM 3 REQD	26	5325527 1	PLUG
7	5319702 1	EXHAUST CLAMP PLT	18	4 40x3 4	LG PAN HD CD PL STL MACH SCR 4 REQD	27	5316478 1	ORIFICE CLEANOUT ASSY
8	5319699 1	LOWER SEAT	19	10 32x1 1	8 LG FIL HD STL MACH SCREW 4 REQD			
9	5319696 1	VALVE STEM	20	5319690 1	COVER			
10	5320156 1	LOWER SEAT SPRING						
11	5319705 1	UPPER SEAT SPRING						

NOTE SPECIFY CODE LABEL NUMBER WHEN ORDERING PARTS

Reset Booster Relay Assembly, Pt No 5319700 5

00 22 08 04 11 07

00 22 10 04 11 07

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 213 — Phone 283 1187

COLORADO

Denver, Code 303 — Phone 757 5408

GEORGIA

Atlanta, Code 404 — Phone 378 4348

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Chicago, Code 312 — Phone 427 7324

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Detroit, Code 313 — Phone 357 0440

MINNESOTA

St Paul, Code 612 — Phone 645 7752

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St Louis, Code 314 — Phone 962 5532

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New York, Code 212 — Phone 986 8770
Schenectady, Code 518 — Phone 374 7991

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Cincinnati, Code 513 — Phone 281 0132
Cleveland, Code 216 — Phone 851 8600

PENNSYLVANIA

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Pittsburgh, Code 412 — Phone 921 6356

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Ottawa, Code 613 — Phone 722 1373
Toronto, Code 416 — Phone 444 8488

QUEBEC

Montreal, Code 514 — Phone 489 3881